Te Whare Wānanga
o Awanuiārangi

PREVENTING MUSCULOSKELETAL DISORDERS IN THE MEAT PROCESSING INDUSTRY

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*A thesis presented to Te Whare Wānanga o Awanuiārangi in fulfilment of the requirements for the degree of Doctor Philosophy in Education,
Te Whare Wānanga o Awanuiārangi*

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Declaration

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This thesis has been stored at Te Whare Wānanga o Awanuiārangi. Therefore, it is available for future students and researchers to read and reference.

Hendrik Jacobus Pienaar

Signature:

Date: 11 August 2024

Acknowledgements

This research project is dedicated to my wife, Heidi, for her continuous support and encouragement … "It's a good time to work on your PhD." Without my family's support and understanding, I would not have been able to juggle family life, studies, and full-time employment throughout this challenging journey.

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Kia kaha, Kia māia, Kia manawanui

"I can do all things through Him who strengthens me."
Philippians 4:13 (AMP)

Thank you

Personal positioning

The researcher is an accredited Clinical Exercise Physiologist who has spent the past three decades treating and educating patients suffering from various musculoskeletal conditions. Back pain has been a large part of the researcher's journey, having suffered from unexplained chronic back pain for many years. The researcher holds a newly established position as the Musculoskeletal Injury Prevention Manager at Alliance Group. This role marks a shift from a reactive approach to injury treatment to a proactive strategy focused on injury prevention. The research is fuelled by a strong motivation and passion to discover enhanced approaches in musculoskeletal injury prevention. Its primary objectives are to develop more effective methods for preventing such injuries, educate and support individuals with musculoskeletal disorders, and offer improved treatment options for employees returning to work after sustaining an injury. Additionally, the research provides valuable recommendations on preventing these conditions, fostering overall wellness, and enabling individuals to lead more productive lives. Ultimately, the aim is to elevate the proficiency of the Musculoskeletal Injury Prevention Manager through the implementation of well-informed practices.

Abstract

Preventing Musculoskeletal Disorders in the Meat Processing Industry

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Keywords: musculoskeletal disorders, musculoskeletal injuries, meat processing industry, musculoskeletal injury prevention.

This thesis investigates the persistent high rates of musculoskeletal disorders (MSDs) within the Alliance Group Limited (AGL) meat processing facilities, aiming to develop a comprehensive MSD intervention strategy. The key objectives are identifying injury clusters, assessing effective interventions, understanding all known MSD risk factors, and identifying obstacles to MSD prevention at AGL. The study also aims to provide insights that could enhance MSD prevention across New Zealand's meat processing industry.

The research employs a mixed-methods approach, starting with an extensive literature review to identify risk factors, barriers, and effective interventions for MSDs in the meat processing industry. Secondary data analysis uses MS Excel to examine AGL's MSD incident data and identify statistical trends. Following this, focus group discussions are held with Health and Safety managers, advisors, and injury management staff to determine the most effective MSD prevention strategies. These strategies are then integrated through action research to identify new interventions for the industry.

The study's results confirm the predicted injury trends, offering new insights and expanding the current understanding of MSDs in the meat processing industry. The findings include a conceptual framework for preventing MSDs at AGL, outlining steps for developing an effective musculoskeletal injury prevention program. This framework can also be applied more broadly to the meat processing industry.

In conclusion, this research's multidimensional approach has significantly advanced our understanding of MSDs in the New Zealand meat processing industry, particularly at AGL. The

insights gained are expected to substantially influence future intervention strategies in the industry.

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Chapter 1 – Introduction

Accident Compensation Corporation (ACC) reports that musculoskeletal disorders (MSDs) have a higher incidence rate in the meat processing industry when compared to most other sectors; this position has seen little change over the past two decades (ACC, 2021). Many attempts have been made to reduce many injury-causing factors; in some areas, progress has been made, yet the injury rates are still unacceptable (Tappin, Vitalis, & Bentley, 2016). The purpose of this study is to review the existing literature, gather and analyse new injury data, and compare injury trends with successful musculoskeletal disorder (MSD) interventions. The collected information will support strategies to address MSD risk factors and prevent MSDs at Alliance Group (AGL).

The research described in this thesis focuses on identifying successful interventions that have been used or could be used in the future to prevent MSDs. According to the Centres for Disease Control and Prevention (CDC), MSDs is a term that is used to refer to a range of conditions that are often referred to as injuries or disorders of the muscles, nerves, tendons, joints, cartilage, and spinal discs (Centers for Disease Control and Prevention, 2020).

Professor Nadine Foster, affiliated with Keele University and the lead author of one of the papers focusing on the global burden of low back pain, emphasised the necessity of reducing the gap between the best evidence and its implementation in practice. She also highlighted the importance of redirecting funding towards strategies encouraging physical activity and enhancing overall functionality. "We also need to intensify further research of promising new approaches such as redesigning patient pathways of care and interventions that support people to function and stay at work." (University of Warwick, 2018, p. 1)

This chapter will focus on the research's background, aim, and purpose, define the research questions, and highlight its significance.

1.1 Background to the Study

Alliance Group (AGL) is New Zealand’s leading farmer co-operative, exporting lamb, beef, venison, and co-products to more than 65 countries worldwide. Their number one priority is ensuring their 5000 employees go home safely every day. AGL is committed to lifting its health and safety performance to world-class standards, part of its core business strategy. Employee care is at the heart of the company's values (Alliance Group Limited, 2021).

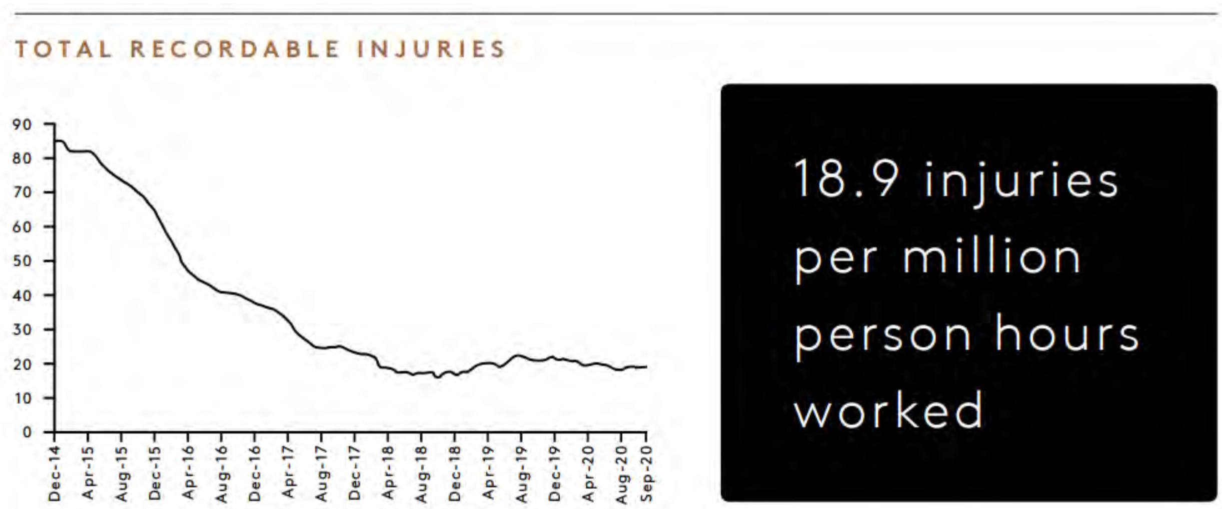
The highest number of injuries occurring in AGL are strains and sprains, reflecting the manual and physical nature of much of the activity at their meat processing plants. It is a challenging area to sustain improvement because people have different physical make-ups that respond differently to work. Alliance Group has developed a strategy to improve its performance in this area. As part of this, the cooperative appointed the researcher to the newly created position of Musculoskeletal Injury Prevention Manager (Alliance Group Limited, 2021).

As shown in Figure 1, AGL’s Total Recordable Injury Frequency Rate (TRIFR) vastly improved from approximately 85 (in December 2014) to 18.9 injuries per million person-hours worked across the seven meat processing plants AGL operates.

Figure 1 also shows a rapid decline in the TRIFR from December 2014 to April 2018, after which only minor changes are noted (Alliance Group Limited, 2021). To enable the researcher to be an effective Musculoskeletal Injury Prevention Manager at AGL, in-depth research will be required to find answers as to why this slowdown has occurred, which past interventions/strategies were effective, which barriers to MSD prevention exist, and which risk factors are responsible for MSD at AGL. The researcher's aim with this study will be to identify successful interventions, all known MSD risk factors, identify all barriers to MSD prevention, and to use this information to develop a systematic process that can be implemented as part of a strategy to reduce the incidence of MSD in the meat processing industry.

Figure 1.1

AGL Total Number of Recordable Injuries per Million Person-Hours Worked for the Period December 2014 to September 2020



Note. The image is sourced from Alliance Group's 2020 annual report, showing the improvement in reducing the Total Recordable Injury Frequency Rate (TRIFR). The rate has decreased significantly from 85 in December 2014 to the current 18.9 injuries per million person-hours worked across AGL's seven meat processing plants (Alliance Group Limited, 2021).

The researcher had access to an existing AGL database of MSD data to support the research (please refer to the letter of support – Appendix A). The database contained secondary data on the occurrence rates, location, and nature of MSDs over the past five years, encompassing seven meat processing plants and the corporate division, each with varying MSD rates. This data was statistically analysed to identify injury trends. Once the trends were identified, the researcher conducted a focus group discussion with all key Health and Safety managers and advisors, including all injury management personnel, to discuss variations between processing plants. It was envisioned that any differences found could provide answers regarding which interventions or injury prevention strategies might be more effective. The research participants included consenting individuals (over the age of 16 years) from all ethnic backgrounds, genders, and creeds who met the inclusion criteria. The research was conducted in New Zealand, primarily in the Southland region.

Therefore, the purposes of this study are:

1. To review existing literature on MSD risk factors, barriers to preventing MSDs, and industry interventions in the NZ meat processing sector.
2. To collect and analyse injury data from the AGL database, identifying and comparing injury trends, including risk factors and barriers to MSD prevention.
3. To utilise the research findings to develop a systematic approach to reduce MSD risk factors and prevent MSDs at AGL.

1.2 Aim and Research Questions

The primary aim of this study is to identify effective interventions and risk factors for MSDs, determine the barriers to MSD prevention at AGL, and use this data to create a systematic process for reducing MSD incidence. This process will benefit AGL and the wider New Zealand meat processing industry.

To achieve this aim, the researcher seeks to address the following questions:

1. What MSD risk factors are prevalent in the NZ meat processing industry?
2. What industry interventions are recommended for addressing MSDs in NZ meat processing?
3. What barriers to MSD prevention have been identified in NZ meat processing?
4. What MSD trends can be observed at AGL?
5. Which MSD prevention interventions have been effective at AGL?
6. What barriers to MSD prevention exist at AGL?

7. Which factors should be considered when developing a systematic MSD prevention program?

1.3 Research Hypothesis

Quality applied research efforts involve identifying a problem, searching, and reviewing relevant literature, followed by specifying and defining testable hypotheses (Thomas, Nelson, & Silverman, 2015). The researcher hypothesizes that a review of relevant literature and a study at AGL will identify risk factors for MSDs and successful interventions to prevent and manage MSDs at AGL and similar sites, in addition to facilitators/barriers to implement these at AGL.

These findings will be instrumental in developing a systematic MSD prevention framework for AGL.

1.4 Significance

This study is significant for several reasons. Firstly, it will inform best practices in developing a systematic MSD prevention program for AGL and the NZ meat processing sector. MSD in the meat processing industry comes at a significant cost, at a national level (ACC costs), at the organisational level (increased cost of production), and most importantly, to the injured individuals experiencing discomfort and pain. Finding answers to the research questions will be of great significance to all parties involved, resulting in cost savings for ACC, increased organisational profit, increased job satisfaction and improved quality of life. The proposed outcome of this research will lead to the development of a systematic process that can be implemented as part of a program to reduce the incidence of MSD in the meat processing industry. When implemented, the process will help the industry identify a wide range of risk factors (both primary and secondary), along with barriers to implementation, prioritising these factors and then systematically implementing a range of interventions over time that act on them.

It is also important to note that reducing MSD risk may also have advantages for productivity and product quality.

Secondly, the development of a systematic MSD prevention program will offer reduced pain and improved quality of life for meat process workers, which in turn will help lighten the global burden of low back pain (Hoy, et al., 2014).

Thirdly, the research will contribute to the current body of knowledge by finding new approaches and help with redesigning pathways of care and interventions that support people's daily functioning, both at home and at work (University of Warwick, 2018).

1.5 Overview of Methods

To achieve the purpose of the research, the research must follow mixed research methodologies, as described by Wisdom and Creswell:

"An emergent methodology of research that advances the systematic integration, or "mixing," of quantitative and qualitative data within a single investigation or sustained program of inquiry" (Wisdom & Creswell, 2013, p. 1).

Within the mixed-mode methodology, the researcher will use applied action research. Action research is defined as:

"Research strategies that tackle real-world problems in participatory, collaborative, and cyclical ways in order to produce both knowledge and action." (Iowa State University, 2021, p. 1)

According to Driskell, King, and Driskell (2014, p. 451), applied research aims to apply or extend "theory to an identified real-world problem with a practical outcome in mind".

An extensive review of current literature related to MSDs in NZ meat processing will be done to identify MSD risk factors, barriers to MSD prevention, and interventions for addressing MSDs in NZ meat processing. This literature review will assist the researcher in identifying best practices and identify areas of focus. The researcher will analyse an existing AGL database of MSD data to support the research. The database contains secondary data on the occurrence rates, location, and nature of MSDs over the past five years across seven meat processing plants with differing MSD rates. This data will be statistically analysed using MS Excel statistical software to identify trends.

Once trends are identified, the researcher will conduct a focus group discussion with all key Health and Safety managers and advisors, including all injury management personnel, to discuss variations between processing plants (Nyumba, Wilson, Derrick, & Mukherjee, 2018). The differences (should they occur) may provide answers to which interventions or injury management strategies may be more effective.

The reasoning behind this methodology is to allow for a more complete and synergistic integration of the research data rather than to do separate quantitative and qualitative data collection and analysis (Wisdom & Creswell, 2013).

This study will employ applied action research to extend existing knowledge and discover new approaches and interventions that will help manage and prevent MSD in the NZ meat processing sector, making use of a mixture of methods to answer the following research questions:

1.5.1 Research Question One – Which MSD Risk Factors are Prevalent in the NZ Meat Processing Industry?

According to Bero, Grilli, Grimshaw, Harvey, Oxman, and Thomson (1998), secondary data analysis and reviews that collect and analyse a wide array of information are best suited to identify which MSD risk factors are prevalent in the NZ meat processing industry.

1.5.2 Research Question Two - What Industry Interventions for Addressing MSD in NZ Meat Processing are Recommended?

Secondary data analysis and reviews that involve collecting and analysing a vast array of information are best suited to provide evidence on the effectiveness of different strategies implemented in clinical practice (Bero, et al., 1998). Secondary data analysis and reviews are the methods to answer the second research question.

1.5.3 Research Question Three - What Barriers to MSD Prevention in NZ Meat Processing Have Been Identified?

Secondary data analysis and reviews are the chosen methods to answer the third research question (Bero, et al., 1998).

1.5.4 Research Question Four - What MSD Trends can be Observed at AGL?

Research question four will be answered with the statistical analysis of the AGL database that contains secondary data on the occurrence rates, location, and nature of MSD over the past five years across seven meat processing plants with differing MSD rates. The extracted MSD data will be collected in MS Excel format and statistically analysed with MS Excel statistical software to identify existing trends.

1.5.5 Research Question Five - Which MSD Prevention Interventions Have Been Effective for Addressing MSD at AGL?

Once trends are identified, answers to research question five will become evident. The researcher will conduct a focus group discussion with all key Health and Safety managers and advisors, including all injury management personnel, to discuss variations between processing plants. The differences (where they occur) may provide answers to which interventions or injury management strategies may be more effective.

1.5.6 Research Question Six - What Barriers to MSD Prevention Exist at AGL?

Research question six will identify barriers to MSD prevention at AGL by conducting a focus group discussion with all key Health and Safety managers and advisors, including all injury management personnel. Findings from research question three (barriers to MSD prevention in NZ meat processing) and outcomes from research question four (MSD prevention interventions, variations, and trends) will be key areas for discussion during the focus group session (Nyumba, Wilson, Derrick, & Mukherjee, 2018).

1.5.7 Research Question Seven - Which Factors Need to be Considered when Developing a Systematic MSD Prevention Program?

To answer research question seven, secondary data analysis and reviews (Bero, et al., 1998) in conjunction with the outcome of all the previous research questions, will be considered when developing a systematic MSD prevention program (Thomas, Nelson, & Silverman, 2015).

1.6 Preview of Thesis

This thesis is structured in six Chapters. In Chapter One, the researcher introduces the research topic and provides some background information related to the need for the investigation. The purpose, aims, research questions, and hypothesis are stated.

Chapter Two of the thesis provides an overview of the key literature that formed part of the secondary research used and discussed in the thesis. The secondary research focuses on several aspects of preventing MSDs.

- Existing literature of known MSD risk factors in NZ meat processing.
- Known barriers to preventing MSD in NZ meat processing.
- Industry interventions for addressing MSD in NZ meat processing.
- Factors to consider when developing/implementing a systematic MSD prevention program for the NZ meat processing industry.

Chapter Three of this thesis discusses the research frameworks and methodologies for the Ph.D. research, as approved by the ethics committee. These include mixed research methodologies, systematically integrating quantitative and qualitative data, and applied action research. In brief, these include a review of existing literature and quantitative secondary data analysis (AGL MSD database), followed by a qualitative focus group discussion about identified significant trends.

Chapter Four of the thesis presents the results and the research findings.

Chapter Five discusses the research findings in detail, followed by Chapter Six, which concludes with a summary of the findings, recommendations made, and suggestions for future research.

1.7 Chapter Summary

This chapter introduced the research by providing a brief background of the topic, the researcher's aim, purpose, research questions, and research hypothesis. It also outlined the methodologies and identified proposed chapter topics. The next chapter reviews the literature on key aspects of preventing MSDs in the NZ meat processing industry.

Chapter 2 - Literature Review

The previous chapter introduced the research, offering a brief background. It outlined the researcher's aim, purpose, research questions, and hypothesis. Additionally, the methodologies were described, and an overview of the elements that will form part of the research was presented. This chapter reviews the literature encompassing key aspects of managing and preventing MSDs in the Meat processing industry. The primary focus of this review is to identify various factors causing MSDs, as well as historical and current industry interventions and barriers to implementing MSD prevention programs in this sector. Medical management and treatment options for MSDs are not the primary focus of this thesis and, therefore, are not included in the literature review.

An extensive review of current literature on MSD in New Zealand's meat processing industry was conducted to identify risk factors, prevention barriers, and interventions. The review utilised online databases and library searches, starting with New Zealand-specific research from the past two decades. It then expanded to include recent studies (from the past five years) from Australasia and relevant international sources. This process enabled the identification of best practices and areas requiring further exploration.

The literature review followed a structured process that evolved as new insights emerged. Insider and applied research methodologies were employed, allowing the researcher to adapt and refine the focus based on emerging trends and findings. This dynamic approach ensured a comprehensive understanding of the current landscape and highlighted areas for future research.

Our world today is plagued by a global burden of disease impacting all of us, regardless of our heritage. Damian Hoy and colleagues found that of the 291 conditions studied in the Global Burden of Disease 2010, MSDs (collectively) accounted for 21.3% of the total years lived with disability worldwide, second only to mental and behavioural problems (23.2%). The researchers reported that prevention and control of MSDs are required and pointed out that further research is necessary to improve the understanding of the predictors and clinical course of MSDs across different settings and how MSDs can be better managed and prevented (Hoy, et al., 2015).

Trigger Warning: *The following pages contain photos of animal carcasses and typical activities at meat processing plants, which some readers may find disturbing. Viewer discretion is advised.*

2.1 Key Literature Topics

Before the researcher could develop strategies to help manage and prevent MSDs, it was necessary to gain an in-depth understanding of all the contributing factors for these conditions. It was important to know the range of MSDs present in the meat processing industry, along with all the different elements involved with the causation of MSDs. To enable the researcher to develop a suitable injury prevention strategy for MSDs in meat processing, a systematic review of existing industry interventions and MSD risk factors was required. To ensure that the injury prevention plan will be effective, it was essential to understand the potential barriers to adherence to such a program; this information will then be incorporated into the MSD prevention management program.

2.2 Overview of Key Roles in Meat Processing Departments

Understanding the roles and tasks performed in meat processing is crucial because the nature of these tasks can significantly contribute to musculoskeletal disorders (MSDs). According to G. Vincent, Regional HR Manager (personal communication, July 3, 2024), there are approximately 450 standard operating procedures (SOPs) related to meat processing roles.

The following subsections describe the three key roles in meat processing: Meat Process Worker (Labourer), Butcher, and Boner.

Meat Process Worker (Labourer Position).

Purpose of the position. The position reports to the relevant department Supervisor and is a member of either the Ovine (Sheep), Bovine (Beef), or Cervine (Venison) team. The purpose of the role is to process the carcasses of slaughtered livestock and prepare meat and meat products in a manner that meets quality, legislative, and customer requirements safely and hygienically.

Significant Challenges and Key Outcomes. The role's key challenges include:

- Ability to process and pack meat products to required specifications.
- Ensuring all work is completed safely.
- Maintaining food safety, hygiene compliance, and product quality.

Role Accountabilities. The essential tasks include, but are not limited to:

- Processing meat, offal, and tripe.
- Packing boned and sliced meat into cartons.
- Moving carcasses to chillers and/or freezers.
- Loading meat products into refrigerated containers.
- Cleaning and sanitising equipment and work areas.
- Ensuring all work is completed safely.
- Maintaining food safety, compliance, and product quality.

Butcher Position.

Purpose of the Position. The position reports to the relevant Primary Department Supervisor and is a member of the primary slaughter team for Ovine (Sheep), Bovine (Beef), or Cervine (Venison). The role focuses on safely and hygienically operating specialised butchering, evisceration, meat cutting, and separating equipment and knives for preparing primary meat products.

Significant Challenges and Key Outcomes. The role faces several key challenges:

- Understand and effectively perform primary meat processing activities.
- Ensuring all work is consistently performed safely.
- Maintaining food safety, compliance, and product quality standards.

Role Accountabilities. Key tasks:

- Opening, preparing, cutting, and separating carcasses using specialised knives and cutting equipment.

- Performing critical tasks such as sticking pens, y-cuts, flaying, cod area processing, pelt removal, and gutting.
- Identifying and isolating product risks or faults, as necessary.
- Undertaking any other primary processing tasks as reasonably required.

Boner position.

Purpose of the position. The position reports to the relevant Further Processing Supervisor and is a member of the further processing team for Ovine (Sheep), Bovine (Beef), or Cervine (Venison). The role focuses on safely and hygienically de-boning, cutting, and trimming meat from carcasses, sides, and bones to produce saleable meat products that meet quality, legislative, and customer requirements.

Major Challenges and Key Outcomes. The role encounters several key challenges:

- Understanding and proficiently executing boning specifications, meat cuts, and processes.
- Ensuring all work is consistently performed safely.
- Maintaining food safety, compliance, and product quality standards.

Role Accountabilities. Key tasks:

- Cutting and separating meat into standardised cuts and portions using specialised knives.
- De-boning standard cuts of meat, such as racks, legs, shoulders, and loins, to prepare meat cuts for packing and distribution.
- Trimming and sorting meat to meet required specifications.
- Identifying and addressing product risks or faults through re-work, as necessary.
- Performing any other further processing tasks as reasonably required.
- Operating band/ATEC/primal/splitting saws to cut carcasses when necessary.

For a more detailed overview of the positions and their associated tasks within different meat processing departments, please consult Table 2.1.

Table 2.1

Overview of Key Roles in Meat Processing Departments

Departments	Position Description	Associated Tasks
Amenities	Janitor	Janitorial duties
	Labourer Amenities	Cleaning tasks
Cold storage	Labourer	Carton handling, inspecting, forklift operation
Cooling Floor	Labourer	Stringing, railing carcasses in/out, manual lifting
	Labourer Pre-Trim	Carcass trimming
Fellmongery	Labourer Felly	Skin's transfer, paint tables, skin trimming, fleshing, salting, cleaning, forklift operation
Freezers	Labourer	Forklift operating, carton handling, stacking
Further Processing	Boner	Specialised deboning cuts. e.g., loin boning
	Labourer	Cleaning, packing, wrapping, carton handling
	Labourer Knife Hand	Trimming, dicing
	Sawyer	Saw operating tasks
Maintenance	Trades Assistant	Equipment maintenance e.g., fitting
Packaging Store	Labourer Packaging Store	Carton handling, packing, stacking
Palletised Stores	Labourer	Forklift operating, carton handling, stacking, load out
Pelts	Labourer Pelts	Pelting, sorting
Plant Services	Labourer	Cleaning tasks
Rendering	Labourer Rendering	Bagging, crushing bones, tallow
Slaughterboard	Butcher	Legging, Y-cut, flaying, pelting, codding, gutting
	Halal Slaughterer	Halal slaughter
	Labourer	Gut trays, broomie, cleaning, grading, lifting
	Labourer Knife Hand	Trimming, Detain
Fancy Meats	Labourer	Offal, Tripe, washing, trimming, packing
Stock Yards	Labourer Yards	Livestock control
	Shepherd with dog	Shepherding
Soup Stock	Labourer	Loading bins, filling, and stacking pales

2.3 Understanding the Nature of Musculoskeletal Disorders (MSDs)

It is important to have a good understanding of what MSDs entail and what is understood when referring to MSDs. Musculoskeletal disorders can be defined as injuries or disorders that involve the muscles, nerves, tendons, joints, cartilage, spinal discs, and other supporting structures of the human body (Centers for Disease Control and Prevention, 2020). Many similar definitions for MSD exist (Gerr, Letz, & Landrigan, 1991). Gerr, Letz, and Landrigan (1991) report that over the past 100 years, an extensive literature relating to occupational MSDs has evolved:

> Such disorders have been considered endemic in certain industries, such as meat processing and packing. They also have been reported to occur with high frequency in other trades, such as construction, clerical work, forestry, product fabrication, garment production, health care, underground mining, and the arts. (p. 543)

When referring to MSD, the term is often preceded by the words “work-related” and often referred to as work-related musculoskeletal disorders (WMSD or WRMSD) (Tappin, 2008). Within this large body of literature, some (Buckle & Devereux, 2002) consider WMSD to include a wide range of inflammatory and degenerative diseases and disorders that would result in pain and functional impairment that may affect many areas of the body, including the neck, shoulders, elbows, forearms, wrists, and hands. Whysall, Haslam, and Haslam (2004) report that many ergonomists focus mainly on the physical aspects of work and would consider psychosocial influences outside of their scope. MacDonald and Evans (2006) have a more holistic view of MSD causation factors quoted by (Tappin, 2008, p. 22) as:

“Stemming from a wide range of factors that together result in an inadequate margin between people’s work demands and the coping resources available to them” (MacDonald & Evans, 2006).

The World Health Organization (WHO) recognises MSDs as conditions where work-related and non-work-related factors contribute to their occurrence. The WHO (World Health Organization, 2021, p. 1) presents the following key facts about MSDs:

- Approximately 1.71 billion people have musculoskeletal conditions worldwide.
- Among musculoskeletal disorders, low back pain causes the highest burden, with a prevalence of 568 million people.
- Musculoskeletal conditions are the leading contributor to disability worldwide, with low back pain being the single leading cause of disability in 160 countries.
- Musculoskeletal conditions significantly limit mobility and dexterity, leading to early retirement from work, lower levels of well-being, and reduced ability to participate in society.
- Because of population increases and ageing, the number of people with musculoskeletal conditions is rapidly increasing.
- The disability associated with musculoskeletal conditions has been increasing and is projected to continue to increase in the following decades.
- Musculoskeletal conditions are also the most significant contributor to years lived with disability (YLDs) worldwide, with approximately 149 million YLDS accounting for 17% of all YLDs.
- Musculoskeletal conditions comprise more than 150 conditions that affect the locomotor system of individuals.
- Musculoskeletal conditions also contribute to the global need for rehabilitation.

According to the WHO, MSDs induce pain (often persistent), limited mobility, dexterity, and a person's level of functioning, reducing people's ability to work (World Health Organization, 2021). The scope of MSDs includes conditions that affect joints (for example, osteoarthritis, rheumatoid arthritis, psoriatic arthritis, gout, ankylosing spondylitis); bones (for example, osteoporosis, osteopenia including associated fragility fractures, traumatic fractures); muscles, (for example sarcopenia); and the spine (for example back and neck pain).

The WHO also mentions MSDs that affect multiple body areas or systems, which include:

"Regional and widespread pain disorders and inflammatory diseases such as connective tissue diseases and vasculitis that have musculoskeletal manifestations, for example, systemic lupus erythematosus" (World Health Organization, 2021, p. 1).

The prevalence of MSDs varies by age and diagnosis. It impacts people of all ages worldwide to such an extent that the WHO launched the Rehabilitation 2030 initiative in 2017 to draw attention to the overwhelming unmet need for MSD rehabilitation worldwide. The WHO held a hybrid meeting on June 7-8, 2022, to identify enablers and barriers in advancing the global MSD rehabilitation agenda. The meeting aimed to foster high-level discussions among decision-makers and stakeholders to improve competency-based rehabilitation education in Central Asian and Eastern European countries. Participants from Armenia, Azerbaijan, Georgia, Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, Ukraine, and Uzbekistan collaborated to create a roadmap for developing rehabilitation education (World Health Organisation, 2022). The objectives were to:

- Develop strategies to build political support and leadership for educating rehabilitation professionals in the targeted countries.
- Establish a roadmap for competency-based education for rehabilitation professionals, leveraging regional partnerships and shared experiences.
- Identify next steps to strengthen the education of rehabilitation professionals in the region.

According to the literature, MSDs are persistent issues with global significance due to their substantial impact. This research aims to comprehensively identify various contributing factors associated with MSDs in the meat processing industry and assess their potential for mitigation within a prevention and management strategy. To achieve this, a classification system with specific criteria for each condition will be utilised, facilitating the identification of work-related MSD cases and enhancing treatment consistency. Additionally, the findings will aid in developing a comprehensive database for formulating effective prevention strategies (Tappin, 2008).

Table 2.2 summarises a list of terms used to refer to WMSD. These terms were included in the literature review process to identify research that will contribute to the body of knowledge that supports this study.

Table 2.2

Summary of Terms used to refer to Work-related Musculoskeletal Disorders

Term	Acronym	Usage
Work-related musculoskeletal disorders	WMSD or WRMSD	Frequent
Occupational cervicobrachial disease	Unknown	Seldom
Repetitive strain injury	RSI	Seldom
Occupational overuse syndrome	OOS	Frequent
Cumulative trauma disorders	CTD	Less frequently
Discomfort, Pain, and Injury	DPI	Emerging
Upper limb disorders	ULD	Frequent
Work-related upper limb disorders	WRULD	Frequent
Upper extremity disorders	UED	Frequent

Note. The usage ratings of terms describing WRMSDs were determined through a review of OOS prevention literature (Boocock, et al., 2005), analysing their occurrence in both past and present literature. For instance, DPI is increasingly used in recent literature by ACC.

The following sections review current literature on MSDs in meat processing, drawing from New Zealand and international research. This includes examining MSD risk factors, barriers to MSD prevention, and interventions to address MSDs within the New Zealand meat processing industry.

2.4 Contributing Risk Factors for MSD in Meat Processing

Most of the earlier research literature comes from Northern European countries, the USA, and Australia. However, many similarities in the work methods within this industry are relevant in New Zealand. There is also a broad consensus within the literature about the key risk factors for MSD (Tappin et al., 2006). Table 2.3 summarises the key risk factors for MSD in meat processing as identified by existing research.

Table 2.3

Summary of the Key Risk Factors for MSD in Meat Processing

Risk Factor	Defined	Researcher(s)
Lack of employee training and education	*The absence of adequate training leads to a lack of knowledge of MSD or technical skills.*	(Drewcynski & Bertolini, 1995) (Barnsley College, 2022)
Cold environment	*Working in a cold environment that causes greater than normal body heat losses (ranges from 2 to 8ºC for fresh food and below –25ºC for frozen food)*	(Encyclopaedia of Occupational Health and Safety, 2011) (Drewcynski & Bertolini, 1995)
Warm or hot environments	*Working in a warm or hot environment where the combination of ambient temperature and relative humidity exposes the worker to heat stress. (Risk determined by a heat and humidity discomfort index – please refer to figures 2.3 & 2.4)*	(Euro Weather, 2022) (Epstein & Moran, 2019)

Risk Factor	Defined	Researcher(s)
Poor tool/plant and equipment design	*Design limitations that put employees at increased risk of injury.*	(Drewcynski & Bertolini, 1995) (Canadian Centre for Occupational Health and Safety, 2019) (Worksafe, 2022)
Noise risk	*The stressors caused by industrial noise affect communication and diminish performance.*	(Nossent, de Groot, & Verschuren, 1996)
Poor work organisation and scheduling	*Limitations in the way tasks are organised and coordinated within the context of an overarching work system.*	(Wall & Clegg, 1998) (OSH, 1997)
Manual handling risk factors	*Includes repetitive work, awkward grips, and handling of heavy loads.*	(Waniganayake & Steele, 1990)
Awkward work posture	*Includes forward reaching, stooping, and twisting, as well as working with arms below knee and above shoulder height.*	(Nossent, de Groot, & Verschuren, 1996) (Waniganayake & Steele, 1990)
Repetitive work	*This includes repeated actions, short work cycles, and a limited range of motion.*	(Riley, 1998) (Nossent, de Groot, & Verschuren, 1996)
Musculoskeletal loads/force	*Forces applied to lifting, gripping, and cutting, including forces applied by the non-knife hand.*	(Nossent, de Groot, & Verschuren, 1996) (Riley, 1998)

Risk Factor	Defined	Researcher(s)
Static work postures (loading)	*Refers to physical exertion in which the same posture or position is held throughout the work activity.*	(Riley, 1998) (JR Ergonomics, 2022)
Lack of recovery (fatigue)	*Insufficient time to regain or return to a normal state.*	(Riley, 1998)
Pay - piecework	*Payment on a production basis.*	(Nossent, de Groot, & Verschuren, 1996) (Riley, 1998)
Contextual factors	*Refers to the social, economic, cultural, political, and organisational factors that create conditions contributing to physical and psychological risk factors.*	(Tappin, Bentley, & Vitalis, 2009)
Poor Injury Management	*Guidelines for early reporting, medical management of early signs and symptoms, and rehabilitation.*	(OSH, 1997)

2.4.1 Lack of Employee Training and Education

Richard Branson famously said: “Train people well enough so they can leave, treat them well enough so they don’t want to.” Failing to provide adequate training to employees can lead to a range of adverse side effects that can have a negative impact on their workplace and be costly for the organisation (Barnsley College, 2022). These negative follow-on effects include low morale, unproductivity, increase in expenses and collectively may lead to placing the employee at an increased injury risk.

Low Morale. Many employees view their place of work as their whānau (extended family) and do feel a sense of pride in their work; they work hard to support each other and do their jobs well to advance in the company (Haar & Roche, 2010). With the lack of training and education in the workplace, it is harder for employees to do this, and they may feel undervalued, inadequate, and unable to achieve their career goals. This may lead to lowered employee morale and, in turn, can lead to higher employee turnover (SG Heilbron Economic & Policy Consulting, 2020).

Unproductivity. When employees are untrained, they are less likely to be able to do their tasks efficiently and confidently, leading to a lack of productivity and an increase in errors. This will place additional pressure on more experienced employees, who must spend more time supervising tasks. Employee training will limit underperformance and reduce valuable time lost due to errors that occur due to a lack of training (Barnsley College, 2022).

Increase in Expenses. Increase in Expenses. Employee training and education programs might be perceived as costly, but in the long run, employers are unlikely to save money by cutting costs on training. When employees are not properly trained, the likelihood of mistakes increases, leading to poor use of time and wasted resources. For instance, untrained employees might mishandle equipment or materials, resulting in costly damages and inefficient production processes. High employee turnover is another significant expense; untrained employees are more likely to feel dissatisfied or overwhelmed, prompting them to leave the company. This increases the costs associated with recruiting and training new employees and disrupts workflow and productivity. Additionally, inadequate training can increase injury rates, affecting employee well-being and resulting in higher workers' compensation claims, insurance premiums, and potential legal costs. Overall, the initial investment in comprehensive training programs can prevent these costly issues, leading to a more efficient, safe, and stable work environment (Barnsley College, 2022).

Increased Injury Risk. According to Jonathan Rosenfeld (injury lawyer), "poorly trained employees are a danger to themselves and those they are working with, and this is not because they choose to be or act in a wilfully negligent manner. There are many ways in which training can improve performance and reduce the risk of injury and just as many ways that a lack of proper training can spell disaster." (Rosenfeld, 2016, p. 1).

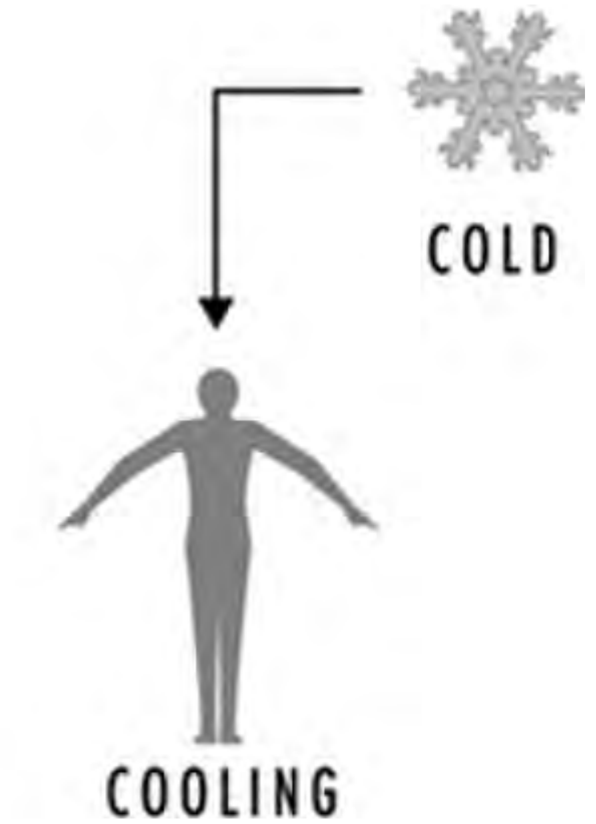
Lack of employee training and education will increase MSD risk. Informing a workforce on the best ways to reduce these risks will reduce the chances that workers will put themselves and others at risk (Rosenfeld, 2016).

2.4.2 Cold Environment

Exposure to a cold environment is part of the requirements for working in the food processing industry (Drewcynski & Bertolini, 1995). In most countries, working under cold conditions will include processing food in temperatures that range from 2 to 8ºC for fresh food and below –25ºC for frozen food. Working under these conditions will cause more significant than normal body heat losses. Cold stress and work in the cold are present in different forms in meat processing plants and affect the whole-body heat balance, including the heat balance of extremities, the skin, and the lungs. The expected way to deal with cold stress is through behavioural action and the modification of clothing. Appropriate clothing will protect employees from the adverse cooling effects. Even so, protective clothing may cause unwanted, adverse effects, as can be seen in Figure 2.1 (Encyclopaedia of Occupational Health and Safety, 2011).

Figure 2.1

Adverse Effects of Cold and Protective Wear



Note. The illustration is sourced from the Encyclopaedia of Occupational Health and Safety and demonstrates how cooling and protective wear can reduce employees' work capacity. (Encyclopaedia of Occupational Health and Safety, 2011).

Discomfort and impaired sensory and neuro-muscular function occur when parts of the body or the whole body are exposed to tissue cooling. The discomfort experienced because of cold tends to be a strong stimulus to behavioural action to reduce or eliminate the effect. The prevention of cooling is primarily achieved by wearing cold-protective clothing, footwear, gloves, and headgear, which interferes with the mobility and dexterity of the worker. According to the Encyclopaedia of Occupational Health and Safety (2011), this is referred to as the “cost of protection” in the sense that movements and motions become restricted and more exhausting and may compromise factors such as vigilance and reaction time (Encyclopaedia of Occupational Health and Safety, 2011).

2.4.3 Cold Storage Work

In the meat processing industry, frozen meat products must be stored and transported below -20ºC. Workers in cold storage face fluctuating temperatures as they move between cold environments and warmer areas outside. Adequate protective clothing is essential to maintain heat balance during physically demanding tasks. Regular breaks of at least 20 minutes every 1.5 to 2 hours are necessary to prevent prolonged exposure of hands and feet to cold. Protective gloves with sufficient insulation in the palms are required for handling frozen products. Infrared radiating heaters can be installed in stationary work areas like blast freezers to enhance thermal comfort (Encyclopaedia of Occupational Health and Safety, 2011).

Most work in cold stores uses open forklifts, which generate relative wind even at slow speeds, increasing body cooling in low temperatures. Fork-lift operators, often stationary, produce little metabolic heat. Initially, cooling affects hands and feet, necessitating limited exposure times. Organising work schedules based on exposure and available protective clothing is crucial. Installing heated seats in fork-lifts (as can be seen in figure 2.2) can prevent localised cooling of the seat and back muscles (Encyclopaedia of Occupational Health and Safety, 2011). Using forklifts with an enclosed heated cab may be an alternative.

Depending on the processing type, meat processing rooms are typically cool, ranging from +2 to +16ºC. Many rooms have high humidity, leading to water condensation in cold spots and wet floors, increasing slip risks. Using high-pressure fans to mitigate these issues can create draft complaints due to high air velocity around workstations. Adjusting airflow or rearranging workstations can often resolve these problems effectively (Encyclopaedia of Occupational Health and Safety, 2011).

Special hygienic requirements dictate the design and type of clothing, headgear, and footwear in food handling areas. When choosing attire, it is crucial to adhere to these requirements. Clothing should shield against draughts, moisture, and water, featuring layers like underwear, insulating materials, and an outer layer for comprehensive protection. Similarly, headgear and footwear should be selected to prevent heat loss and help maintain a balanced body temperature in cold environments. Ergonomics research aims to enhance clothing functionality while ensuring workplace protection (Canadian Centre for Occupational Health and Safety, 2022).

Figure 2.2

Fork-lift Operating in a Cold Storage Area

Note. The image shows how open cab forklifts expose employees to cold environments. Installing heated seats in forklifts improves heat balance by preventing localised cooling of the seat and back muscles.

Maintaining manual dexterity in cool workplaces is challenging. Low to moderate muscular activity quickly cools hands and fingers. Gloves offer cold protection but may limit dexterity. Balancing protection and dexterity is crucial; for example, a metal mesh glove is worn when cutting meat with a knife. A thin textile glove underneath is recommended to enhance comfort and reduce cooling. Insulated handles for tools and equipment can also minimise hand-cooling (Encyclopaedia of Occupational Health and Safety, 2011).

According to the Encyclopaedia of Occupational Health and Safety (2011), cold does not directly cause MSDs or rheumatism. However, working in cold conditions places significant demands on muscles, tendons, joints, and the spine due to the forces and high loading involved. Joint temperatures decrease faster than muscle temperatures, leading to stiffness and increased resistance to movement caused by thicker synovial fluid. Muscle contractions become shorter and weaker under these conditions. Coupled with heavy work or internal strain, this increases the risk of musculoskeletal injuries. Protective clothing can further restrict movement, adding to the risk of injury.

Working in cold conditions can adversely affect work efficiency and accident rates. Cold-related discomfort reduces mental alertness, particularly impacting complex cognitive tasks. Additionally, the sensitivity and dexterity of fingers are diminished when working in the cold, which hampers manual handling tasks. Prolonged exposure to lower temperatures further affects deeper muscles, reducing muscular strength and stiffening joints. These factors collectively increase the likelihood of workplace accidents when working in cold conditions (Canadian Centre for Occupational Health and Safety, 2022).

2.4.4 Warm or Hot Environments

Employees in the meat processing industry face more than just cold temperatures. The body generates significant heat through muscular exertion, releasing 75 to 80% of energy as heat during peak efficiency. At mild to moderate work intensity, the core temperature can rise about one degree Celsius every 15 minutes without effective heat dissipation. Heat stress is likely in warm or hot environments like the Slaughterboard and Rendering departments, potentially leading to MSDs. Regulating body temperature in these conditions is challenging as heat is mainly dissipated through radiation, convection, and evaporation (Encyclopaedia of Occupational Health and Safety, 2011).

In places like the Sheepyards, high temperatures and humidity pose challenges for the body's main thermoregulation mechanisms: skin vasodilation and sweating. Skin vasodilation transfers heat from the core to the skin through radiation and convection. Sweating effectively cools blood before returning it to deep body tissues. However, wearing additional personal protective equipment (PPE) can diminish these thermoregulatory functions (Encyclopaedia of Occupational Health and Safety, 2011).

In the meat processing industry, ambient temperature alone does not provide adequate information about the existing climatic heat stress. It can be determined by a combination of temperature, radiation (solar and heat-generating equipment), and humidity. For example, solar radiation can add 5°C to the operative temperature when the ambient temperature is

30°C. The operative temperature heat stress would be equivalent to working at 35°C (Epstein & Moran, 2019).

Various indices assess environmental heat load, which is crucial for establishing safety guidelines aligned with work intensity, duration, and heat stress (Epstein & Moran, 2019). Adhering to these guidelines enhances the meat industry's capacity to protect employees from heat-related risks.

Temperature alone does not provide enough information about how much heat load is experienced by an employee. The discomfort index (DI) is an important guide that measures the human heat sensation for different climate conditions (Xu, Hu, & Hee, 2017). The DI of Thom (Figure 2.3) is one of the most frequently used bioclimatic indices to describe the level of thermal sensation a person experiences in modified climatic conditions (such as indoor work environments). The DI in Figure 2.3 reflects the proportionate contribution of air temperature and relative humidity on human thermal comfort (Stathopoulou, Cartalis, Keramitsoglou, & Santamouris, 2005).

Burke, Sipe, Evans, and Mellifont (2006) introduced the HUMIDEX (HDI), developed by Canadian meteorologists to gauge how hot and humid weather feels to the average person. Like Thom's DI, the HUMIDEX combines temperature and humidity to determine perceived temperature, offering a more comprehensive measure of discomfort than assessing temperature or humidity alone. Equation 1 outlines the HUMIDEX calculation, while Figure 2.4 illustrates scores across various temperature and humidity levels, depicting relative discomfort and associated comfort levels for individuals (Burke, Sipe, Evans, & Mellifont, 2006).

Equation 2.1

Calculation of HUMIDEX

$$\text{HUMIDEX} = T + 5/9*\left(\left(6.112*10^{\frac{7.5*T}{237.7+T}}*H/100\right) - 10\right)$$

Where:

T = air temperature (degrees Celsius)

H = relative humidity (%)

Note. HUMIDEX calculation (Burke, Sipe, Evans, & Mellifont, 2006, p. 5) is used to provide a more accurate measure of the average person's "perceived temperature" in specific conditions.

Figure 2.3

Thom's Discomfort Index

Thom's discomfort index

	25%	30%	35%	40%	45%	50%	55%	60%	65%	70%	75%	80%	85%	90%	95%	100%
42°	32	32	33	33	34	34	35	35	36	36	37	37	37	38	38	38
41°	31	32	32	33	33	34	34	35	35	35	36	36	37	37	37	37
40°	30	31	31	32	32	33	33	34	34	35	35	35	36	36	36	37
39°	30	30	31	31	32	32	33	33	34	34	34	35	35	35	36	36
38°	29	30	30	31	31	31	32	32	33	33	34	34	34	35	35	35
37°	28	29	29	30	30	31	31	32	32	32	33	33	33	34	34	34
36°	28	28	29	29	30	30	30	31	31	32	32	32	33	33	33	34
35°	27	27	28	28	29	29	30	30	30	31	31	32	32	32	33	33
34°	26	27	27	28	28	29	29	29	30	30	30	31	31	31	32	32
33°	26	26	27	27	27	28	28	29	29	29	30	30	30	31	31	31
32°	25	25	26	26	27	27	27	28	28	29	29	29	30	30	30	30
31°	24	25	25	26	26	26	27	27	27	28	28	28	29	29	29	30
30°	24	24	24	25	25	26	26	26	27	27	27	28	28	28	29	29
29°	23	23	24	24	25	25	25	26	26	26	27	27	27	27	28	28
28°	22	23	23	23	24	24	25	25	25	25	26	26	26	27	27	27
27°	22	22	22	23	23	23	24	24	24	25	25	25	26	26	26	26
26°	21	21	22	22	22	23	23	23	24	24	24	25	25	25	25	26
25°	20	21	21	21	22	22	22	23	23	23	23	24	24	24	25	25
24°	20	20	20	21	21	21	22	22	22	22	23	23	23	24	24	24
23°	19	19	20	20	20	21	21	21	21	22	22	22	22	23	23	23
22°	18	19	19	19	19	20	20	20	21	21	21	21	22	22	22	22

Up to 21	No discomfort
From 21 to 24	Less than half of the population experience discomfort
From 25 to 27	More than half of the population experience discomfort
From 28 to 29	Most of the population experience discomfort and deterioration of psychophysical conditions
From 30 to 32	The whole population experience high levels of discomfort
Over 32	Extreme levels of discomfort for all with a high-risk of a medical emergency (heatstroke)

Note. Thom’s 1959 discomfort index (°C) with a modified legend (Sajani, et al., 2016, p. 147) is a commonly used bioclimatic index to describe the thermal sensation experienced by individuals in modified climatic conditions, such as indoor work environments.

Implementing the HUMIDEX can be valuable in reducing the risk of exposure for employees working in a hot environment within a meat processing facility. It helps better understand and manage the potential impact of heat and humidity on employee well-being and safety.

Figure 2.4

HUMIDEX Index of Apparent Temperature (°C)

	25%	30%	35%	40%	45%	50%	55%	60%	65%	70%	75%	80%	85%	90%	95%	100%
42°	48	50	52	55	57	59	62	64	66	68	71	73	75	77	80	82
41°	46	48	51	53	55	57	59	61	64	66	68	70	72	74	76	79
40°	45	47	49	51	53	55	57	59	61	63	65	67	69	71	73	75
39°	43	45	47	49	51	53	55	57	59	61	63	65	66	68	70	72
38°	42	44	45	47	49	51	53	55	56	58	60	62	64	66	67	69
37°	40	42	44	45	47	49	51	52	54	56	58	59	61	63	65	66
36°	39	40	42	44	45	47	49	50	52	54	55	57	59	60	62	63
35°	37	39	40	42	44	45	47	48	50	51	53	54	56	58	59	61
34°	36	37	39	40	42	43	45	46	48	49	51	52	54	55	57	58
33°	34	36	37	39	40	41	43	44	46	47	48	50	51	53	54	55
32°	33	34	36	37	38	40	41	42	44	45	46	48	49	50	52	53
31°	32	33	34	35	37	38	39	40	42	43	44	45	47	48	49	50
30°	30	32	33	34	35	36	37	39	40	41	42	43	45	46	47	48
29°	29	30	31	32	33	35	36	37	38	39	40	41	42	43	45	46
28°	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43
27°	27	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
26°	26	26	27	28	29	30	31	32	33	34	34	35	36	37	38	39
25°	25	25	26	27	27	28	29	30	31	32	33	34	34	35	36	37
24°	24	24	24	25	26	27	28	28	29	30	31	32	33	33	34	35
23°	23	23	23	24	25	25	26	27	28	28	29	30	31	32	32	33
22°	22	22	22	22	23	24	25	25	26	27	27	28	29	30	30	31

Up to 29 C°	No discomfort
From 30 to 34 C°	Slight discomfort
From 35 to 39 C°	Strong discomfort. Caution: Limit demanding physical activities
From 40 to 45 C°	Strong indisposition sensation. Danger: Avoid physical activities that require effort
From 46 to 53 C°	Severe danger: Stop all physical activities
Over 54 C°	Extreme danger: imminent heatstroke could lead to loss of life

Note. HUMIDEX, like Thom's DI index of apparent temperature index (°C) with a modified legend (Burke, Sipe, Evans, & Mellifont, 2006, p. 5) is a newer approach that combines temperature and humidity to calculate the "perceived temperature" for the average person in specific conditions. Considering these two important factors, the HUMIDEX provides a more comprehensive measure of relative discomfort than separately evaluating temperature or humidity.

It should be noted that the HDIs are perceived ratings and, therefore, subjective and not definitive. Another possible shortfall with most DI is that the indices do not allow wind chill factors. Wind chill factors influence a person's perception of temperature, leading to additional risk due to underestimating the perceived ratings (Burke, Sipe, Evans, & Mellifont, 2006).

An artificial wind chill factor may be another issue in meat processing plants due to large "cooling" fans (P. Sykes, personal communication, January 24, 2022). Working in warm and hot environmental conditions induces heat stress and fatigue, with the added metabolic heat produced by muscular effort (Encyclopaedia of Occupational Health and Safety, 2011). Under these conditions' employees are likely to be exposed to MSDs in the workplace, and accidents have a higher probability of occurring. Working in warm and hot environments will require a set of control measures to mitigate the potential risk (Canadian Centre for Occupaional Health and Safety, n.d.).

2.4.5 Poor Tool/Plant and Equipment Design

Poorly designed tools and equipment significantly increase the force needed to complete the work task. Providing employees with suitable supporting guides or fixtures for tasks that require holding products saves much muscular effort and reduces time in awkward positions. Ergonomic-designed tools that are well-maintained will reduce muscle strain (Canadian Centre for Occupational Health and Safety, 2022).

New Zealand legislation under the Health and Safety at Work Act 2015 requires the management of all foreseeable risks (s.30):

(1) A duty imposed on a person by or under this Act requires the person—
 (a) to eliminate risks to health and safety, so far as is reasonably practicable; and
 (b) if it is not reasonably practicable to eliminate risks to health and safety, to minimise those risks so far as is reasonably practicable.

(2) A person must comply with subsection (1) to the extent to which the person has, or would reasonably be expected to have, the ability to influence and control the matter to which the risks relate.

Employers must provide a safe working environment for all employees (Health and Safety at Work Act 2015, s.30). Eliminating poor tool, plant or equipment design is a legal requirement. Therefore, thinking about health and safety risks during the design stage is essential. International research illustrates the value of suitable plant and equipment design (Health and Safety Executive, 2004; Safe Work Australia, 2014; Safe Work Australia, 2015; American Society of Safety Professionals, 2021; Worksafe, 2022):

- Reductions in work-related ill-health and injuries can be achieved through good design.
- Damage to property, the environment, and related costs are reduced by good design.
- Good design enhances employee productivity, health, and well-being.
- Eliminating hazards can be one of the most effective risk control measures when done as part of the planning or design stages. It is also less costly than managing risks once operational.
- Design limitations of plant or equipment cause a significant proportion of work-related injuries. In many cases, solutions already exist for these design limitations.
- Managing risk throughout the design phase is more efficient and effective than retrofitting health and safety solutions.
- When health and safety by design principles are followed, the need for retrofitting, personal protective equipment, health monitoring, exposure monitoring, and maintenance can be reduced.

Health and Safety by Design (HSD) is the process of managing health and safety risks throughout the lifecycle of structures, plant, equipment, substances, or other products (Figure 2.5). According to Worksafe (2022), designers are best positioned to make work healthy and safe from the start of the design process. Their influence, however, diminishes over the product lifecycle. The HSD key points are:

Early Risk Management. Identifying and addressing potential health and safety risks during the initial design phase.

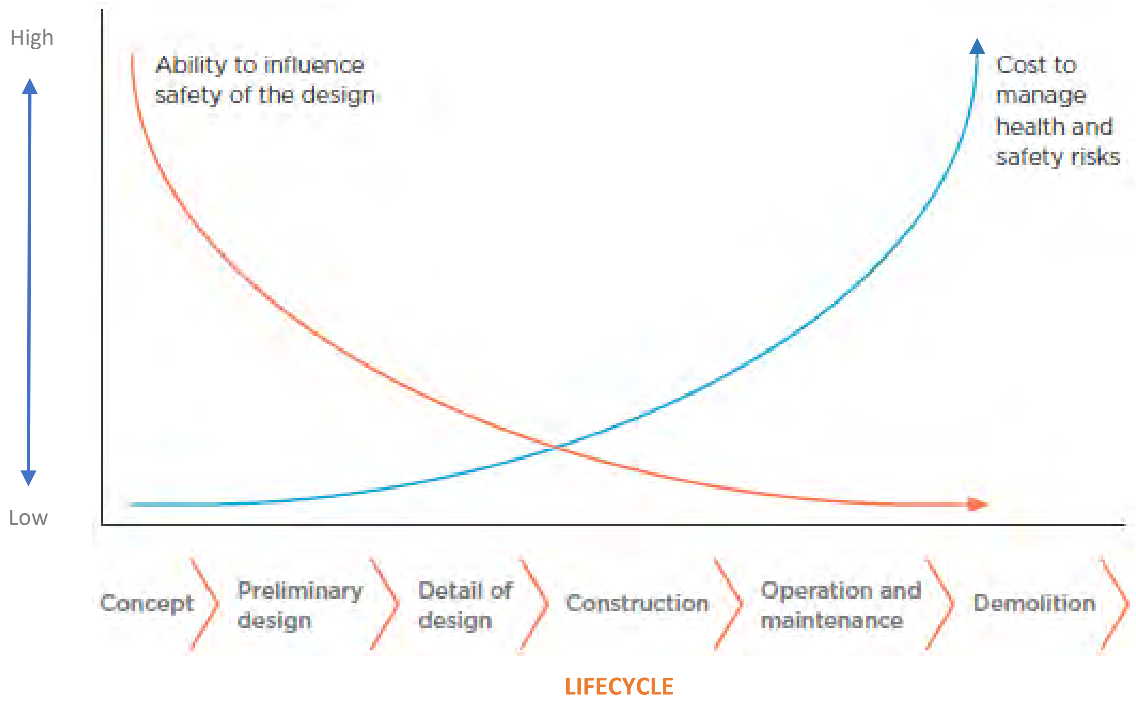
Safety Integration. Incorporating safety features and controls in the design to eliminate or minimise risks.

Lifecycle Influence. Designers have the most significant impact on health and safety at the beginning of a product's lifecycle, with their influence decreasing as the product progresses through its lifecycle.

By incorporating HSD principles, we can prevent injuries and illnesses, save costs, enhance productivity, and ensure regulatory compliance.

Figure 2.5

Symberszki Chart of the Ability to Influence Safety by Design Over a Product's Lifecycle



Note. The Symberszki time/safety influence curve was adapted from Szymberski (1997, p. 71) to demonstrate the sequential events required to influence safety through design throughout the lifecycle of a product or piece of equipment (Worksafe, 2022).

When project managers, engineers, construction supervisors, and end users collaborate to identify ergonomic solutions that address issues arising from inadequate tool, plant, and equipment design, there is potential for reducing accidents. This can be achieved by prioritising safety right from the initial planning stages of a project, ensuring that the ultimate goal is to create a safe working environment for the end user (Szymberski, 1997). Employees in the meat processing industry are entitled to the utmost level of protection reasonably achievable. If it is not reasonably possible to eliminate risks to health and safety, efforts should be made to minimise those risks to the greatest extent reasonably practicable (Health and Safety at Work Act 2015). Opting for tools and equipment that prioritise good ergonomics and managing known risks during the plant and equipment design stage is a highly effective means of providing optimal protection. This approach is more efficient and cost-effective than replacing or modifying existing plant and equipment later in its lifecycle (Worksafe, 2022).

2.4.6 Noise Risk

According to Scharine, Cave, and Letowski (2009), the human response to auditory stimuli is called auditory sensation. This response is influenced by the sound's intensity, duration, and frequency. On the other hand, auditory perception involves our past experiences and interpretation of the sound. The unit of measurement for sound is Hertz (Hz), and the human hearing range typically spans from 20 Hz to 20,000 Hz (Weeks, et al., 2009). Noise is defined as sound that surpasses the limits of comfortable auditory perception. It is widely regarded as an unpleasant experience for humans and animals, triggering physiological responses that necessitate adaptation. Noise acts as a non-specific stressor that stimulates the endocrine and autonomic nervous systems (Münzel, et al., 2017). The stressors caused by industrial noise have an impact on effective communication and lead to diminishing performance (Nossent, de Groot, & Verschuren, 1996). In addition to causing auditory health issues, noise can negatively impact a person's ability to focus and concentrate. This, in turn, can divert attention from important cues necessary for task performance and increase the risk of developing MSDs. Human performance is influenced by various factors related to job and workplace conditions, including the levels of noise present (Nassiri, et al., 2013).

2.4.7 Poor Work Organization and Scheduling

Poor work organisation and task scheduling refer to limitations in the way tasks are organised and coordinated within the context of an overarching work system (OSH, 1997; Wall & Clegg, 1998). In a review of the literature on the New Zealand meat processing industry, Tappin, Moore, Ashby, Bentley, and Trevelyan (2006) noted that many authors have identified the suspected effectiveness of work organisations in managing MSD risk factors. Work organisation and task scheduling in New Zealand were identified by OHS (1997) as the most important risk control factor. Within these factors, OSH (1997) identified supervisory structures, task description clarity, chain speeds, the effects of a busy season on workload, monotony, shift work, and the need for overtime work.

2.4.8 Job Task Rotation

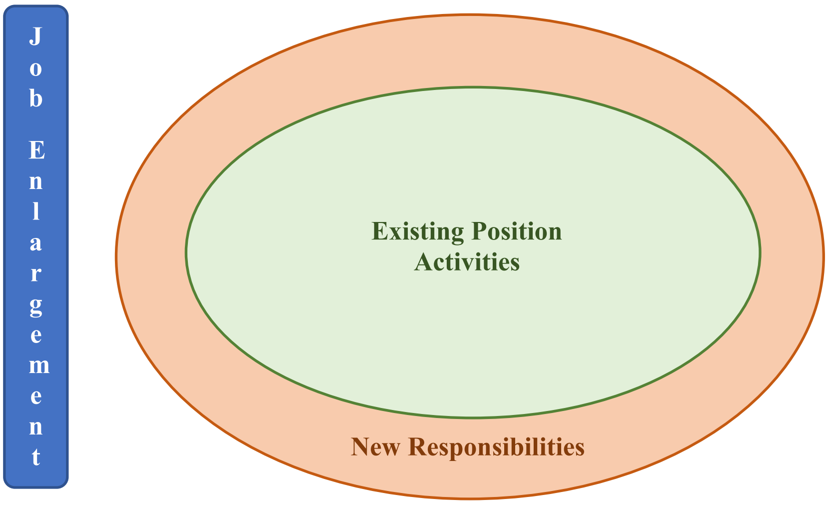
Job task rotation is a strategy where employees rotate to different tasks to benefit both the employee and the employer. Job rotation is aimed at increasing employee interest and motivation levels (Kokemuller, 2019). Job task rotations will deepen an employee's skill set and offer the employer more depth, with the benefit of more employees having skills in each functional area. In the case of absences, having numerous capable replacements will be valuable. Not only will employees develop more skills with a job task rotation system in place, but it will also limit boredom, reducing the likelihood of injuries. Employees will develop more skills in a range of different tasks, which will offer them job stability and the prospect of better opportunities (Kokemuller, 2019). Despite benefits related to multiple skill development, job rotation has disadvantages. Experienced employees may be reluctant to move out of their comfort zones, or employees who use teamwork may struggle to give up their friendship groups. Training employees can be costly. Moving employees into different positions will require investment in time and capital. There are the costs of time lost due to training and the cost of the trainers or managers delivering the training. During the training and subsequent acclimation period, one can expect a loss of productivity, with the added risk that some employees may not be suitable for specific tasks, regardless of how effective the training program is (Kokemuller, 2019).

2.4.9 Job Enlargement

Job enlargement refers to the horizontal expansion of a job, as depicted in Figure 2.6. This expansion involves broadening the job scope and increasing the associated range of tasks. (MBA Skool, 2021). In practice, this means an employee will do more activities in their current role (AIHR, 2022). Job enlargement assists in determining the necessary skills, duties, and responsibilities of an employee. It also fosters an awareness of increasing importance as individuals take on greater responsibility and accountability within the organisation due to the expanded scope of their work. With management support and suitable training, employees can effectively adapt to the enlarged job role. While this process may require time, the outcome of this strategy will always be advantageous for the organisation (MBA Skool, 2021).

Figure 2.6

Job Enlargement Illustration



Note. Job enlargement, as depicted, involves horizontally expanding a job by broadening its scope and increasing the range of associated activities the employee can perform.

MBA Skool. (2021, August 26). *MBA Skool*. Retrieved from Job Enlargement Meaning, Importance & Example: https://www.mbaskool.com/business-concepts/human-resources-hr-terms/3113-job-enlargement.html

Job enlargement offers advantages for both employees and employers. It involves training employees in various skills, promoting personal and professional development, fostering career growth, and providing opportunities for higher wages. This approach leads to increased job satisfaction and alleviates the monotony of repetitive tasks, resulting in reduced employee turnover rates, which benefits the organisation. However, job enlargement has some drawbacks, such as an increased workload for employees and added work pressure, which may impact the quality of their work. (MBA Skool, 2021).

In the meat processing industry, job rotation and enlargement must be carefully designed to provide effective rest for different muscle groups. Task analysis and consideration of the specific demands of each workstation in the work sequence are essential. By factoring in these aspects, the work process can be optimised to reduce the risk of MSDs (Tappin, Moore, Ashby, Bentley, & Trevelyan, 2006).

2.4.10 Insufficient Rest Breaks

Park, Lee, and Lee (2020) found significant associations between insufficient rest breaks and an increased risk of MSDs and recommended rest breaks as a workplace intervention for preventing MSDs.

In New Zealand, one of the initial reports attributing lower injury rates to reduced manual handling and the implementation of an additional five-minute break at the conclusion of each working hour (as part of a safety program) was published in the Gazette of 1967. Tappin et al. (2006) reported that the Gear Meat Company in Petone, near Wellington, witnessed a decline in lost time accidents from 20 per 100,000 work hours in 1962 to approximately 8 per 100,000 work hours five years later (Gazette, 1967). In 1962, the national incidence rate for the meat industry stood at 14.7 per 100,000 work hours. The noteworthy achievement of the company was not only transitioning from being below average to becoming a high-performing entity but also observing improved production levels and a decrease in injuries attributed to progressive fatigue. The advantages of the safety program outweighed the associated costs, with savings realised in reduced production downtime, recruitment expenses, equipment, clothing, and the training of new staff members (Tappin et al., 2006).

Earlier research by Sundelin and Hagberg (1989) and (Genaidy, Delgado, & Bustos, 1995) as cited by Tappin et al. (2006) reported the following three types of breaks:

- Passive breaks, during which the employee relaxes at his/her post.
- Active breaks, during which employees are required to stretch and carry out other dynamic movements.
- ‘Free’ breaks, where the employee was allowed to move around freely in their work area.

According to Genaidy et al. (1995), a four-week intervention involving self-selected active (stretching) micro-breaks led to significant reductions in perceived discomfort levels among employees. These micro-breaks allowed workers to take two-minute breaks, accumulating to

24 minutes (equivalent to 5% of their working day). However, how such breaks were facilitated for employees working on the chain remains unclear.

Only a few objective studies conducted in the New Zealand meat industry have explored feasible work-rest patterns. It is worth noting that most of these studies were conducted in laboratory settings rather than in actual plant environments. (Tappin, Moore, Ashby, Bentley, & Trevelyan, 2006). Wood, Fisher, and Andres (1997) conducted a laboratory study in which three work-rest schedules were compared using a hand dynamometer. The findings revealed that the most effective work-rest pattern involved medium-force contractions and moderate-duration rest periods. Conversely, the most fatiguing pattern was observed when maximal force was exerted in short bursts with long rest intervals. Low force-short work-rest patterns were marginally more fatiguing than the medium force contractions with moderate duration rest periods. According to P. White (personal communication, May 12, 2021), Slaughterboard supervisor at AGL Lorneville plant employees prefer passive breaks to active breaks and that passive breaks might be the more effective for preventing MSD in the meat processing industry. Several researchers supported his statement (Henderson et al., 1994, cited in Loppinet & Aptel, 1997).

Dababneh, Swanson, and Shell (2001) conducted a study comparing the effects of short half-hourly breaks and more extended rest breaks each hour on the productivity and well-being of 30 workers in a meat-processing plant. The regular break schedule consisted of two 15-minute rest breaks and a 30-minute lunch break. An additional 36 minutes of break time was provided during the trial periods compared to the regular break schedule.

In the first trial, workers received 12 breaks of 3 minutes each, evenly distributed throughout the workday (with a 3-minute break for every 27 minutes of work). In the second trial, workers received four 9-minute breaks, also evenly distributed throughout the workday (with a 9-minute break for every 51 minutes of work). The researchers recorded production rate, discomfort levels, and stress ratings.
It was unclear whether the additional break time was compensated for by increasing the line speed or if it was added to the overall workday duration. However, the findings indicated that the 9-minute break schedule improved discomfort ratings without negatively impacting

production across both trials. Furthermore, most employees preferred the 9-minute rest break schedule, suggesting that employees are unlikely to accept the fragmentation of break time into short, recurrent breaks (Dababneh, Swanson, & Shell, 2001).

Many researchers supported the findings that rest breaks or pauses at work help recovery from fatigue and reduce the incidence of MSDs (Nagasu, et al., 2007; Wami, Dessie, & Chercos, 2019). A recent review of workplace interventions targeting musculoskeletal disorders (MSDs) in office and agriculture workers examined the outcomes of randomised trials. The review revealed that incorporating additional rest breaks, as compared to standard rest breaks, resulted in a reduction of musculoskeletal symptoms in the neck, shoulder, back, and upper limbs (Stock, et al., 2018).

Implementing various work-break schedules can be beneficial in reducing extended periods of repetitive workloads. Such schedules can also help to break up prolonged periods of static or awkward work postures, which are recognised risk factors for the development of work-related musculoskeletal disorders (Luger, Maher, Rieger, & Steinhilber, 2019).

2.4.11 Manual Handling Risk Factors

Meat processing is a labour-intensive industry that requires frequent manual handling of heavy loads of meat products at high frequencies (Bottia, Morab, & Regattieri, 2015). The most common manual handling risk factors in the Australian meat industry were identified as high-frequency handling, awkward grips, forward reaching, bending, and twisting, poor workstation design, and handling of heavy loads (Waniganayake & Steele, 1990). According to Caple (2003), the injury claims rate for the meat processing industry between 1998 and 2001 was four times higher compared to the manufacturing industry. Additionally, Caple (2003) noted that manual handling claims constituted 54% of these claims, with the associated costs being nearly 50% higher than other types of injuries (as cited in Tappin, 2009).

The researcher's initial observations and data analysis in the current study provide further support for the findings above, emphasising the significant role of manual handling risk factors in developing MSDs at AGL. Each manual handling risk factor encompasses various contributing factors that impose additional workload beyond the typical work task cycle. For example, insufficient maintenance practices or reliance on reactive rather than preventive maintenance can lead to unexpected equipment breakdowns, thereby increasing the risk of

MSDs due to the additional manual handling required during such breakdown periods. A comprehensive discussion of the influential factors related to manual handling risks will be presented in dedicated subsections.

2.4.12 Awkward Work Posture

Meat processing workers face significant pressure to sustain elevated work rates, engaging in physically demanding repetitive tasks while frequently assuming awkward postures (see Figure 8). Ergonomic risk assessments consistently demonstrate that manual handling activities performed under these conditions expose meat-processing workers to substantial physical risks (Bottia, Morab, & Regattieri, 2015).

According to (Andrasfay, Raymo, Goldman and Pebley (2021), awkward work postures occur when joints are moved outside of their normal range of motion, positions that deviate significantly from neutral positions while performing work activities. When joints are in an awkward position, muscles operate less efficiently, and more force must be applied to perform the task. According to OSHA "Working in awkward postures increases the exertion and muscle force an employee must apply to complete a task and compresses tendons, nerves and blood vessels. Generally, the more extreme the postures, the more force is needed to complete the task." (Ferraro, 2014, p. 1). Ferraro (2014), identified five awkward postures that should be avoided; these include:

Working with Your Hands Above Shoulder or Head Height. Working with hands positioned above shoulder or head height is common in various workplaces at AGL and throughout the meat processing industry (see Figure 2.7). Working with hands positioned above shoulder or head height creates an additional strain on the spine, shoulders, and neck, leading to increased arm fatigue. This posture places additional stress on the musculoskeletal system, potentially causing discomfort and increasing the risk of injuries. The elevated position also heightens the risk of accidental tool or object drops, which can result in injuries to oneself or others in the vicinity. It is important to be cautious and employ appropriate ergonomic practices to minimise the strain on the body and reduce the likelihood of accidents.

Twisting of the Spine. In numerous work situations, employees reach for objects without adjusting their feet or aligning their spine with the work area. Figure 2.8 depicts several work tasks at AGL that involve or result in twisting of the spine. When employees twist their spines in such positions, their risk of injury is heightened.

The entire body must be turned to face the item to prevent injuries. Whenever possible, adjust the positioning of the items to eliminate the need for such motions.

Figure 2.7

Work Tasks at AGL That Requires Working Above Shoulder or Head Height

Note. The collage of images shows a selected range of work tasks at AGL that require working above shoulder or head height. The researcher took these pictures with permission from the employees to illustrate these tasks.

Figure 2.8

Work Tasks at AGL That Require or Cause Twisting of the Spine

Note. The collage of images showcases a variety of work tasks at AGL that involve twisting of the spine. The researcher obtained permission from the employees to capture these pictures, which illustrate these tasks.

Bending Down. There are multiple reasons why employees may need to bend down during work tasks (see Figure 2.9). They could do so to access a specific area requiring attention, pick up products, or get closer to an item they are working on. However, this awkward posture strains the employee's neck and back. Bending can also affect their balance, increasing the risk of falls.

Figure 2.9

Work Tasks at AGL That Requires Bending and Reaching Downwards

Note. The collage of images depicts a diverse range of work tasks at AGL that involve bending down. The researcher received permission from the employees to capture these pictures, which serve as visual representations of these tasks.

The following are some simple ways to lessen the need to bend down or reach downward while performing work activities:

> *Raised work platform* - When cutting products, place the product on a raised platform that reduces the need to bend over to reach it.

Floor cart – When the item being worked on cannot be moved, use a floor cart to slide the worker into a position that will allow for a more natural position to work in.

Suitable tools—Use specially made tools that allow workers to work on an item that is lower to the ground without bending down.

While raising the work object or item may seem obvious, this aspect is often overlooked during the design stages and can be challenging to retrofit. However, elevating the item makes maintaining a more natural work posture easier. It is crucial to be mindful of awkward postures that involve bending and to explore alternative ways of accessing and working on products or items. Discovering improved methods to access items while working not only ensures the safety of employees throughout the day but also aids in reducing the risk of injuries (Ferraro, 2014).

Low Squatting and Kneeling. Engaging in low squatting or kneeling positions to protect the back (Figure 2.10) by utilising leg muscles still poses a risk of injury to the individual. These positions exert considerable pressure on the knees, leading to discomfort and pain over time. Moreover, maintaining balance becomes challenging during low squatting, particularly when lifting objects, thereby further heightening the risk of injury (Ferraro, 2014).

Kneeling on one knee or low squatting places high forces on the knee joint and should not be sustained for long periods of time as this may result in knee strain. Frequent changing of posture will reduce the cumulative effect on the tissues (Pollard, Porter, & Redfern, 2011).

Numerous work tasks at AGL (as depicted in Figure 2.11) involve low squatting and kneeling postures. It is advisable to avoid these awkward positions whenever possible and instead utilise aids such as floor jacks or forklifts. When low squatting is necessary, it is important to pay attention to correct knee angles and foot placement (In Balance Physio and Pilates, 2015). By doing so, the overall risk can be reduced, and a more stable posture can be achieved for the task at hand (Pollard, Porter, & Redfern, 2011).

Figure 2.10

Correct Knee Angles and Foot Placement for Low Squatting Tasks

Note. The image by In Balance Physiotherapy and Pilates highlights the distinction between good and poor knee angles during low squatting. When engaging in low squatting, it is crucial to prioritise correct knee angles and correct foot placement. (In Balance Physio and Pilates, 2015).

Figure 2.11

Work Tasks at AGL That Requires Low Squatting and Kneeling Postures

Note. The collage of images portrays selected work tasks at AGL that involve low squatting and kneeling postures. The researcher obtained permission from the employees to capture these images.

Bending or Twisting of the Wrists. Weak wrists are a common contributing factor to wrist injuries, particularly in activities that involve repetitive bending or twisting of the wrists (as illustrated in Figure 2.12). These actions can result in inflammation of the surrounding tissues or even stress fractures. Therefore, it is crucial to prioritise wrist strength and ensure correct technique to minimise the risk of such injuries (Mayo Clinic, 2022).

While our wrists are naturally capable of securely holding items, performing tasks that involve bending or twisting while maintaining strength can be challenging. Opening jars or engaging in similar movements can become increasingly difficult under such circumstances.

To mitigate the risk associated with bending or twisting of the wrists, it is advisable to minimise such movements and consider alternative approaches to complete tasks. Maintaining good wrist angles, lifting items, and rotating the arms instead of relying solely on wrist movement is a safer and easier method. This approach not only reduces wrist fatigue but also mitigates the potential for accidents or injuries (Ferraro, 2014). By adopting these practices, employees can safeguard their wrist health and overall well-being while performing work tasks.

Figure 2.12

Work Tasks at AGL That Requires Bending or Twisting of the Wrists

Note. The collage of images depicts a wide array of work tasks at AGL that involve bending or twisting of the wrists. Permission was obtained to capture these images.

2.4.13 Static Posture

Static postures involve maintaining the same position or posture during a work task. These tasks impose greater stress on the muscles and tendons, leading to fatigue. The static nature of these postures increases the muscular effort required, while the absence of movement restricts the necessary blood flow for tissue recovery. This restricted blood flow hinders the supply of nutrients to the muscles and the removal of waste products, such as acids, from the tissues. Consequently, limited blood flow reduces the oxygen delivery to the working muscles, hastening the onset of fatigue (JR Ergonomics, 2022).

In the meat industry, various work tasks necessitate static postures, as depicted in Figure 2.13. One typical example is gripping tools for extended durations. Additional instances include:

- Butchers (constantly holding onto a knife while maintaining their posture at their workstations).
- Carton scanners (constantly holding onto a scanning gun).
- Supervisors watching a computer monitor or processing screens above eye level (often seated for prolonged periods).
- Labourers (constantly holding onto their work tools while maintaining their posture at their workstations).
- Graders (maintaining a prolonged static posture at their workstations).

Static or stationary postures, which involve remaining in a single position for a prolonged period, are a frequent source of back, neck, and leg pain.

Working with an awkward posture puts significant stress on the spine, which can result in accelerated muscle fatigue and pain. Consistently reminding employees to avoid or limit such awkward postures (as shown in Figure 2.14) is crucial. These postures are widely recognised as contributing factors to MSDs. By promoting correct and ergonomics, employers can help reduce the risk of MSDs and create a healthier and safer work environment for their employees. Regular training, ergonomic assessments, and providing suitable equipment or tools can further support the prevention of these injuries (Colby Education, 2022).

Figure 2.13

Work Tasks at AGL That Require Frequent Static Postures

Note. The collage of images depicts a wide array of work tasks at AGL that involve working in stationary positions. Employee permission was given for the capture of these images.

Figure 2.14

Work Tasks at AGL that Places Employees in Awkward Postures

Note. The collage of images illustrates a wide range of work tasks at AGL that subject employees to awkward postures, thereby increasing the risk of MSD-type injuries. The employees provided permission to capture these images.

2.4.14 Poor Posture

Postural strain often leads to spinal discomfort in many individuals. Generally, good posture is developed during childhood, and young children tend to exhibit commendable postural habits. However, this changes when individuals are compelled to assume awkward positions in their work environment. Several factors can influence posture, including maintaining level eyesight and facing forward, as well as ensuring balanced muscle engagement around the pelvis and shoulder girdle areas (Normal Posture, 2023). Poor posture, while seated (refer to Figure 2.15), is one of the primary culprits behind low back pain. This occurs as a result of excessive pressure exerted on the joints, muscles, and discs when adopting a slouched position during sitting (Harvard Medical School, 2019). The position of the pelvis influences the sitting posture, specifically its degree of backward or forward tilt. In an ideal sitting posture (refer to Figure 2.15), the pelvis should be in a neutral tilt, ensuring vertical alignment of the front edges of the pubic and ilium bones, also known as the ASIS. This alignment is widely recognised as the optimal position for maintaining good posture while seated (Normal Posture, 2023).

Figure 2.15

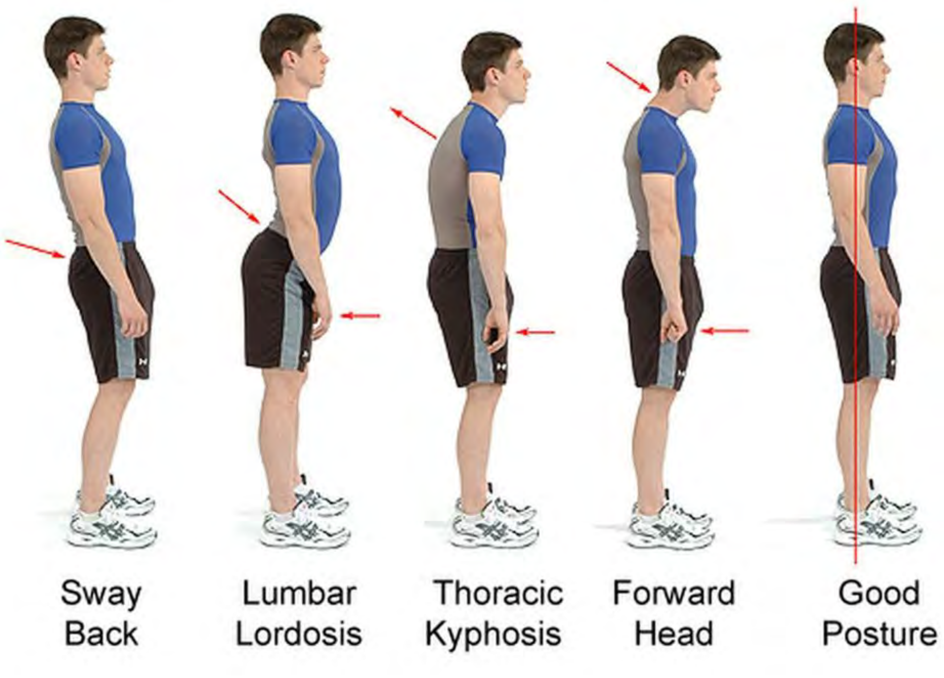
Posture Variations When Seated

Note. The images illustrate the contrast between good and poor seated posture, which is relevant as many tasks at AGL require employees to work in a seated position. The basics of posture. (2019). Retrieved from: http://www.health.harvard.edu/media/2146.

Poor standing posture poses a significant risk factor for spinal pain and contributes to numerous MSDs associated with the spine. Ideally, when observed from the side, the head and pelvis should be level with a neutral tilt, while the ears should align directly above the shoulders and hips. A straight line drawn through these three points should pass through the knee and extend slightly in front of the ankles, reaching the ground. The body should display a predominantly symmetrical appearance from the front or back. When viewed from the back, the spine typically appears straight, although minor variations may occur due to activity and dynamic movement. Over time, poor postures can lead to the development of excessive spinal curves, as depicted in Figure 2.16 (Normal Posture, 2023).

Figure 2.16

Poor Posture When Standing



Note. The images illustrate the contrast between good and poor standing posture, which is relevant as many tasks at AGL require employees to work in prolonged standing positions. *Normal posture.* (2023). Retrieved from: http://www.ennisphysioclinic.ie/posture.html

According to Patton and Thibodeau (2016), muscles play a vital role in maintaining posture. Good posture facilitates optimal body alignment to support functioning. This alignment can be achieved by ensuring that the body's centre of gravity remains over its base, thereby minimising the muscular effort required. Muscles continuously pull on bones in the opposite direction to gravity to sustain posture.

In addition to the muscular system, other structures, such as the nervous system, play a role in maintaining posture. The nervous system is responsible for muscle tone and regulating and coordinating the amount of pull exerted by individual muscles. Furthermore, the respiratory, digestive, excretory, and endocrine systems all contribute to the maintenance of posture (Patton & Thibodeau, 2016). During work, posture can be recognised as either static or dynamic. Acknowledging that a combination of both types often occurs concurrently is crucial. This means that while one part of the body performs the work, other areas are responsible for stabilising the rest of the body to perform the task.

Standing workstations are the predominant choice for workstations in the meat industry. When working in a standing posture, it is essential to maintain a straight alignment of the spine. Bending should be minimised and not sustained for prolonged periods while completing tasks. Several factors need to be considered to alleviate strain on the spine and muscles, including hand movements, foot positioning, stability of the standing surface, head position, and sight lines. Moreover, the task's nature will determine the appropriate height for the workstation. For precision work, increased support for the upper limbs is necessary, while heavy work requires the utilisation of body weight during task execution (Normal Posture, 2023).

Maintaining good posture during work activities enhances employees' work efficiency, conserves energy, and minimises fatigue. Efficient work postures contribute to better balance and support the body, including the internal organs. Employees must be mindful of their work postures to prevent potential issues from arising later in life (Syed Ali, Kamat, & Mohamed, 2018).

2.4.15 Repetitive Work, Muscle Load and Fatigue

Repetitive movements are a significant risk factor in the workplace (Riley, 1998); (Nossent, de Groot, & Verschuren, 1996). Defined as cyclical activities involving repeated motions of specific body parts, repetition encompasses tasks performed repeatedly with slight variations over time. In meat processing, this occurs due to maximising production efficiencies by simplifying worker movements. Repetitive work can lead to physiological problems such as muscle fatigue and increased muscle loading, leading to changes in tissue density and tissue exertion. Repetitive movements exert tissues, influenced by the properties of the materials constituting the tissue. Viscoelastic materials deform slowly under force and return to their original shape after the force is removed. Most body tissues, such as muscles, tendons, and ligaments, are made of viscoelastic materials (Pavlovic, 2013). MSDs develop when risk factors associated with MSDs cause a musculoskeletal imbalance due to fatigue outpacing recovery (refer to Figure 2.23). This imbalance occurs when the loading on these tissues exceeds their ability to recover, especially when workers are exposed to MSD risk factors. Repetitive work poses a dual risk factor: it creates physical strain and imposes organisational constraints leading to psychological strain. Additionally, concerning the causes, it should be noted that short-cycle work is attributed not only to automation and technology but also to how work is organised (Nossent, de Groot, & Verschuren, 1996).

2.5 Contextual Factors

Contextual factors encompass various social, economic, cultural, political, and organisational elements that collectively contribute to developing physical and psychological risk factors associated with MSDs. These factors interact and create conditions that can affect the health and well-being of individuals in the workplace (Tappin, Bentley, & Vitalis, 2008).

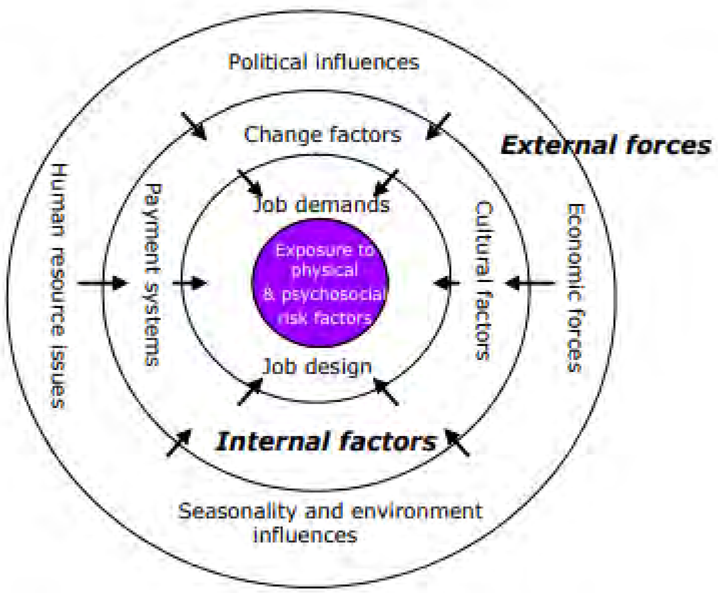
Contextual factors, including external forces, significantly shape the industry environment. Extreme environmental conditions, such as floods or droughts, directly impact the work environment and physical demands on employees. National unemployment rates also influence industry structure and management practices, affecting working conditions and employee experiences. These external elements can subsequently affect internal workplace factors. Increased job demands due to changes in industry structure or intensified production goals contribute to higher physical and psychological strain on employees. Monotonous work environments with repetitive tasks and limited variation pose risks to musculoskeletal health. Reduced autonomy, resulting from organisational practices or management decisions, limits employees' control over work processes and increases the risk of MSDs (Tappin, Bentley, & Vitalis, 2008).

Overall, contextual factors encompass various influences that shape the work environment and contribute to physical and psychological risk factors associated with MSDs. External forces, such as extreme environmental conditions and unemployment rates, can cascade into internal factors, resulting in anticipated risk factors like increased job demands, high task repetition, monotony, and reduced autonomy. Recognising and addressing these contextual factors is crucial for organisations to promote healthier and safer work environments.

Tappin, Bentley, and Vitalis (2008) examined contextual factors related to MSDs across 28 New Zealand meat industry plants. Figure 2.17 provides an overview of the relationship between various contextual factors identified by Tappin et al.

Figure 2.17

Role of Contextual Factors in MSD Causation in Meat Processing as Viewed by Tappin et al.(2008)



Note. The image depicts the spectrum of external forces and internal factors that influence and contribute to physical and psychosocial risk factors affecting employees, heightening the risk of MSDs (Tappin, Bentley, & Vitalis, 2008).

Among the contextual factors, job demands and human resource issues were identified as the most frequently mentioned factors directly impacting staff with the risk of MSDs. In contrast, staff expressed lesser concern regarding external factors like payment and scheduling systems (Tappin, Bentley, & Vitalis, 2008).

Table 2.4 summarises contextual factors associated with MSDs in meat processing, as identified by Tappin, Bentley, and Vitalis (2008). The contextual factors are ranked based on the percentage scores assigned to each factor within plant and staff groups, with a higher percentage indicating greater importance in the ranking order.

Table 2.4

Summary of Contextual Factors for MSD in Meat Processing

Contextual factor group	**Contextual factor origin**	**Contextual factors ranked**
Cultural influences	Internal	1 - Culture of high work pace 2 - Competitive and entrenched culture 3 - Machoistic culture 4 - Mono-causality belief 5 - 'Blame the victim' culture
Political and human relations influences	External & internal	1 - Seniority factors 2 - Level of workforce participation 3 - Adversarial relationship between management and workers 4 - Hygiene compliance requirements
Economic factors	External	1 - Company mergers, plant closures 2 - Low national unemployment 3 - Export focus 4 - High exchange rates
Human resource issues	External & internal	1 - Labour resourcing 2 - Staff and skill retention issues 3 - Training factors 4 - Preparedness of recruits 5 - Ageing workforce 6 - Limited career pathways

Table 2.4 *(Continued)*

Summary of Contextual Factors for MSD in Meat Processing

Contextual factor group	Contextual factor origin	Contextual factors ranked
Job demand factors	Internal	1 - Production pressures 2 - Work compression and scheduling 3 - Low control of work planning and method 4 - Variability in workflow 5 - Task complexity 6 - Increases in carcass weights
Job design factors	Internal	1 - Barriers to job rotation and enlargement 2 - High job specialisation
Payment and scheduling systems	Internal	1 - Work compression 2 - Bonus systems 3 - Piece-rate work
Change factors	Internal	1 - Entrenched industry resistant to change 2 - Competitive nature of the industry 3 - Industry scepticism about MSD 4 - Low participation in the workforce 5 - Pre-contemplative management
Seasonality and environmental influences	External & internal	1 - Off-season issues – recruitment, retention 2 - Workload variability 3 - Weather impacts on workflow

According to Tappin, Bentley, and Vitalis (2008), health and safety staff exhibited a higher percentage of identifying contextual factors related to MSD risks than managers and processing staff. This disparity can be attributed to the health and safety staff's heightened awareness of MSDs and their involvement in addressing risks and managing injury cases. Furthermore, the health and safety staff emphasised cultural influences and change factors more than managers and processing staff, indicating a deeper understanding of the multifaceted nature of MSDs specific to meat processing. Managers and supervisors identified similar factors concerning human resourcing, job demands, and job design. In contrast, processing staff displayed a greater familiarity with risk factors directly associated with the specific aspects of their work, such as job demands and human resource issues.

2.5.1 Cultural Influences on MSD Risk

Within the meat industry, companies and plants vie for shared resources. Coupled with condensed processing seasons, specialised processing demands, and an emphasis on production volumes, this dynamic gives rise to fast-paced work environments and extended working hours, leaving little time for rest breaks. Work practices that prioritise production can impede efforts to prevent MSD injuries (Tappin, Bentley, & Vitalis, 2008). A significant hindrance to efforts in preventing musculoskeletal disorders (MSDs) is the prevalence of a "blame the victim" mentality, attributing injuries to individual characteristics such as resilience, work technique, and false reporting. Previous MSD prevention initiatives have been flawed due to the assumption that an MSD has a single cause, neglecting to recognise the complex nature of MSD incidents with multiple risk factors involved. Despite a growing emphasis on early symptom reporting and the implementation of more comprehensive injury prevention strategies, the meat processing industry continues to be characterised by a "machoistic" culture, where toughness and work speed are rewarded and respected, while pain and discomfort are deemed unavoidable and expected to be endured or worked through. (Tappin, Bentley, & Vitalis, 2008).

2.5.2 Political and Human Relations Influences on MSD Risk

During various stages of meat processing, overseas market requirements (OMAR) and regulatory bodies impose strict expectations regarding hygiene compliance. As Tappin, Bentley, and Vitalis (2008) noted, these requirements and production considerations are often prioritised as business imperatives, potentially overshadowing health and safety concerns. For instance, when physical design limitations are in place to prevent contact with specific surfaces, these constraints can inadvertently elevate the risk of MSDs.

The meat industry experiences a high degree of unionisation, introducing a significant political factor. This factor often leads to divided relations between management and the workforce. Consequently, employee engagement in health and safety initiatives and other work organisation and design aspects becomes limited. This divide acts as a barrier to effectively reducing musculoskeletal disorder (MSD) risks throughout the industry (Tappin, Bentley, & Vitalis, 2008). Health and safety concerns are frequently utilised as bargaining chips to negotiate better employment conditions, even when unrelated to the original issues raised. Unfortunately, this practice fosters scepticism between the involved parties and diminishes the recognition of musculoskeletal disorders (MSDs). Consequently, opportunities for staff participation in matters affecting their workplace are curtailed.

In the meat industry, a seniority system is prevalent in most plants. This system provides security to workers and employers by determining factors such as the timing of staff return after seasonal shutdowns, job roles, and set pay levels. The seniority system grants the highest job security throughout the working year to workers who have been with the plant for the longest period. While the seniority system offers security to some individuals, it can also be a potential risk factor for MSDs. It is a barrier to implementing alternative work options that could reduce MSD risk. This can lead to an increased risk of MSDs due to limited training opportunities, restricted staff rotation, and minimal staff transfers. Moreover, it can potentially contribute to staff turnover, as career progression may depend on others retiring or leaving the plant. Workers with low seniority may be limited from training for tasks with higher seniority, while senior workers may not rotate to tasks with lower seniority. Additionally, the seniority system can discourage department or shift transfers, as transferring often results in a loss of seniority (Tappin, Bentley, & Vitalis, 2008).

2.5.3 Economic Factors Influence on MSD Risk

As stated by the Meat Industry Association (2007), fluctuations in the exchange rate have various impacts on the meat industry. They can increase production, reduce production costs, and promote value-added production. However, these fluctuations also contribute to an increased risk of MSDs. This is due to limited staffing numbers, reduced recovery time, shorter training periods, an accelerated work pace, and the introduction of new processing requirements.

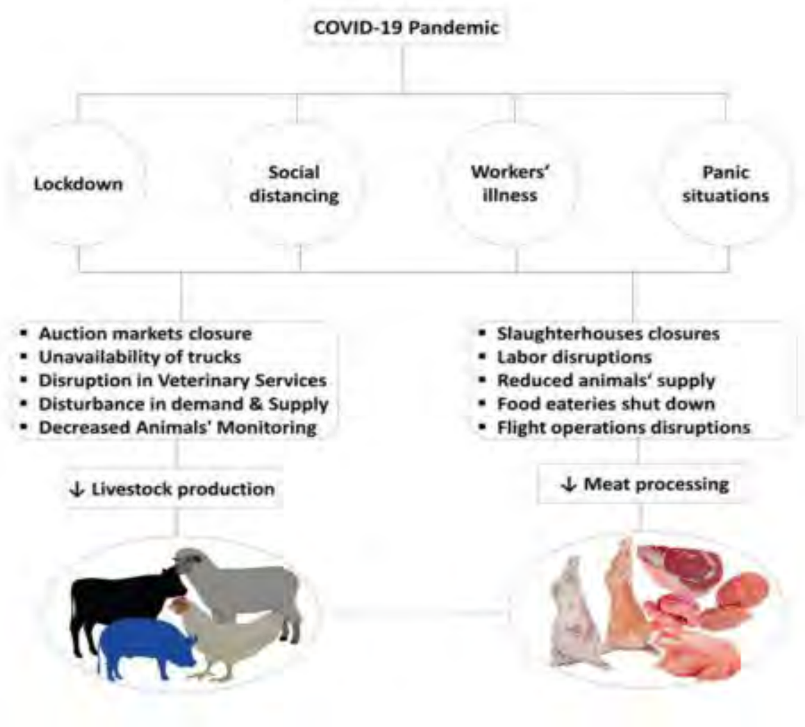
Furthermore, the industry faces challenges related to staffing shortages caused by low national unemployment levels. This puts additional pressure on meat processing plants, which must operate with fewer staff members. As a result, employees are overloaded with extended work hours and have limited training and skill development time. These circumstances exacerbate the risk of MSDs within the workforce.

The COVID-19 pandemic profoundly affected meat production, resulting in disruptions throughout the supply chain and volatile fluctuations in meat prices. These challenges ultimately contributed to a widespread socio-economic crisis that reverberated globally (Ijaz, et al., 2021). In the early stages of the pandemic, meat product prices surged due to reduced production and increased demand. However, as lockdown restrictions were imposed and consumers faced decreased purchasing power, the prices of meat products subsequently declined. The closure of meat packing facilities due to the rapid spread of the COVID-19 virus among workers further strained the industry. Figure 2.18 shows the various obstacles meat producers and processors encountered in harvesting and shipping their products due to lockdown measures, a decrease in the available workforce, and restrictions on animal movement within and between countries. Additionally, changes in legislation pertaining to local and international export markets presented additional challenges for the industry (Ijaz, et al., 2021). In New Zealand, the meat processing industry was classified as an essential service and permitted to operate during the lockdown period. However, various restrictions were implemented to mitigate the spread of COVID-19 within the industry. These measures included enforcing social distancing protocols in processing areas, implementing separation screens between workers, and mandating additional PPE like masks and full facial screens. Despite these precautions, these conditions gave rise to an increased risk of MSDs due to factors such as heightened workloads, elevated rates of absenteeism, restricted workspaces, changes in work speeds, and the adjustment required when working with additional PPE (e.g., dealing with safety glasses fogging up).

Figure 2.18, as presented by Ijaz et al. (2021), depicts the impact of COVID-19 on meat production and the associated supply chain.

Figure 2.18

Impact of COVID-19 on Meat Production and Supply Chain as Viewed by Ijaz, et al. (2021)



Note. The illustration provides a comprehensive overview of the factors influencing meat production and the associated supply chain during the COVID-19 pandemic.

Ijaz, M., Yar, M., Badar, I., Ali, S., Islam, M., Jaspal, M., . . . Guevara-Ruiz, D. (2021, May 7). Meat Production and Supply Chain Under COVID-19 Scenario: Current Trends and Future Prospects. *Frontiers in Veterinary Science, 8*(660736), 1-10. doi:10.3389/fvets.2021.660736

Nevertheless, the New Zealand meat industry exhibited remarkable resilience and adaptability, successfully navigating most of the challenges presented by the pandemic. Companies like AGL have even achieved record profits, showcasing the industry's ability to overcome obstacles and thrive amidst adversity (McAvinue, 2022).

2.5.4 Human Resource Issues for MSD Risk

The meat industry encounters several challenges in attracting new staff, which can be attributed to various factors. One notable hurdle is the geographical placement of many meat processing plants in remote areas, which restricts the available labour pool for recruitment. Moreover, factors such as low unemployment rates, comparatively modest wages, a shortage of skilled workers, limited prospects for career progression, and the potential availability of more enticing job opportunities all contribute to an elevated risk of musculoskeletal disorders (MSDs) among the existing workforce in the industry. (Tappin, Bentley, & Vitalis, 2008). Attracting employment to the meat industry is also impacted by long off-seasons, weekend work and the requirement to work night shifts.

According to G. Vincent (personal communication, October 19, 2022), HR manager at AGL, we have an ageing workforce, with the median age of the employees being over 50 years. The retirement of highly skilled older staff raises concerns, as it contributes to higher staff turnover and gradually diminishes the industry's pool of experienced workers. Given the physical demands of the workload, an ageing workforce is more susceptible to MSDs due to the accumulated wear and tear on their musculoskeletal systems over the years. Furthermore, a considerable proportion of workers in this demographic may have pre-existing conditions that further exacerbate their vulnerability to MSDs (Tappin, Bentley, & Vitalis, 2008).

According to reports, new entrants and younger workers are reportedly less physically prepared for heavy work compared to previous generations. This lack of physical preparedness may contribute to the higher turnover of new staff who struggle to cope with the physical demands of their tasks. These employees require an extended conditioning period to adapt to the increased physical demands, thereby increasing the likelihood of sustaining an MSD injury during this transitional phase. The delayed reduction in physical task requirements within the industry further narrows the pool of potential staff, including younger and ageing candidates, who can efficiently perform the required tasks.

Several training factors also influence MSD risk. Tenure and the number of acquired skills often determine the progression and compensation of employees, which can restrict training and development opportunities for many. Seniority can be a barrier to training, as employees may resist training for tasks of lower seniority in favour of those with higher seniority. Most of the training in the industry is hands-on and occurs during processing, which increases the risk of MSDs. This is due to reduced training effectiveness caused by divided attention influenced by production noise, incomplete information resulting from poor communication, and the transmission of poor technique due to the perpetuation of bad habits (Tappin, Bentley, & Vitalis, 2008).

2.5.5 Seasonality and Environmental Influences on MSD Risk

The red meat processing industry in New Zealand is inherently seasonal, as it depends on the availability of pasture-grazed stock. As a result, most meat processing plants have an off-season period ranging from a few weeks to several months. Environmental factors that affect pasture growth and stock procurement influence the timing of starting up processing lines. This has implications for staff recruitment and training, as it is based on projected stock volumes.

However, this approach to recruitment and training can introduce additional risks for MSDs. The combination of high workloads and inadequate training during the busy season to meet the demands of slaughter and processing can lead to overworking and undertraining of staff. The need to process a higher stock volume within a limited timeframe can strain the workforce, increasing the risk of MSDs.

The industry must carefully manage workloads and provide sufficient training and support to mitigate the risks associated with these seasonal fluctuations. Prioritising the well-being and safety of employees through effective workload management and comprehensive training programs can help reduce the incidence of MSDs and ensure the industry's sustainability.

In their study, Tappin, Bentley, and Vitalis (2008) discovered that concerns regarding work pace, work duration, and the effects of seasonality and line balancing factors could lead to longer working hours. Consequently, this can result in an increased workload and limited training opportunities. The combination of these factors exposes employees to a higher risk of developing MSDs due to the physical and psychosocial risk factors associated with the seasonal nature of the work. Additionally, there is a possibility of reduced physical work capacity upon returning to processing work after a seasonal break.

2.5.6 Job Demand Factors for MSD Risk

The average carcass weight for exported lamb increased from 14 kg to 18 kg over the last 15 years (Morris, 2013). According to the Meatworkers' Union, the quantity of products handled by each individual in the meat processing industry has significantly risen over the years. In 1980, it was estimated to be around 23 tonnes per person employed, whereas in 2004, it reached approximately 37 tonnes. This increase can be attributed partially to the higher carcass weight, the subsequent growth in production, and the increased expectations for productivity. Consequently, this has impacted workloads and other physical risk factors, ultimately influencing the pressure to meet production targets. It is important to note that competition within the meat industry plays a crucial role in driving innovation and fostering productivity growth (Keogh, 2017). There has been a shift in focus from prioritising yield to emphasising increased productivity. As a result, many workstations have been automated, chain speeds have been elevated, and there is a greater degree of job specialisation in more confined workspaces. This transition poses challenges for new workers as they strive to match the pace of their more experienced colleagues while simultaneously developing their skills and physical abilities (Tappin, Bentley, & Vitalis, 2008). A study conducted by the Institute for Work and Health in 2012 revealed that the increased risk of work injuries among new workers has remained consistent over the past decade. Workplaces must take further measures to ensure that new employees receive the necessary training and supervision to maintain a safe work environment (Institute for Work and Health, 2012). When employees return to work after suffering from an MSD injury, their risk of further injuries increases if the work pace surpasses their current level of recovery. Unfortunately, many meat processing plants do not have adequate measures to facilitate a gradual return to work (Thrive at work, 2022). The risk of MSDs escalates when there is a lack of control over work planning, work methods, and work pace. This absence of control has a detrimental impact on social support at work, which is also associated with an increased risk of MSDs (Aleid, Eid Elshnawie, & Ammar, 2021). Over the past 25 years, the meat industry has undergone notable growth and transformation. In recent years, task complexity has substantially increased, primarily driven by automation, the need for hygiene compliance, and a broader range of further processing requirements (Barbut, 2020). The increased skill requirement for meat workers to meet the wider range of processing needs is challenged by resourcing and timely training of employees to learn these new skills.

Tappin, Bentley, and Vitalis (2008) have identified that:

> Modifications to plant, workspace, packaging, and line balancing are also often required. Any lag between a change in product requirements and accompanying changes in the work system can lead to the occurrence of MSD risk as workers adapt to meet the shortfall. As many of these special requirements are either seasonal or sporadic, workers do not always get the opportunity to learn the required techniques well enough to avoid redundant energy wastage, leading to further MSD risk. (p. 12)

2.5.6 Job Design Factors for MSD Risk

Within the meat processing industry, the work tasks assigned to many meat workers lack diversity. The limited variation in task specialisation results in decreased levels of job satisfaction, ultimately making positions in meat processing less appealing (Norton, 2010). The physical layout of production lines in the meat processing industry is tailored to meet production requirements and accommodate specific tasks performed at individual workstations. However, this design approach often limits the options for task rotation, thus restricting alternative job designs. While effective task rotations can help distribute physical loading and alleviate boredom, the similarity in nature among many tasks in this industry may limit the potential reduction of MSD risks through frequent rotations. As a result, the increased job specialisation contributes to heightened physical and psychosocial risk factors associated with MSDs (Tappin, Bentley, & Vitalis, 2008).

2.5.7 Payment and Scheduling Systems and MSD Risk

To cope with periods of high demand and shortened production seasons, many meat processing plants implement payment incentives to optimise output and increase work pace in alignment with industry requirements. Commonly utilised payment and work scheduling systems include the piece rate system, where employees are compensated based on a fixed rate for completing a specific amount of work rather than the time taken to finish the task. For instance, employees may be paid based on the cartons loaded into a shipping container or the fixed tally of animals slaughtered per shift (Employsure, 2023). Bonus-driven work provides additional incentives for surpassing established targets. Compressed work schedules, as described by Duke Human Resources (2023), allow employees to complete a 35–40-hour work week in fewer than five workdays. For instance, instead of working five 8-hour days, employees may work four 10-hour days. In the meat industry, seasonal employees experience compressed work schedules that condense their work hours into fewer months, resulting in more working hours and reduced downtime (Duke Human Resources, 2023). Extended hours and weekend work contribute to heightened task exposure. Each payment and scheduling system promotes and is often responsible for creating fast-paced working conditions. These conditions, in turn, contribute to an elevated risk of MSDs (Trevelyan & Hasslam, 2001). The nature of work on a production line necessitates that all employees maintain the established work pace. This creates pressure from co-workers who rely on their teammates to maintain their earnings. However, payment and work scheduling systems that increase task exposure and fast-paced working conditions heighten the risk of musculoskeletal disorders (MSDs). These practices limit opportunities for off-line training and reduce the effectiveness of on-the-job training. However, if implemented, adequate task rotation times and variations in rest break routines could provide more recovery time and help mitigate MSD risks. These practices are often restricted, which exacerbates the risk of MSDs (Tappin, Bentley, & Vitalis, 2008).

2.5.8 Change Factors for MSD Risk

Tappin, Bentley, and Vitalis (2008) highlighted the difficulties in shifting attitudes towards employee health and well-being and implementing effective strategies to mitigate MSD risks in New Zealand. This challenge partly stems from the competitive environment prevailing within the meat processing industry, which predominantly prioritises efficiency and production output. However, this emphasis frequently leads to a detrimental effect on quality and yield in order to meet processing demands. A fundamental change in attitudes towards employee health and well-being is necessary to address this issue.

Although substantial supporting data underscores the significant issue of MSDs in the New Zealand meat processing industry, many levels of management remain in a pre-contemplative stage regarding this matter. Unfortunately, numerous individuals at various management levels throughout the industry still do not genuinely consider the need for change or demonstrate a willingness to accept assistance in reducing the MSD risk. This is evident in the inadequate response to appeals for improvements in working conditions aimed at minimising exposure to MSD risks (Barrett, Haslam, Lee, & Ellis, 2005).

According to Greg Allan, the Lorneville plant health and safety manager (personal communication, September 19, 2021), there is a high level of scepticism about MSD in the meat processing industry since MSD injuries can be challenging to diagnose. Employees who experience non-specific disorders are often perceived by management and colleagues as malingerers. The inconspicuous nature of MSD discomfort and the absence of visible signs or symptoms, unlike more apparent injuries like knife cuts, contribute to these perceptions.

2.5.9 Conclusion

While it may be feasible to enhance the physical conditions of meat processing work through knife sharpening and regular equipment maintenance, the industry often encounters challenges when addressing broader economic, political, social, and cultural factors beyond its direct control or influence. Acknowledging the impact of contextual factors on workplace dynamics is the crucial initial step in tackling these associated problems. By adopting a fresh mindset and exploring solutions to minimise the impact of external contextual factors, such as seasonality and human resource issues, while simultaneously addressing internal factors like cultural influences and payment systems, the meat industry can make significant progress in enhancing the acceptance and effectiveness of MSD interventions within the sector (Tappin, Bentley, & Vitalis, 2008).

2.6 Barriers to MSD Prevention in NZ Meat Processing

To effectively tackle the barriers to preventing MSDs in New Zealand's meat processing industry, it is crucial to display a readiness to confront and dismantle existing attitudes that could hinder progress. This endeavour might necessitate questioning long-standing industry norms and practices.

It holds utmost importance to aid the industry in comprehending the repercussions of neglecting the issue of MSDs at this scale. Musculoskeletal disorders can lead to substantial costs for employees and employers, encompassing diminished productivity, escalated healthcare expenses, and a decline in workers' quality of life. Neglecting to address MSDs can also contribute to elevated turnover rates and recruitment challenges, further impacting the industry's financial performance (Bevan, Gunning, & Thomas, 2012).

By emphasising the economic and social ramifications of MSDs and advocating for the advantages of prevention, stakeholders within the meat processing industry can potentially foster a greater willingness to allocate resources to programs and initiatives that target the barriers hindering MSD prevention. This endeavour may entail partnering with researchers, healthcare providers, and other stakeholders to formulate evidence-based solutions tailored to the industry's distinct needs and challenges.

Yazdani and Wells (2018) emphasised the critical role of integrating MSD prevention measures into management systems and the potential positive outcomes that could reduce workplace injuries. The researchers argue that organisations must understand the challenges and barriers they face to incorporate MSD prevention activities and strategies into their management systems.

There are several barriers to preventing MSDs in the New Zealand meat processing industry, including:

2.6.1 Lack of Ergonomic Design

Concerns have been raised in the New Zealand meat industry about the lack of ergonomic design in the tools and equipment used during meat processing tasks. This issue has been observed in various stages of meat processing, from the initial stages of animal handling to the final stages of packaging and dispatch.

Using non-ergonomically designed tools and equipment can lead to various ergonomic hazards, such as awkward postures, repetitive movements, and excessive force exertion. For example, poorly designed knives can require workers to apply excessive force and pressure, leading to repetitive strain injuries in the hands, wrists, and arms. Similarly, poorly designed cutting boards or workstations can force workers to bend or twist their bodies into awkward positions, leading to back, neck, and shoulder strains. Overall, the lack of ergonomic design in the tools and equipment used in the New Zealand meat industry can significantly increase the risk of work-related MSDs among workers. To address this issue, there have been calls for employers to invest in more ergonomically designed tools and equipment and for workers to receive appropriate training and education on correct ergonomic techniques (Meat Industry Health and Safety Forum, 2020).

2.6.2 Limited Worker Participation

Workers in many workplaces, including the meat industry, are often not actively involved in developing and implementing MSD prevention programs. This can be problematic because workers have first-hand experience of the tasks they perform and the physical demands associated with them. By involving workers in the process, their insights and knowledge can be used to identify ergonomic hazards and develop solutions that are practical and effective (Yazdani & Wells, 2018).

When workers are not involved in developing and implementing MSD prevention programs, it can lead to a lack of buy-in and a reduced likelihood of success. Workers may view the program as irrelevant or impractical, leading to a lack of engagement and participation. Furthermore, workers may not be aware of the program's goals or strategies, leading to confusion and a lack of cooperation.

In contrast, when workers are involved in developing and implementing MSD prevention programs, they are more likely to feel invested in the program's success. This can lead to greater engagement, participation, and motivation to make changes that reduce the risk of MSDs. Workers' insights and knowledge can also help identify hazards that may have been overlooked, leading to more effective solutions (WorkSafe, 2023).

Overall, involving workers in developing and implementing MSD prevention programs is essential to creating safer and healthier workplaces. It can help ensure that programs are practical, effective, and well-supported by workers, ultimately leading to a reduced risk of MSDs and improved workplace health and safety.

(Farr, Laird, Lamm, & Bensemann, 2019).

2.6.3 Inadequate Work Organization

Work organisation can play a crucial role in preventing MSD in the NZ meat processing industry. MSD is a common health issue among meat processing workers, caused by repetitive motions, awkward postures, and forceful movements involved in the production process. Poor work organisation can exacerbate these risk factors, leading to a higher likelihood of MSD (Canadian Centre for Occupational Health and Safety, 2019).

One example of how work organisation can be a barrier to preventing MSD in the NZ meat processing industry is the high-speed processing line. The high-speed line often requires workers to perform repetitive tasks at a fast pace, which can lead to fatigue and increased risk

of injury. Moreover, the production line may be organised in a way that requires workers to use awkward postures or exert excessive force, such as lifting heavy objects or performing repetitive cutting motions. These factors can contribute to the development of MSD.
Another example of how work organisation can be a barrier to preventing MSD is inadequate breaks. The fast-paced nature of the meat processing industry can make it challenging for workers to take regular breaks. This can lead to fatigue and overuse of muscles, increasing the risk of MSD.
Moreover, the absence of job rotation and ergonomic workplace design can impede the prevention of MSD. Job rotation, which involves alternating workers between different tasks, is a proven strategy to prevent the overuse of specific muscles and joints, thereby reducing the risk of MSD. However, some meat processing facilities may not have robust job rotation practices, leading to workers performing the same task repeatedly. Similarly, an ergonomic design can be crucial in minimising the risk of MSD by ensuring that the workplace is designed to minimise awkward postures and repetitive motions. Nevertheless, some meat processing facilities may not have embraced ergonomic design practices, increasing the risk of MSD. (Padula, Comper, Sparer, & Dennerlein, 2017).
In conclusion, work organisation is pivotal in preventing MSD in the NZ meat processing industry. High-speed processing lines, inadequate breaks, lack of job rotation, and ergonomic design are all examples of how poor work organisation can act as a barrier to preventing MSD. As managers, supervisors, and workers in this industry, we must address these issues. By implementing job rotation, ergonomic design, and regular breaks, we can significantly reduce the risk of MSD and ensure the safety and well-being of our workforce.

2.6.4 Time Pressures

Workers in the meat processing industry often face intense pressure to meet production targets and work quickly. If not managed carefully, this pressure can lead to a focus on speed over safety, significantly increasing the risk of MSDs. We must be aware of this potential risk and ensure that safety is always a priority, even in high-pressure situations. When workers are pressured to meet production targets, they may be inclined to work faster and take shortcuts. This can lead to increased strain on their bodies and an increased risk of MSDs. For example, workers may use awkward postures or exert excessive force when cutting or lifting meat to keep up with the pace of the production line. These actions can place additional stress on their muscles and joints, increasing the risk of MSDs.

Moreover, the pressure to work quickly can make it challenging for workers to take adequate breaks. Regular breaks allow workers to rest their muscles and joints, reducing the risk of MSDs. However, workers who feel pressure to work continuously without breaks may experience fatigue and an increased risk of injury (Tappin et al., 2007).

The focus on speed over safety can also contribute to a culture where workers are hesitant to report injuries or take time off. Workers may be concerned that reporting an injury will lead to a delay in production or that they will be penalised for not meeting production targets. This can result in workers continuing to work despite experiencing pain or discomfort, which can exacerbate the injury and lead to long-term MSD.

To address these issues, employers in the meat processing industry need to prioritise worker safety over production targets. This can involve implementing job rotation to allow workers to rest their muscles and joints, providing adequate breaks, and encouraging workers to report injuries without fear of reprisal. Employers should also provide regular training on safe work practices and ergonomic design to reduce the risk of MSDs. By prioritising worker safety, employers can create a culture where workers feel supported and empowered to prioritise their health and well-being while meeting production targets.

2.6.5 Limited Training and Supervision

One of the significant issues contributing to the increased risk of MSDs in the meat processing industry is inadequate training. Many new workers in this industry may not have received sufficient training in safe work practices. Without adequate training, workers may not know how to perform tasks correctly, use equipment appropriately, or adopt correct body mechanics, leading to an increased risk of injury. Additionally, workers may not be aware of the early signs of MSDs, such as pain or discomfort, and may not seek medical attention until the condition has progressed (Huziej, 2022).

Inadequate supervision contributes to workers' adoption of unsafe work practices.

Supervisors are crucial in ensuring workers are trained in safe work practices, use equipment appropriately, and follow correct body mechanics. However, if supervisors are not adequately trained or present, workers may be more likely to adopt unsafe practices, leading to an increased risk of injury.

To mitigate the risk of MSDs in the meat processing industry, employers must ensure that workers receive adequate training in safe work practices. Training should cover topics such as safe lifting techniques, the use of equipment, and the early signs of MSDs. Employers should also provide refresher training regularly to reinforce safe work practices and ensure that workers are aware of any new hazards or risks.

In addition to training, employers must ensure that supervisors are adequately trained in promptly identifying and addressing unsafe work practices. Supervisors should be trained to recognise early signs of MSDs and encourage workers to report any discomfort or pain promptly. Employers should also ensure that supervisors are present and actively monitoring workers' performance to identify any unsafe practices and provide corrective action immediately (Yanar, Lay, & Smith, 2019).

In conclusion, the meat processing industry is physically demanding, and workers are at an increased risk of MSDs. Adequate training in safe work practices and adequate supervision are critical to mitigating this risk. Employers must ensure that workers receive comprehensive training and that supervisors are adequately trained to promptly identify and address unsafe practices. By doing so, employers can create a safe work environment, protect workers from injury, and improve productivity.

2.6.6 Limited Training and Education for MSD Prevention

Another pressing concern in the meat processing industry is the lack of or limited training and education for MSD prevention. MSDs are injuries and disorders that affect the muscles, tendons, ligaments, nerves, and joints of workers, and they are common in industries such as the NZ meat processing industry, where workers perform repetitive tasks, work in awkward postures, or lift heavy objects. In the meat processing industry, workers are often required to perform repetitive tasks, such as cutting and packaging meat, which can lead to MSDs. Workers may also be required to work in awkward postures, such as bending or twisting, which can further increase the risk of MSDs. Moreover, workers may be required to lift heavy objects, such as boxes of meat, which can put additional strain on their muscles and joints (EU-OSHA, 2012).

Despite the high risk of MSDs in the meat processing industry, many workers do not receive adequate training and education on MSD prevention. This can lead to workers being unaware of the risks and not knowing how to prevent MSDs from occurring. Training and education on MSD prevention should cover various topics, including safe lifting techniques, ergonomic workstation design, stretching and warm-up exercises, and the importance of taking breaks and rotating tasks. Workers should also be taught to recognise the signs and symptoms of MSDs, such as pain and stiffness in the affected area (EU-OSHA, 2012).

In addition to training and education, employers can take other steps to prevent MSDs in the meat processing industry. For example, they can provide workers with ergonomic tools and equipment, such as adjustable workstations and lifting aids, to reduce the risk of injury. Employers can also implement job rotation programs to reduce workers' time performing repetitive tasks. Overall, the lack of training and education for MSD prevention is a significant concern in the meat processing industry. Employers must ensure that workers are adequately trained and educated on MSD prevention to reduce the risk of injury and promote a safe and healthy workplace.

2.6.7 Inadequate Equipment

Inadequate equipment in the meat processing industry can significantly impact worker health and safety. MSD is a common type of workplace injury that can occur due to improper or insufficient equipment.

Meat processing involves a lot of repetitive and physically demanding tasks, such as lifting heavy carcasses, cutting and deboning meat, and operating machinery. These tasks put a significant amount of strain on the body, especially on the muscles and joints. Inadequate equipment such as outdated or poorly maintained machinery, dull or improperly sharpened knives, and improper ergonomic design of workstations can increase the risk of MSDs (Redivo & Olivier, 2021).

For example, using dull knives or blades can require more force and pressure to cut through meat, which can cause occupational overuse injuries (OOI) in the hands, wrists, and arms. In addition, poorly designed workstations that do not allow for good work postures can lead to awkward postures, which can put additional stress on the body.

Furthermore, outdated or improperly maintained machinery can also increase the risk of injury (Meat Industry Health and Safety Forum, 2013). For instance, improperly lubricated or adjusted equipment can cause excessive vibration or noise, leading to hand-arm vibration syndrome (HAVS) or hearing loss. Inadequate safety guards or shields can also expose workers to dangerous moving parts, increasing the risk of cuts, amputations, and other traumatic injuries.

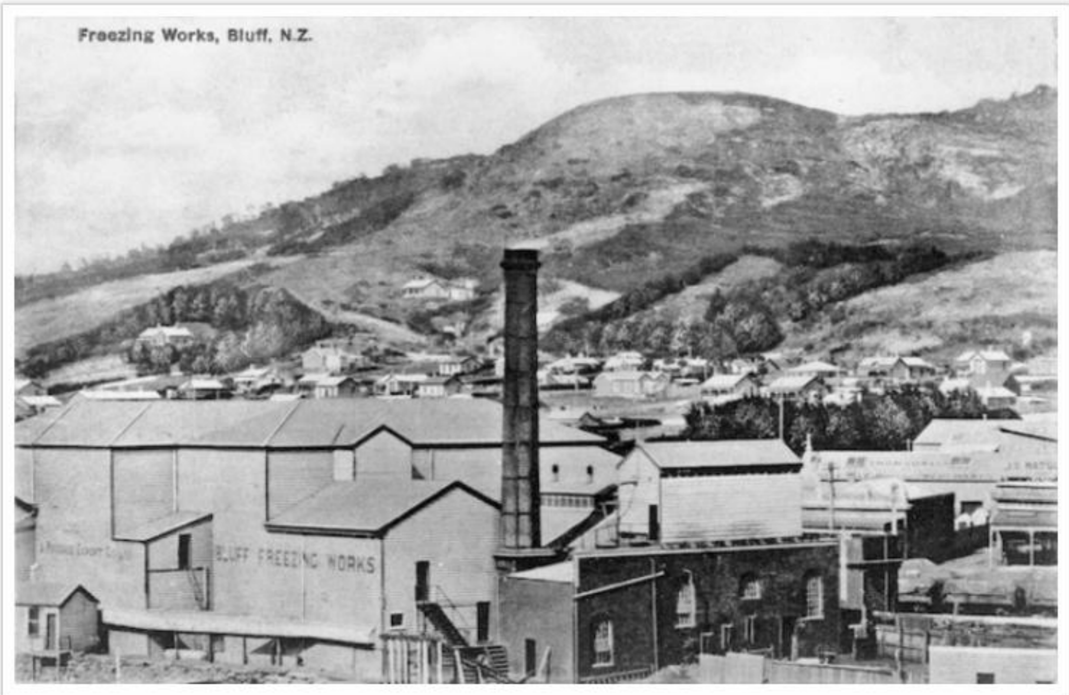
In conclusion, the use of inadequate equipment in the meat processing industry can increase the risk of MSDs and other workplace injuries. Ensuring that equipment is maintained correctly, sharpened, and adjusted to minimise this risk is essential. Employers should also invest in ergonomic workstations and provide appropriate training to workers on how to properly use equipment to reduce the risk of injury (Redivo & Olivier, 2021).

2.6.8 Workplace Culture as a Barrier to Preventing MSDs

Musculoskeletal disorders are a common occupational health issue in many industries, including the meat industry in New Zealand. Workplace culture can play a critical role in preventing MSD by creating a work environment that encourages safe work practices, promotes employee well-being, and supports injury prevention efforts. However, workplace culture can also become a barrier to preventing MSD if it does not prioritise employee safety and well-being. This can result in workers pushing themselves beyond their physical limits and increasing the risk of MSDs. “We are rough and tough, and we come from Bluff” is a sentiment shared by many meatworkers who worked at the former Ocean Beach meat processing plant in Bluff (Figure 2.19). The employees knew the work was physically demanding and accepted that many would get hurt (G. Hammond, personal communication, 3 June 2022).

Figure 2.19

Bluff Freezing Works



Note. Bluff Freezing Works at Ocean Beach, circa 1910. Photographer unidentified.

Within the New Zealand meat industry, various elements of workplace culture can contribute to the emergence of MSDs. A prevalent concern is a "macho" culture in certain workplaces, where employees are encouraged to endure pain or discomfort without complaint. This culture often discourages workers from reporting injuries or seeking necessary medical attention, ultimately resulting in the escalation of injuries or the development of chronic pain over time (Tappin, Bentley, & Vitalis, 2008).

Another factor is the fast-paced and physically demanding nature of meat processing work, which can lead to a culture of "getting the job done" at the expense of best ergonomic practices and safe work procedures. For example, workers may prioritise speed over taking breaks or using correct lifting techniques, leading to overexertion and repetitive strain injuries.

Additionally, there may be a lack of communication and collaboration between workers and management, making it difficult for employees to voice concerns or suggest improvements to working conditions (Redivo & Olivier, 2021). This can contribute to a culture of "just dealing with it" rather than addressing the root causes of MSDs (Yazdani & Wells, 2018).

Overall, addressing workplace culture as a barrier to preventing MSDs in the meat industry requires a concerted effort from all stakeholders, including workers, management, and regulators. This may involve promoting a culture of safety and well-being, providing training on best ergonomic practices and injury prevention, encouraging open communication, and implementing policies that prioritise employee health and safety. By addressing these issues, it is possible to create a safer and healthier workplace for everyone in the New Zealand meat industry.

2.6.9 Language and Cultural Barriers

In the NZ meat processing industry, language and cultural barriers can pose challenges in various aspects of operations, specifically the prevention of MSD. Understanding safety guidelines is crucial for preventing MSDs in the NZ meat processing industry. Language barriers impede comprehension of instructions and training materials, reducing awareness of ergonomic techniques, safe lifting practices, and equipment usage. Inadequate understanding may result in workers unknowingly engaging in activities that raise their risk of MSD development (Yazdani & Wells, 2018).

Language barriers hinder the effective delivery of training programs in the NZ meat processing industry. Limited language proficiency between trainers and trainees makes conveying crucial information, technical knowledge, and best practices challenging. Inadequate training negatively impacts worker productivity, quality standards, and compliance with health and safety regulations (Arcury, Estrada, & Quandt, 2010).

Clear communication is vital for safety and risk management in the NZ meat processing industry. With language barriers present, employees may have difficulty understanding safety instructions, warning signs, and emergency protocols, resulting in a heightened risk of accidents and injuries. Overcoming these barriers is essential to maintain a safe working environment. Cultural differences in the NZ meat processing industry impact workplace culture and integration. Diverse workforces bring varying cultural norms, communication styles, and expectations. Without cultural understanding and sensitivity, misunderstandings, conflicts, or segregation among employees may occur, negatively affecting teamwork and morale (Farnaaz, 2020).

Language barriers in the meat processing industry impede effective communication, crucial for maintaining quality control standards. With language barriers, conveying specific requirements, quality expectations, and feedback to employees becomes challenging. This can lead to inconsistencies in product quality and potential customer dissatisfaction. Moreover, language barriers hinder efficient workflow and coordination, reducing overall productivity (Donovan, 2021).

2.6.10 Limited Access to Healthcare

Limited access to healthcare poses a significant barrier to MSD injury prevention in the meat processing industry. Workers may face challenges accessing affordable healthcare or lack knowledge of navigating the healthcare system effectively. Consequently, they may not receive timely medical care for MSDs, leading to the worsening of their condition and prolonged recovery time. When workers cannot afford healthcare services or lack health insurance coverage, they may delay seeking medical attention for MSD-related symptoms. This delay can result in the progression of the injury, exacerbating pain and hindering the effectiveness of treatment. Without prompt diagnosis and intervention, minor MSD issues can develop into more severe and chronic conditions, impacting the worker's ability to perform their job effectively and potentially leading to long-term disability. Moreover, unfamiliarity with the healthcare system, especially among immigrant workers or those from different cultural backgrounds, can further impede access to appropriate healthcare services. Workers may struggle to understand healthcare procedures, find suitable healthcare providers, or navigate the paperwork and administrative requirements of seeking treatment for MSDs. This lack of knowledge and confidence in the healthcare system can deter workers from seeking help promptly, leading to delayed or inadequate care for their MSD-related injuries (Suphanchaimat, Kantamaturapoj, Putthasri, & Prakongsai, 2015).

2.6.11 High Production Demands

Meat processing in New Zealand is a fast-paced industry that transforms raw animal meat into various processed products. It includes slaughtering, butchering, packaging, and distribution (IBISWorld, 2023). The work in meat processing plants is physically demanding, requiring repetitive movements, heavy lifting, and working in cold and wet conditions (Tappin et al., 2007). One of the significant challenges faced in this industry is the pressure to meet production targets. Due to the high demand for meat products, processing plants often operate under strict deadlines to ensure a continuous supply to the market. As a result, workers may face intense time constraints and work rapidly to meet production demands (Heathrose Research, 2013).

This focus on meeting production targets can sometimes lead to a neglect of worker safety concerns. When emphasising maximising output, adequate attention may not be given to implementing and maintaining the best safety protocols. The need to prioritise speed and efficiency may overshadow workplace ergonomics and hazard prevention considerations. Consequently, this situation can create barriers to the prevention of MSDs among workers.

2.6.12 Limited Resources

Smaller meat processing businesses often face specific challenges when it comes to investing in ergonomic assessments, engineering controls, and worker training, which can create barriers to MSD prevention (Middlesworth, 2019). Limited financial resources are a primary barrier for smaller meat processing businesses. These businesses may have tight budgets and struggle to allocate funds for comprehensive ergonomic assessments, equipment upgrades, or training programs. The costs associated with hiring external consultants or investing in specialised equipment can be prohibitive, leaving smaller businesses at a disadvantage regarding MSD prevention. Implementing engineering controls and introducing specialised equipment can help reduce the risk of MSDs. However, purchasing ergonomic tools, machinery, or mechanical aids often has a significant price tag. For smaller businesses with limited financial resources, investing in expensive equipment may be a challenge, leaving them with outdated or suboptimal equipment that can contribute to increased injury risk (Yazdani & Wells, 2018).

2.6.13 Resistance to Change

Resistance to change can significantly hinder MSD prevention in the meat processing industry. Resistance to change in work practices or implementing new controls can arise due to concerns about increased costs, reduced productivity, or impacts on work processes. This resistance may be observed among workers and managers within the meat processing industry. Implementing changes to prevent and reduce MSDs requires a proactive approach and a willingness to adapt to new practices and technologies (Yazdani & Wells, 2018). Organisations can create a more conducive environment for MSD prevention initiatives by addressing resistance to change within the meat processing industry. By fostering a culture of continuous improvement and prioritising the well-being of workers, safer and healthier workplaces can be achieved, ultimately benefiting both the employees and the organisation (Stoewen, 2016).

2.6.14 Inadequate Reporting and Tracking of MSD Incidents

In the meat processing industry, the lack of comprehensive reporting and tracking of MSD incidents and injuries can significantly hinder the identification of problem areas and the assessment of prevention efforts. The lack of a comprehensive reporting and tracking system for MSD incidents and injuries in the meat processing industry can lead to incomplete data, causing a distorted perception of the true prevalence and severity of MSDs in the workplace. This incomplete data makes it challenging to identify specific problem areas where MSDs are more likely to occur, impeding the ability to target prevention efforts effectively. Without accurate information on the frequency and nature of MSD incidents, organisations may struggle to allocate resources, implement appropriate interventions, and prioritise areas of high risk (J. Spiers, personal communication, 19 May 2023).

The incomplete picture of MSDs in the workplace can hinder the development of tailored prevention strategies, as it becomes challenging to pinpoint the root causes and implement targeted solutions. A robust reporting and tracking system is necessary to capture comprehensive data, enabling organisations to gain an accurate understanding of the MSD landscape, identify problem areas, and implement effective prevention measures (Van Eerd, Irvin, Le Pouésard, Butt, & Nasir, 2022). By implementing a detailed reporting and tracking system, accurate data collection, analysis, and evaluation become possible. This, in turn, facilitates the identification of areas with problems and enables informed decision-making, as well as the implementation of effective preventive measures. Reporting MSDs promptly can lead to an improved reactive treatment response, resulting in reduced severity of the condition and faster recovery times for individuals (WorkSafe, 2023). To ensure continuous improvement in the prevention of MSDs, organisations must cultivate a reporting culture and actively promote timely incident reporting by their employees. This approach allows for the capture and effective utilisation of all pertinent data.

2.6.15 Conclusion

A comprehensive approach, including worker participation, ergonomics, work organisation, training, and supervision, is necessary to effectively address barriers to MSD injury prevention. Employers can work with employees to identify risk factors and implement strategies to reduce MSD risks. These strategies may involve introducing ergonomic equipment, implementing task rotation, providing regular breaks, and reporting injuries early. It is vital to prioritise worker safety above production targets and ensure adequate training and supervision to promote safe job performance.

2.7 Interventions for Addressing MSD in NZ Meat Processing

Musculoskeletal disorders are prevalent occupational health concerns within the meat processing industry due to the repetitive tasks, heavy lifting, awkward postures, and forceful exertions involved. To acknowledge the importance of addressing these concerns, WorkSafe and the Meat Industry Association (MIA) have supported industry research in New Zealand, explicitly identifying interventions that effectively mitigate MSDs in the meat processing sector. The following interventions are among those implemented in NZ:

2.7.1 Incident Reporting and Investigation

A system for reporting and investigating incidents and injuries should be established to identify any underlying causes and to implement corrective actions. Implementing a comprehensive incident reporting and investigation system in the meat processing industry is essential for effectively reducing MSDs (Goode, et al., 2016). Given the physically demanding nature of the work, MSDs pose a significant concern within this industry. Establishing a system for reporting incidents and injuries enables workers in the meat processing industry to communicate potential hazards or unsafe conditions they come across promptly. This system facilitates the early identification of such hazards, allowing employers to recognise patterns or trends contributing to MSDs (Carrillo-Castrillo, Pérez-Mira, Pardo-Ferreira, & Rubio-Romero, 2019). For instance, if multiple workers report experiencing discomfort or pain while using a specific workstation, it suggests the necessity for ergonomic enhancements or modifications to the equipment.

Conducting investigations following incidents or injuries is instrumental in understanding the root causes that contribute to MSDs in the meat processing industry. These investigations thoroughly examine the incident's circumstances, work practices, and environmental factors. By identifying the underlying causes, organisations can directly address the issues at their core rather than solely focusing on mitigating the symptoms (Carrillo-Castrillo, Pérez-Mira, Pardo-Ferreira, & Rubio-Romero, 2019). This process may involve evaluating factors such as workstation design, tool ergonomics, task rotation policies, or deficiencies in training programs.

Incident investigations serve as a foundation for implementing corrective actions to prevent the recurrence of similar incidents in the meat processing industry. By addressing the root causes identified during these investigations, organisations can make specific modifications to enhance safety and effectively reduce MSDs (Goode, et al., 2016). Incident reporting and investigation systems in the meat processing industry play a crucial role in identifying areas that require additional training or awareness programs. By analysing incident reports, organisations can discern if workers lack the necessary knowledge or skills to carry out their tasks safely. Based on this information, tailored training programs can be developed to educate employees on essential aspects such as correct lifting techniques, ergonomics, posture, and other relevant factors that contribute to the prevention of MSDs (Goode, et al., 2016). This proactive approach ensures that workers have the requisite understanding and abilities to mitigate the risks associated with their work activities.
Incident reporting and investigation systems in the meat processing industry offer valuable data for continuous monitoring and evaluation, enabling organisations to enhance workplace safety and reduce the occurrence of MSDs (Meat Industry Health and Safety Forum, 2013). Through the systematic tracking and analysis of incidents over time, organisations can identify trends and patterns, evaluate the effectiveness of implemented measures, and make necessary adjustments. This iterative process of continuous improvement ensures that workplace safety measures remain up-to-date and effective, leading to a proactive approach to mitigating the risks associated with MSDs (Goode, et al., 2016).

Incident reporting and investigation systems are critical in identifying and mitigating the causes of MSDs in the meat processing industry. However, these systems often face several issues. First, there is the problem of underreporting, where workers might not report incidents due to fear of repercussions or lack of awareness about the importance of reporting. This underreporting can lead to incomplete data, hampering the identification of trends and underlying causes (Carrillo-Castrillo et al., 2019). Additionally, investigations may not always be thorough, sometimes focusing more on immediate causes rather than deeper systemic issues such as poor workstation design or inadequate training programs (Goode et al., 2016). This can result in corrective actions that address symptoms rather than root causes, leading to repeated incidents. Furthermore, the effectiveness of these systems relies heavily on the commitment and engagement of both management and employees. If a lack of buy-in or the system is perceived as a mere compliance exercise, its impact can be significantly diminished. Continuous monitoring and evaluation are essential for ensuring that implemented measures remain effective. However, without robust data analysis capabilities and a proactive approach to making necessary adjustments, organisations may struggle to improve workplace safety continuously (Meat Industry Health and Safety Forum, 2013). In conclusion, while incident reporting and investigation systems have the potential to enhance safety and reduce MSDs significantly, their effectiveness can be compromised by issues related to reporting practices, investigation depth, stakeholder engagement, and ongoing evaluation.

2.7.2 Ergonomic Assessments

Conducting comprehensive ergonomic assessments in meat processing plants plays a crucial role in addressing and preventing MSDs. These assessments involve a systematic evaluation of various aspects of the work environment, including workstations, tasks, tools, and equipment, to identify potential risk factors that may contribute to the development of MSDs (Johnson, 2018).

Ergonomic assessments in meat processing plants involve the participation of knowledgeable and experienced ergonomic experts or specialists. These professionals possess ergonomics, human factors, and occupational health and safety expertise. They utilise various methods, including direct observation, worker interviews, and measurement tools, to collect data and evaluate the ergonomic factors present in the workplace. As part of the assessment process, the workstations in meat processing plants undergo evaluation to ensure they are appropriately designed and adjustable, catering to the specific needs of individual workers. This evaluation includes an examination of the height and positioning of work surfaces, chairs, and controls, as well as the arrangement and accessibility of tools and equipment.

Simultaneously, tasks are thoroughly analysed to identify potential risk factors such as repetitive motions, forceful exertions, awkward postures, or excessive reaching that could contribute to developing MSDs. Moreover, a careful examination of tools and equipment takes place to determine their ergonomic design and identify opportunities for modifications or enhancements that can effectively reduce strain and enhance usability (Occupational Safety and Health Administration, 1993).

The assessments conducted by ergonomic experts yield valuable findings that enable them to provide recommendations for enhancing work processes, equipment, and workstations. These recommendations may involve suggesting modifications to existing tools or equipment, aiming to improve ergonomics and make them user-friendly. Additionally, the experts may propose implementing new tools or technologies to alleviate physical strain and optimise efficiency. Moreover, adjustments to work processes can be recommended to reduce repetitive motions or excessive force, thereby promoting a safer and healthier work environment (Hoe, Urquhart, Kelsall, & Zamri, 2018).

Several specific technical assessment techniques are recommended for ergonomic assessments in meat processing plants to address and prevent musculoskeletal disorders (MSDs):

Direct Observation: Ergonomic experts observe workers performing their tasks directly to identify risk factors such as awkward postures, repetitive motions, and forceful exertions (Johnson, 2018). This hands-on approach allows for real-time identification of potential issues.

Worker Interviews: Interviewing workers helps gather insights about their experiences, discomfort, and suggestions for improvement. This qualitative data is crucial for understanding the ergonomic challenges faced by employees.

Measurement Tools: Various measurement tools, such as goniometers for assessing joint angles and force gauges for measuring exertions, are used to quantify ergonomic risk factors. These tools provide objective data to support the observations and interviews.

Workstation Evaluations: Detailed evaluations of workstations are performed to ensure they are designed and adjustable to meet the needs of individual workers. This includes assessing the height and positioning of work surfaces, chairs, and controls and the arrangement and accessibility of tools and equipment.

Task Analysis: Thorough task analyses are conducted to identify repetitive motions, forceful exertions, awkward postures, and excessive reaching that could contribute to MSDs. This helps in understanding the specific ergonomic demands of each task.

Tools and Equipment Assessment: The ergonomic design of tools and equipment is evaluated to identify opportunities for modifications or enhancements. This involves examining tools' usability, weight, and design to reduce strain and improve efficiency (Occupational Safety and Health Administration, 1993).

Comprehensive ergonomic assessments in meat processing plants offer invaluable insights into the precise risk factors associated with MSDs, guiding the implementation of necessary changes and improvements in the work environment. By addressing these identified factors, the primary objectives are to diminish the occurrence of MSDs, enhance the well-being of workers, and foster a safer and healthier workplace within the meat processing industry.

2.7.3 Job Rotation and Task Variety

Implementing job rotation and task variety strategies in the meat processing industry can significantly reduce repetitive strain on specific muscle groups and joints, ultimately promoting the health and safety of workers. These strategies entail the periodic shifting of workers between different tasks and introducing a diverse range of tasks within the work environment. One of the key advantages of job rotation is that it allows workers to switch between different tasks, relieving prolonged exposure to a single task (Tappin, et al., 2007). In meat processing, specific tasks, such as deboning or packaging, may involve repetitive motions that place strain on specific muscle groups and joints. The repetitive strain on those areas can be minimised by rotating workers to different tasks at regular intervals. This helps to alleviate muscle fatigue and prevent the development of overuse injuries.

Another crucial aspect of reducing repetitive strain is the introduction of task variety. When workers repeatedly perform the same task for extended periods, the muscle groups and joints are subjected to continuous strain. This prolonged strain can eventually lead to the development of MSDs such as tendinitis, carpal tunnel syndrome, or back pain (Barr, Barbe,

& Clark, 2004). However, by incorporating a variety of tasks into the work routine, workers are allowed to engage different muscle groups and execute different movements. This effectively reduces the risk of overusing specific muscle groups, alleviates strain, and significantly lowers the likelihood of developing MSD.

Implementing job rotation and task variety strategies should be approached with careful planning and attention to detail. Employers need to assess the specific tasks involved in meat processing, identify the potential risks and strains associated with each task, and develop a well-designed rotation schedule that ensures workers receive adequate training and possess the necessary competency for each task. Providing adequate training and supervision is crucial to ensure workers can safely and effectively perform all assigned tasks (Van Eerd et al., 2022). In addition, it is crucial to establish regular communication channels and feedback mechanisms to effectively monitor the effectiveness of job rotation and task variety strategies. These channels facilitate ongoing evaluation and allow adjustments to the rotation schedule and task assignments based on valuable input and suggestions from the workers. By actively considering and incorporating the feedback of the workers, the rotation schedule and task assignments can be refined to optimise results, enhance the well-being of the workforce, and maximise productivity (WorkSafe, 2023). This collaborative approach fosters a sense of ownership and engagement among the workers, leading to a more effective and sustainable implementation of job rotation and task variety strategies.

2.7.4 Manual Handling Training

Providing comprehensive manual handling training to meat process workers is crucial for several reasons. Manual handling tasks in the meat processing industry often involve lifting and moving heavy loads, which can put workers at risk of developing MSDs and other injuries (Meat Industry Health and Safety Forum, 2013). Employers can enhance the safety and well-being of their workers by offering thorough training. Manual handling training helps workers avoid workplace injuries by teaching them how to lift objects without straining their muscles and joints (Provention, 2019). These techniques involve bending the knees, maintaining a straight back, and utilising the strength of the legs instead of relying solely on the back. Teaching these techniques can significantly reduce the risk of back injuries and other muscular strains associated with lifting heavy loads (WorkSafe, 2023).

Within the meat processing industry, one of the essential task requirements is handling heavy loads, such as carcasses or cartons of meat products, which can weigh up to 27 kg (60 lbs). Ensuring the safe handling of these heavy loads is another crucial aspect of manual handling training. Workers must receive education on techniques for securely gripping and controlling such objects. This includes understanding their weight limits and discerning when to seek assistance or employ lifting aids. By ensuring that workers possess a comprehensive understanding of how to handle heavy loads safely, the risk of dropping objects, self-injury, or causing harm to others or property is significantly reduced (Health and Safety Executive, 2019).

Using assistive devices like lifting aids or trolleys is an effective strategy to minimise the physical strain on workers during manual handling tasks. Training should include information on the different types of lifting aids available in the workplace and how to use them correctly. This empowers workers to use these tools effectively, significantly reducing the risk of injuries and making their workloads more manageable. An essential aspect of manual handling training is educating workers about the significance of maintaining good posture and taking regular breaks. It is crucial to inform workers about the potential consequences of poor posture, such as heightened stress on the spine and other body parts (Ferraro, 2014).

The training should emphasise the benefits of maintaining a neutral spine alignment and avoiding prolonged periods of static posture. Additionally, it is essential to encourage regular breaks to allow workers to rest, stretch, and recover from physically demanding tasks. By promoting correct posture and regular breaks, fatigue is reduced, overexertion is prevented, and overall musculoskeletal health is enhanced.

Manual handling training in the meat processing industry faces several critical issues that can undermine its effectiveness. One significant problem is the tendency for training to be overly generic and not tailored to the specific tasks and environments workers encounter. This can result in training that is not entirely relevant or applicable, leaving workers ill-prepared to handle the unique challenges of their roles (Meat Industry Health and Safety Forum, 2013). Additionally, there is often an over-reliance on training alone without considering the broader context of workplace ergonomics and the necessity of ongoing reinforcement and assessment of skills (Provention, 2019). Training sessions may be too brief and infrequent, leading to poor retention of crucial techniques, such as correct lifting methods, essential for preventing

MSDs (WorkSafe, 2023). Furthermore, despite being taught correct manual handling techniques, workers may revert to unsafe practices due to time pressures, inadequate supervision, or a lack of available lifting aids, such as trolleys and mechanical lifts. Another critical issue is the cultural and language barriers that can impede the comprehension and application of training content. In diverse workforces, training materials and methods may not be sufficiently adapted to address these barriers, resulting in a significant portion of the workforce not fully understanding or implementing safe handling practices (Health and Safety Executive, 2019). Lastly, while training emphasises the importance of good posture and regular breaks, the demanding nature of meat processing work often means that these practices are not consistently followed, leading to increased fatigue and risk of injury (Ferraro, 2014). Therefore, while manual handling training is essential, its effectiveness is often compromised by a lack of specificity, insufficient reinforcement, workplace culture, and practical implementation challenges.

In conclusion, providing comprehensive manual handling training to meat process workers is essential for promoting their safety and well-being. This training should encompass correct lifting techniques, safe handling of heavy loads, using assistive devices, maintaining good posture, and taking regular breaks. By equipping workers with the necessary knowledge and skills, employers can significantly reduce the risk of workplace injuries, improve productivity, and create a safer work environment.

2.7.5 Engineering Controls

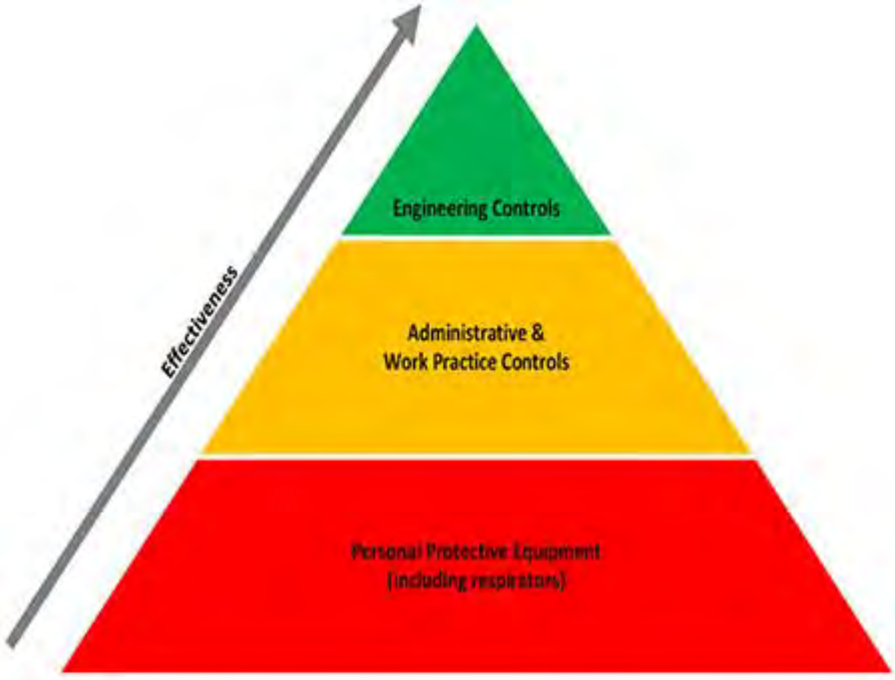
Implementing engineering controls can be crucial in minimising the risk of MSDs in the workplace. Employers can mitigate the potential for MSD injuries by incorporating engineering solutions that modify the work environment and tasks, reducing the physical demands on workers' bodies. This includes the installation of conveyors, lifting devices, height-adjustable work surfaces, adjustable seating, and adequate lighting to reduce the physical strain on workers. Automating and mechanising specific tasks can also help reduce repetitive motions and heavy lifting (OSHA, 2023).

Figure 2.20 demonstrates that engineering controls are regarded as the most effective strategy for reducing MSD hazards in the workplace. Work tasks should be designed to minimise exposure to ergonomic risk factors to minimise the risk of injury. Ideally, engineering controls should be prioritised. However, administrative or work practice controls may be suitable when engineering controls are not feasible, or new procedures are required following their implementation. It is important to note that personal protection solutions have limited effectiveness in addressing ergonomic hazards. The following are examples of engineering controls that can be implemented:

In meat processing, employers can enhance worker safety and reduce strain on their musculoskeletal systems by implementing ergonomically optimised workstation designs. This includes considering factors such as suitable workstation height, adjustable equipment, suitable lighting, and the convenient placement of tools and materials. Providing adjustable equipment and workstations allows workers to customise their setup based on their needs and physical characteristics. This adaptability helps ensure workers can maintain correct and reduce the risk of MSDs. Engineering redesigns encompass the modification of machinery or tools and the provision of assistance to facilitate work. For instance, one example of machinery redesign involves realigning workstation controls to enable more natural body postures. Similarly, a tool redesign may focus on reducing hand tool weight or improving grip, both of which alleviate body loads. The primary objective of engineering redesigns is to mitigate biomechanical risk factors by reducing their impact (National Research Council, 1999).

Figure 2.20

Overview of Controls for MSD Hazards



Note. The control pyramid illustrates that engineering controls are the most effective measures for addressing MSD hazards. In contrast, PPE and administrative controls are viable options only when engineering controls are not feasible. OSHA. (2023). *Overview of Controls for MSD Hazards* [Visual of the pyramid of control]. https://www.osha.gov/ergonomics/control-hazards

To reduce the risk of MSDs, employers can alleviate physical burdens associated with handling heavy objects or performing repetitive tasks by providing mechanical aids and lifting equipment. Conveyor belts, hoists, or forklifts, for example, can assist in lifting, carrying, or moving heavy loads, effectively mitigating the potential for MSDs (National Research Council, 1999).

Implementing automation and robotics in physically demanding or repetitive tasks can reduce the risk of MSDs. This is achieved by allowing machines to take over these tasks, relieving workers of excessive strain and repetitive motions. Automated processing systems for specific tasks can decrease repetitive motions and prolonged exposure to awkward postures.

For example, automated cutting or deboning machines can reduce the strain on workers' hands, wrists, and arms (Jones, 2021).

Using pneumatic tools instead of hand tools for repetitive or forceful tasks can reduce the physical strain on workers. Tools such as pneumatic knives or brisket cutters (see image in Figure 2.21) can decrease the effort required to perform cutting or trimming operations in the meat processing industry.

Figure 2.21

Pneumatic brisket cutter

Note. AGL uses pneumatic brisket cutters instead of hand tools for repetitive or forceful tasks, which can reduce physical strain on workers by minimising the effort required to perform cutting tasks. Image from Jarvis retrieved from https://jarvisanz.com.au/product/423-17-brisket-scissors/

Introducing anti-fatigue mats is a simple yet effective intervention that can significantly reduce employee fatigue. By placing these mats on the floor, workers who are required to stand for extended periods can experience the benefits of enhanced cushioning and support. As a result, these mats effectively alleviate discomfort associated with prolonged standing by reducing strain on the lower limbs (Zhang, et al., 2022).

Engineering controls can be implemented to minimise the force required for specific tasks. This may entail redesigning equipment or processes to enhance ergonomics and utilising assistive technologies such as power tools to minimise physical exertion. When utilising power tools, addressing the potential risks associated with excessive vibration and noise in the workplace is essential, as it can contribute to MSDs. Implementing engineering controls to reduce vibration levels is crucial (Barr & Barbe, 2002). This can be achieved through vibration-damping materials or isolating vibrating machinery, which safeguards workers' musculoskeletal systems.

Another new, rapidly developing engineering solution is the use of personal ergonomic devices (PED), such as exoskeletons, that have the potential to prevent WMSDs in the meat processing industry and similar industries (Choi, Trout, Earnest, & Garza, 2022). This will be discussed as a separate topic in the next section.

In conclusion, while engineering controls can help mitigate MSD risks, they should be supplemented with administrative controls (e.g., work schedules, training, and supervision) and personal protective equipment (e.g., gloves and back belts) to create a comprehensive approach to worker safety in the meat processing industry.

2.7.6 Personal Ergonomic Devices

Amidst the current scenario marked by significant skill shortages, instances of lost time due to injuries, and an emphasis on the mental well-being of the workforce, the integration of PEDs, robotics and data analytics to assist manual labour tasks could potentially lead to a decrease in staff turnover costs and bridge the skills gap. Concurrently, this approach has the potential to enhance staff engagement and overall productivity (Industrial Safety News, 2023). PEDs, such as exoskeletons, have the potential to prevent WMSDs in the meat processing industry and similar industries (Choi, Trout, Earnest, & Garza, 2022).

As per A. Daurat (personal communication, December 16, 2021), the utilisation of PEDs, including exoskeletons, within the meat processing industry has the potential to bring about a transformative shift in how workers engage in physically demanding tasks. This adoption could effectively mitigate the risks of MSDs and injuries. Exoskeletons are wearable devices designed to support, enhance movement, and reduce physical strain on the user's body. According to Daurat, the solutions and technologies offered by the use of PEDs have demonstrated a remarkable reduction of 75% in injury-causing bends, a 30% decrease in sprains and strains, a 25% reduction in injury-related downtime, and a 25% decrease in absenteeism. Simultaneously, these solutions have led to a notable increase of 20% in staff attraction and retention and a 16% improvement in productivity (Industrial Safety News, 2023). In the context of the meat processing industry, where workers frequently engage in tasks involving heavy lifting, repetitive motions, and awkward postures, exoskeletons can offer significant benefits:

Enhanced Ergonomics. Exoskeletons are designed with ergonomic principles in mind. They can assist workers in maintaining correct body mechanics during tasks that would otherwise strain their muscles and joints. By supporting specific body areas, such as the back, shoulders, or arms, exoskeletons help distribute the weight of heavy objects and reduce the physical load on individual body parts.

Reduced Physical Fatigue. Tasks in the meat processing industry can be physically demanding and lead to fatigue over time. By offering mechanical support, exoskeletons help reduce the fatigue associated with lifting, carrying, or repetitive movements. This reduction in physical fatigue enhances worker comfort and lowers the risk of injuries caused by tired muscles.

Prevention of Overexertion Injuries. Overexertion is a common cause of workplace injuries, particularly in manual labour industries. Exoskeletons can mitigate the risk of overexertion-related injuries by providing mechanical assistance that offsets the strain on workers' bodies. This is especially valuable in the meat processing sector, where heavy carcasses and products are handled regularly.

Customised Assistance. Modern exoskeletons are designed to be adjustable and customisable, allowing workers to adapt the device to their unique physical needs. This adaptability ensures that the exoskeleton provides optimal support for each individual, regardless of body size or shape.

Training and Acceptance. Implementing exoskeletons in the workplace requires adequate training for workers to wear and operate the devices effectively. Ensuring workers are comfortable using exoskeletons is crucial for successful integration. However, as exoskeleton technology evolves, the learning curve is expected to decrease, making them more user-friendly.

Workforce and Productivity. Exoskeletons can lead to a healthier and more productive workforce by reducing the risk of injuries and fatigue. Workers who feel more comfortable and protected will likely perform their tasks more efficiently and with reduced downtime due to injuries.

Rehabilitation Aids for Injured Employees Returning to Work. It is important to note that implementing exoskeletons as recovery tools requires careful planning and coordination between medical professionals, employers, and injured employees. Exoskeletons provide support, enhance movement, and alleviate physical strain when working with an injured employee. They promote correct body mechanics, reduce physical fatigue, prevent overexertion injuries, and offer customisable assistance. A thorough assessment of the injury and rehabilitation progress is essential to determine the appropriate level of support and the tasks that can be safely performed with the exoskeleton (Pienaar, Rapp, & Mills, 2022). Furthermore, training on exoskeleton usage and the device's functionalities is vital to ensure injured workers can operate them confidently and effectively. Regular monitoring and communication between all stakeholders will facilitate adjustments to the rehabilitation plan as needed.

Figure 2.22 illustrates a Personal Ergonomic Device (PED) undergoing a trial at Lorneville, AGL's largest processing facility. In April 2018, the Meat Industry Association (MIA) and WorkSafe New Zealand entered a Partnership Agreement aiming to decrease worker injuries, with a significant focus on technology playing a crucial role in enhancing the sector's health and safety performance. This initiative led to a collaborative research endeavour involving MIA, AGL, Silver Fern Farms, and AgResearch. The researcher played a pivotal role in spearheading this joint research project.

Figure 2.22

Personal Ergonomic Device Undergoing a Trial at Lorneville

Note. Jim Curran of Alliance Group's Lorneville Plant near Invercargill tries out the exoskeleton. Photo credit: Supplied

Exoskeletons can serve as valuable tools for injured employees returning to work. They aid their recovery journey and promote a safer and smoother reintegration into physically demanding work environments like meat processing.

Despite their potential benefits, exoskeletons face challenges, including cost, design compatibility with various tasks, and worker acceptance. Their effectiveness depends on their design, correct usage, and integration into existing work processes.

In conclusion, using personal ergonomic devices like exoskeletons in the meat processing industry can improve worker well-being, enhance workplace safety, and reduce the prevalence of MSDs. As technology advances and exoskeletons become more adaptable to specific tasks and user needs, their integration could lead to a safer and more efficient meat processing industry. However, a comprehensive approach that combines exoskeleton use with other ergonomic strategies, worker training, and continuous assessment will be vital to maximising the benefits of this technology (Pienaar, Rapp, & Mills, 2022).

2.7.7 Personal Protective Equipment

Personal Protective Equipment (PPE) refers to equipment, clothing, or accessories that protect individuals from workplace hazards. While PPE is crucial in ensuring the safety and well-being of workers, it should be regarded as a secondary control measure rather than the primary solution for addressing Musculoskeletal Disorders (MSDs).

The concept of the hierarchy of controls (Figure 2.23) is a widely recognised framework for managing workplace hazards. It prioritises control measures based on their effectiveness in reducing or eliminating hazards. According to this hierarchy, eliminating or substituting the hazard with a safer alternative is the most effective approach. Engineering controls, administrative controls, and work practice controls are considered primary measures that target the source of the hazard. PPE, on the other hand, is the last line of defence and is used when other control measures are not feasible or sufficient (NIOSH, 2023).

A PPE program incorporating essential components is necessary when introducing PPE to ensure understanding and utilisation of the equipment's purpose and usage. The program should encompass a workplace hazards assessment to identify risks, ensure the appropriate selection of PPE and provide necessary training to employees for correct usage. Additionally, employers must monitor and conduct regular inspections to promptly replace damaged or worn-out PPE items (NIOSH, 2023).

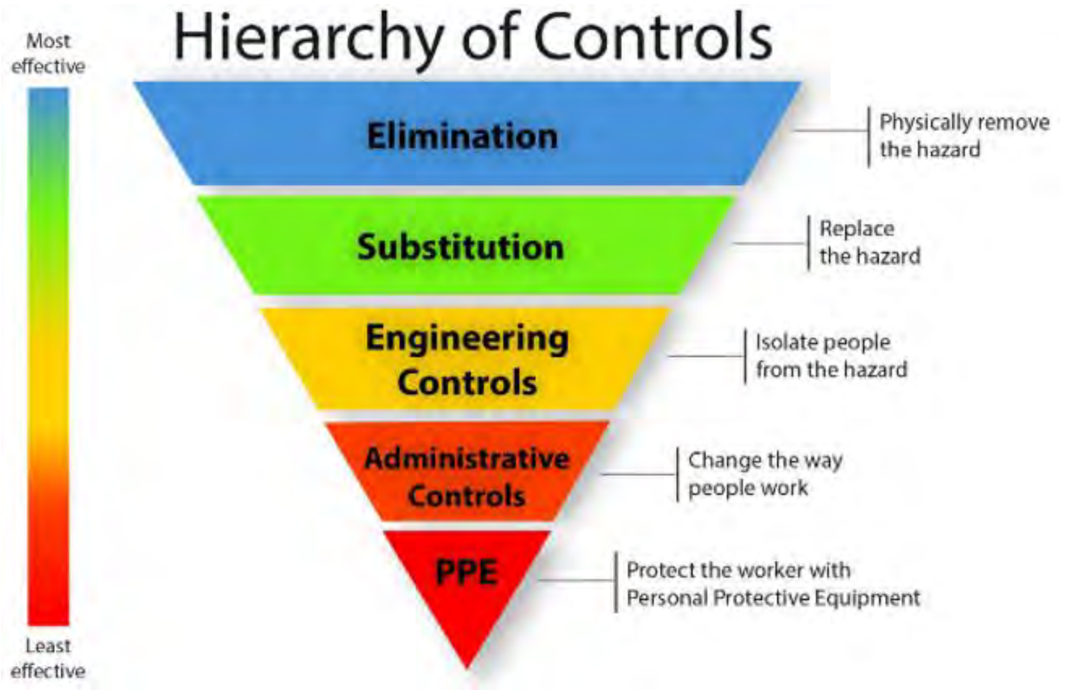
Specific PPE is crucial in preventing MSDs in the meat processing industry. This includes exoskeletons to support the upper body, back braces for proper posture, wrist braces to stabilise wrists, and tennis elbow bands to reduce forearm strain (Choi, Trout, Earnest, & Garza, 2022). Additionally, knee pads protect the knees, anti-vibration gloves mitigate the impact of machinery, and supportive footwear reduces lower body strain. Ergonomic mats help those standing for long periods, and protective sleeves and arm guards provide extra support for repetitive tasks. These measures, combined with regular ergonomic assessments and proper training, significantly reduce MSD risks (OSHA, 1993).

In conclusion, it is essential to recognise that while PPE is vital for safeguarding workers against workplace hazards, it should be considered a secondary control measure in addressing

MSDs. Primary control measures, including engineering controls, administrative controls, and work practice controls, present a more comprehensive and effective approach to preventing MSDs by directly targeting the root causes of these disorders.

Figure 2.23

Hierarchy of Controls for Reducing Injury Risk



Note. The hierarchy of controls is a widely recognised framework for managing workplace hazards, prioritising control measures based on their effectiveness in reducing or eliminating hazards. According to this hierarchy, eliminating or substituting the hazard with a safer alternative is the most effective approach. Image by NIOSH https://www.cdc.gov/niosh/topics/hierarchy/default.html

2.7.8 Stretching Programs

Stretching programs can be an effective strategy to reduce the risk of MSDs in the meat processing industry. MSDs are injuries or disorders that affect the muscles, tendons, ligaments, and other soft tissues, often resulting from repetitive tasks, awkward postures, or excessive force exertion. Implementing stretching programs before and after work can provide several benefits, including increased flexibility and reduced muscle tension, which can help prevent MSDs (King, Campbell, James, & Duff, 2020). Stretching programs offer various benefits, including increased flexibility. Through stretching exercises, muscles, tendons, and soft tissues are lengthened and elongated, improving joint range of motion and enhanced flexibility. Considering the repetitive tasks and prolonged maintenance of static or awkward postures in the meat processing industry, stretching before work can effectively prime the muscles for the forthcoming demands, enabling them to move more easily within their complete range of motion. This heightened flexibility effectively reduces strain on muscles and joints, minimising the risk of developing MSDs (Afonso, Olivares-Jabalera, & Andrade, 2022).

Prolonged periods of repetitive motions and sustained muscular contractions can lead to muscle fatigue and increased muscle tension. This heightened tension can contribute to the development of MSDs. Stretching after work can help alleviate muscle stiffness and tightness by promoting relaxation. Stretching exercises encourage blood flow to the muscles, providing them with oxygen and nutrients while flushing out metabolic waste products. This process can help reduce muscle soreness and tension, preventing the accumulation of microtraumas that could lead to MSDs over time. Poor posture significantly contributes to the development of MSDs. Workers in the meat processing industry often perform tasks requiring bending, lifting, and repetitive motions, which can strain the musculoskeletal system. By integrating stretching exercises that focus on the muscle groups involved in these actions, it becomes possible to enhance posture and alignment (Hrysomallis, 2010). Stretching the muscles prone to becoming tight or shortened during work activities, such as the lower back, hips, and shoulders, aids in restoring balance and diminishes the risk of MSDs associated with inadequate posture.

Stretching programs to prevent MSDs in the meat processing industry face several challenges. Time constraints and a less-than-ideal environment for stretching, such as cold or slippery conditions, may hinder participation. Ensuring consistent worker engagement and proper technique is crucial but can be difficult. Additionally, while stretching can improve flexibility and reduce muscle tension, it should be part of a broader strategy that includes ergonomic adjustments and proper training. Addressing these factors holistically will enhance the effectiveness of stretching programs in reducing MSD risk.

To summarise, stretching programs are beneficial for increasing flexibility and reducing the risk of MSDs and serve as effective warm-up and cool-down routines. Before commencing work, engaging in dynamic stretching exercises aids in enhancing blood flow, raising body temperature, and preparing the muscles and joints for physical exertion. Dynamic stretches involve controlled movements that activate the muscles and improve joint mobility. Conversely, static stretching helps cool down the body after work, gradually restoring the heart rate and breathing to normal levels. Implementing post-work stretching routines is crucial in resetting the body and preventing muscles from cooling down in a contracted and tight position. Failing to address this issue could put the worker at a disadvantage the next day, hindering their performance as a workplace athlete. By engaging in after-work stretching, the body can relax, allowing muscles to release tension and promoting optimal recovery for improved performance and reduced risk of future injuries (Alger-Norton, 2023).

2.7.9 Worker Engagement and Participation

Encouraging worker engagement and participation in identifying and addressing MSD hazards is crucial. Establishing joint health and safety committees or worker-led initiatives allows employees to voice their concerns, provide input on workplace design and practices, and contribute to developing and implementing interventions. By involving workers in decision-making processes, interventions are more likely to be effective and sustainable (WorkSafe, 2019). Engaging workers in identifying and addressing MSD hazards is vital because they possess valuable first-hand knowledge of their work processes, tasks, and challenges. As individuals who directly experience the physical demands and potential ergonomic risks associated with their job roles, their expertise and insights contribute to a more accurate understanding of the specific ergonomic issues present in the workplace. Involving workers in the process of addressing MSD hazards allows for the development of solutions that are better suited to the specific needs and capabilities of the workforce. Workers can provide insights on feasible and practical control measures to implement in their daily work routines. This collaboration between workers and management ensures that interventions and solutions are realistic, effective, and sustainable (Van Eerd et al., 2022).

Active engagement of workers in the decision-making process enhances their acceptance and compliance with implemented control measures. Involving workers from the outset allows them to develop a deeper understanding of the rationale behind the interventions and become advocates for their successful implementation. Consequently, this fosters improved adoption of safe work practices and cultivates a positive safety culture within the organisation.

Encouraging worker engagement and participation in addressing MSD hazards faces several challenges. Workers may be reluctant to participate due to fear of retaliation or time constraints. Diverse perspectives among workers can complicate the identification of comprehensive solutions and translating their input into practical interventions can be difficult. Ensuring consistent engagement and effective communication requires ongoing motivation and adequate training. Addressing these issues involves creating a supportive environment that values and acts upon worker contributions, thereby enhancing the effectiveness and sustainability of MSD prevention efforts.

Tappin, Vitalis and Bentley (2016) have demonstrated the value of an industry-level participatory ergonomics approach in developing MSD interventions. Participatory ergonomics in meat processing is a collaborative approach that involves workers, management, and occupational health and safety staff working together to improve ergonomic conditions in the workplace. This method relies on the active involvement of employees who perform meat processing tasks, utilising their first-hand insights to identify risks and develop practical solutions. The goals are to reduce MSDs, enhance worker safety and comfort, and improve productivity and job satisfaction. Key elements include:

Employee Involvement. Workers actively assess and redesign workstations, tools, and processes to ensure practical and effective ergonomic solutions.

Collaborative Problem-Solving. All stakeholders, including workers, supervisors, ergonomists, and health and safety professionals, work together to identify risks and brainstorm interventions.

Risk Assessment. Thorough evaluations of tasks, postures, and equipment identify factors contributing to ergonomic stress and MSD risk.

Training and Education. Workers and management receive training on ergonomic principles, proper work techniques, and ergonomic tools and equipment.

Continuous Improvement. A feedback loop ensures that ergonomic interventions are regularly reviewed and refined based on worker input and injury data.

Supportive Management. Management provides the necessary resources, such as time, funding, and expertise, to implement and sustain ergonomic improvements.

By leveraging workforce knowledge and experience, participatory ergonomics aims to create safer and more efficient work environments, reduce MSDs, and enhance overall operational performance. However, its practical application is limited by the need for a key stakeholder group with industry support and adequate resources to participate actively (Tappin, Vitalis, & Bentley, 2016).

Encouraging worker engagement and participation in identifying and addressing MSD hazards is crucial as it capitalises on the expertise and perspectives of those directly affected by the risks. By involving workers, organisations can obtain valuable insights, enhance risk assessments, foster ownership and empowerment, customise solutions to the workforce, and boost acceptance and compliance with safety measures (WorkSafe, 2019).

2.7.10 Conclusion

In conclusion, while various interventions to address MSDs in the New Zealand meat processing industry show potential, several challenges often compromise their effectiveness. Incident reporting systems face underreporting and insufficient focus on systemic causes, leading to repeated incidents. Ergonomic assessments require ongoing commitment and proper implementation, while job rotation and task variety strategies necessitate meticulous planning and continuous feedback to be sustainable. Manual handling training is often too generic, lacks reinforcement, and faces cultural and language barriers. Though highly effective, engineering controls can be costly and complex to implement. Stretching programs struggle with time constraints, environmental suitability, and consistent worker engagement. Additionally, fostering worker participation is crucial but can be hindered by fear of retaliation and communication barriers. Addressing these issues holistically through continuous improvement and targeted research is essential for effectively mitigating MSD risks and enhancing worker well-being in the meat processing industry (Figure 2.24).

To find practical solutions for addressing MSDs in the New Zealand meat processing industry, it is crucial to customise interventions based on each meat processing facility's specific needs and challenges. Regular monitoring, evaluation, and continuous improvement of these interventions are essential to ensure their effectiveness in reducing MSDs and promoting the well-being of workers. The current research literature on interventions for preventing WRMSDs in the meat processing industry is often generic, lacking specificity regarding the variation in risk factors and successful interventions across different processing plants. There is a significant need for more targeted research to address these gaps, focusing on developing new, more effective interventions or mitigating existing MSD risks. A conceptual model tailored to the unique conditions at AGL is essential for preventing MSDs, ensuring that interventions are designed and implemented to address the organisation's specific challenges effectively.

Figure 2.24

The impact of exposure to MSD risk factors in the development of MSDs

Note: MSDs develop when risk factors cause a musculoskeletal imbalance due to fatigue, outpacing recovery. The extent and the number of risk factors involved impact the onset of the MSD. The fatigue vs recovery curve was adapted from the MSD Prevention 101 Webinar (https://ergo-plus.com/msd-prevention-101-webinar/)

2.8 Chapter Summary

This chapter provided a comprehensive review of secondary research data about key aspects of managing and preventing MSDs in the New Zealand meat processing industry. The primary objective of the literature review was to identify a wide range of factors contributing to MSDs, examine past and current industry interventions, and highlight the barriers hindering the implementation of MSD prevention programs in this specific sector. The next chapter will outline the research methodologies used in this thesis.

Chapter 3 – Methods

The previous chapter reviewed secondary research data regarding the key aspects that impact MSDs, emphasising the importance of understanding the underlying factors contributing to MSDs in the meat processing industry. This chapter details the different research methodologies employed to answer the research questions.

3.1 Overview

This chapter outlines the research framework used in the study. To achieve the research objectives, it is essential to follow mixed research methodologies as described by Wisdom and Creswell:

"An emergent methodology of research that advances the systematic integration, or "mixing," of quantitative and qualitative data within a single investigation or sustained program of inquiry" (Wisdom & Creswell, 2013, p. 1).

The reasoning behind this methodology is to allow a more complete and synergistic integration of the research data rather than to do separate quantitative and qualitative data collection and analysis. The synergistic integration of research data refers to the process of combining and analysing various datasets to create a more comprehensive and cohesive understanding of all the variables that influence and impact the prevention of MSDs in the NZ meat industry, specifically AGL. By merging and analysing different datasets, the researcher will be able to leverage the strengths of each dataset and overcome their limitations, ultimately leading to deeper insights and more robust findings. Figure 3.1 presents a diagrammatic overview of the research framework utilised.

Secondary data analysis and reviews, which involve collecting and analysing extensive information, were used to provide evidence on the effectiveness of strategies implemented to reduce and prevent MSD in the meat processing industry.

To identify best practices, a review of current literature related to MSD in the meat processing industry and interventions for addressing MSD in New Zealand was conducted.

The researcher had access to an existing Alliance Group database (Curo) of MSD data to support the research, as referred to in the letter of support in Appendix A.

Figure 3.1

Overview of the Research Framework for Identifying and Implementing MSD Prevention Strategies at AGL

The database contains secondary data on the occurrence rates, location, and nature of MSD over the past eight years across seven meat processing plants with differing MSD rates. The data was analysed using MS Excel statistical software to identify trends. After identifying these trends, the researcher held a focus group discussion with all available AGL Health and Safety team members, including Health and Safety managers, advisors, and injury management personnel, to discuss plant variations. The goal was to determine which interventions or injury prevention strategies might be more effective based on these differences.

The purposes of this study are:

1. Review existing literature on known MSD risk factors, barriers to preventing MSD, and industry interventions for addressing MSD in NZ meat processing.
2. Collect and analyse injury data from the AGL database to identify and compare trends, including risk factors and barriers to MSD prevention.
3. Use the findings from this research and develop a systematic approach/intervention programme to combat MSD risk factors and prevent MSDs at AGL.

3.2 Methodology

This section identifies how the use of mixed research methodologies is best suited to address each research question. The reasoning behind this methodology is to allow more complete and synergistic integration of the research data rather than to do separate quantitative and qualitative data collection and analysis (Wisdom & Creswell, 2013).

Within the mixed-mode methodology, the researcher will use applied action research. Action research is defined as

"Research strategies that tackle real-world problems in participatory, collaborative, and cyclical ways in order to produce both knowledge and action." (Iowa State University, 2021)

According to Driskell, King, and Driskell (2014, p. 451), applied research aims to apply or extend "theory to an identified real-world problem with a practical outcome in mind".

By employing the research above methodologies, the researcher can effectively identify various factors contributing to the successful prevention of MSDs in the meat processing industry. This will significantly benefit the researcher by enabling the application of these findings in their role as the Musculoskeletal Injury Prevention Manager, leading to immediate advantages for their employer, AGL.

3.2.1 Ethical Considerations

This research is underpinned by a commitment to ethical standards, ensuring all participants' protection, welfare, and confidentiality. The study was initiated only after obtaining ethical approval from the Te Whare Wānanga o Awanuiārangi Ethics Committee. This process involved a detailed submission outlining the study's objectives, methodology, and potential risks and benefits. Appendix C contains the approval letter, information sheet, and consent form for reference, highlighting the importance of the ethical approval process in this research.

Informed consent was obtained from all participants before participating in the focus group discussions. Participants were briefed on the study's goals, procedures, potential risks, and benefits, as well as their right to withdraw from the study at any time without facing consequences. Special attention was given to ensuring participants comprehended the voluntary nature of their involvement and the assurance that their anonymity would be rigorously preserved in all research outputs. In anticipation of potential restrictions, we are actively collaborating with AGL to address any issues that may prevent the public dissemination of (AGL-sensitive) research findings. Consequently, there is a chance that the thesis may be placed under embargo.

3.2.2 Literature Review

An extensive review of current literature on MSD and musculoskeletal injuries in New Zealand's meat processing industry was conducted to identify risk factors, prevention barriers, and interventions. Online databases (PubMed, Proquest, Informit, DOAJ, ClinicalKey, ResearchGate, Google Scholar) and library searches were utilised with keywords such as "musculoskeletal disorders," "musculoskeletal injuries," "meat processing industry," and "musculoskeletal injury prevention."

The review began with New Zealand-specific research from the past two decades. Then, it expanded to include recent studies from Australasia and relevant international sources from the past five years. This comprehensive process enabled the identification of best practices and areas requiring further exploration in musculoskeletal injury prevention.

The literature review followed a structured and evolving process. Insider and applied research methodologies were employed, allowing the researcher to adapt and refine the focus based on emerging trends and findings. This dynamic approach ensured a thorough understanding of the current landscape and highlighted areas for future research in the meat processing industry.

3.2.1 AGL Database – Secondary Data

The researcher analysed the AGL injury database to identify emerging trends. Data was extracted from the company's Curo database as an ACDNTNE3 report. The report contained data on 16,380 injury incidents recorded between October 1, 2016, and August 11, 2021, by the AGL medical clinic team members who treated the injured employees. The database included secondary data on the type of injury, occurrence rates, tasks performed, locations and nature of the MSDs over the past five years, collected from seven meat processing plants with varying MSD rates. To effectively manage MSDs at AGL, it is essential to identify and track the right safety metrics. These metrics provide valuable insights to improve safety performance. Lagging indicators, such as historical data on the number and severity of incidents, offer insights into past performance. At AGL, lagging indicators are referred to as recordable (MTI & LTI) injuries. However, they provide limited information on the behaviours and conditions that precede these incidents. Leading indicators (discomfort reporting, aches and pains, sprains and strains) offer proactive insights into these behaviours and conditions, helping to prevent future incidents. Combining both types of indicators provides a comprehensive view of safety performance, enabling the identification of MSD prevention opportunities and areas for improvement. Another metric that will be used for inter-plant comparisons to identify potential risks is the lead-lag ratio. Given the unique differences between each plant, a plant-specific lead-lag ratio will enable meaningful comparisons and allow each plant to track its year-on-year safety performance. This metric is based on Heinrich's Pyramid, also known as Heinrich's Safety Pyramid or the Accident Triangle, a theoretical model in occupational safety and health developed by H.W. Heinrich in the 1930s. The model illustrates the proportional relationship between different types of workplace incidents to predict injuries and accidents. Although this model is still widely used, it has been challenged in recent research due to its limitations, as it implies a direct causal relationship that cannot be established with the available data in this study (Yorio & Moore, 2018).

The data set exhibited certain limitations, primarily from the variability in injury input categories utilised across different plants and the absence of detailed descriptions for injuries and tasks. Furthermore, there were instances where recurring themes, such as back injuries, were spread across multiple categories, necessitating their consolidation for analysis. A data coding and cleaning process was implemented to distinguish MSD incidents from other injury occurrences within the data set (see Appendix B for more details). Another limitation of the data format is that only frequency and trends could be analysed across the seven plants. Due to interplant variations in size, number of employees, hours worked, shift variations, length of processing season, plant and equipment design, task rotation, and species processed, statistically comparing differences between plant groups was impractical. For instance, some plants operated with up to six "chains" (processing lines), while others were single or double-chain operations. Therefore, the researcher decided to treat each plant as a business unit and focus on injury clusters to identify patterns.

Moreover, the size of the plants differed not only in terms of the number of employees, ranging from 270 to 2000, but also in the number of people working on similar production lines, which could vary significantly, ranging from 28 to 120 persons. Such variations directly affected production line speeds and the types of "cuts" that could be made. Additionally, variations were observed between species, such as Ovine, Bovine, and Cervine, and in the size of the livestock processed. Seasonal processing variations also played a role in influencing the overall operations.

These findings highlighted the complex and diverse nature of the meat processing industry, underscoring the importance of considering these variations when analysing the data and drawing conclusions. The researcher recognised that these factors could significantly impact the successful prevention of MSDs and needed to be carefully accounted for in the study's analysis and recommendations.

3.2.2 Focus Group

A focus group discussion was conducted to identify barriers to successful MSD injury prevention and effective MSD prevention strategies. Focus groups, a valuable qualitative research method, were chosen for their ability to foster group interaction and generate rich, detailed data. This method effectively explores group norms, consensus, and diverse perspectives, stimulating deeper insights and discovering nuances through group dynamics and interactions (Marczyk, DeMatteo, & Festinger, 2010). Additionally, focus groups are cost-effective, allowing insights from multiple participants simultaneously. Using Microsoft

Teams during COVID restrictions enabled the researcher to receive immediate feedback on ideas and concepts, enhancing understanding of the subject matter.

However, focus groups have limitations. Group dynamics can lead to conformity or dominance by specific individuals, limiting diverse perspectives. Organising and conducting focus groups can be time-consuming, especially when coordinating multiple participants. A focus group's effectiveness depends on the moderator's skills and neutrality, as biased moderation can skew results. In comparison, one-on-one interviews offer deeper individual insights but may lack the breadth of perspectives in group settings and are more resource intensive. Surveys are effective for collecting quantitative data from many respondents but lack the depth and context of qualitative methods and do not allow for interactive discussions. Observation studies provide a first-hand understanding of behaviours but may miss participants' thoughts and can introduce observer bias (Krueger & Casey, 2014).

During the focus group session, the researcher shared insights from the literature review and notable trends from secondary data analysis. Key discussion points (detailed in Appendix K) were presented, and participants were invited to provide feedback through open-ended questions and discussion prompts. Using a semi-structured format, the researcher facilitated an open-ended discussion, actively participating in the research process (Saunders, Lewis, & Thornhill, 2019). This approach is valuable as it encourages thorough exploration of participants' experiences and offers flexibility in addressing the complexities of MSD management and prevention strategies.

All AGL Health and Safety managers, advisors, and injury management personnel were invited via email to discuss the findings and any variations between processing plants. Participant demographics are detailed in the research participant section. The consent form (Appendix C) was shared electronically, allowing participants to review and understand the process. It was clear that anyone could leave the recorded meeting at any time. Once consent was given, the researcher recorded the focus group discussion using Microsoft Teams. The recorded information was transcribed for further analysis (Appendix K).

In summary, focus groups are chosen for their ability to generate rich qualitative data and explore group dynamics, offering unique insights that complement other research methods.

3.2.3 Applied Action Research

As a Musculoskeletal Injury Prevention Manager at AGL, the researcher's goal is to carry out their role effectively by implementing all feasible interventions while continuing to develop a systematic process that utilises this knowledge to reduce the occurrence of MSDs in the meat processing industry. The implementation process will include action research (please refer to Figure 3.1). Action research aims to generate practical knowledge to enhance individual and organisational practices and empower participants to act. The learnings gained from answering the research questions were applied in practice after employee engagement at all levels. Action research aims to generate practical knowledge and solutions that can be implemented to improve the situation under study. It is a participatory and democratic approach to research wherein the participants involved in the research are active agents in the process of change (Shani & Coghlan, 2021).

Another significant opportunity has presented itself to the researcher, allowing for evaluating the effectiveness of selected interventions implemented since the start of this research project. This opportunity arose because AGL decided to invest in a cloud-based risk management solution specifically tailored for the New Zealand workplace, which is known as Risk Manager. Notably, this solution is the first developed in New Zealand and offers a flexible, best-practice framework that can be configured to meet AGL's unique requirements. With the Risk Manager Incidents Module, AGL now can efficiently capture incidents, near misses, and hazards across the entire organisation (Impac, 2023). All injury data is now stored in the new database. The official transfer date occurred on the 1st of August 2021, with AGL's previous Curo database being retired on the 11th of August 2021.

As the Musculoskeletal Injury Prevention Manager, the researcher can now use this data to assess the effectiveness of new initiatives and identify the best areas to invest in or allocate new resources. This data will aid in making informed decisions and optimising strategies for preventing musculoskeletal injuries.

3.3 Research Participants

To facilitate a comprehensive discussion on the findings derived from the literature review and to examine any variations or injury trends identified through the secondary data analysis across different processing plants, an invitation was extended to all members of the Central Safety team, Plant Health and Safety managers, Plant Health and Safety advisors, and injury management personnel to participate in the focus group. This group of individuals were identified since they are in the best position to know barriers and injury trends across AGL and, therefore, are the research population. All individuals who met the inclusion criteria mentioned above criteria were deemed eligible to participate in the research. A total of 15 invitations were sent via e-mail.
The focus group discussion, held on the 7th of May 2021, featured 11(73% of invitees) participants who brought extensive knowledge and experience. Their ages ranged from 30 to 66, with an average age of 53. Together, they possessed 95.6 years of experience in the meat industry and held diverse tertiary qualifications. These qualifications spanned various fields, including engineering/safety process management, ergonomics in the workplace, occupational health and safety, nursing, injury management, ACC case management and return to work programming, injury data management, exercise physiology, biomechanics, musculoskeletal rehabilitation and most importantly experience in meat processing. The focus group participants demonstrated a diverse range of backgrounds, making them a representative sample of workers in the meat processing industry. For detailed participant demographics, please refer to Table K1 in Appendix K.

Following the focus group discussions, supplementary discussions were conducted with specific consenting health and safety team members, including those absent during the focus group discussions, supervisors, and health and safety representatives. This level of engagement aimed to apply many of the insights gained as part of the musculoskeletal injury prevention strategy.

3.4 Research Questions

3.4.1 Research Question One – Which MSD Risk Factors are Prevalent in the NZ Meat Processing Industry?

Bero, Grilli, Grimshaw, Harvey, Oxman, and Thomson (1998) propose that the most effective method for identifying prevalent MSD risk factors in the New Zealand meat processing industry involves secondary data analysis and reviews. Utilising this approach, the researcher collected and analysed a broad range of information, providing a comprehensive understanding of the risk factors.

3.4.2 Research Question Two - What Industry Interventions for Addressing MSD in NZ Meat Processing are Recommended?

Secondary data analysis and reviews that involve collecting and analysing a vast array of information are best suited to provide evidence on the effectiveness of different strategies implemented in clinical practice (Bero, et al., 1998). Secondary data analysis and reviews are the methods to answer the second research question.

3.4.3 Research Question Three - What Barriers to MSD Prevention in NZ Meat Processing have been Identified?

Secondary data analysis and literature reviews can be used to identify barriers to MSD prevention in the New Zealand meat processing industry. These methods have been identified as the preferred method for answering the third research question (Bero et al., 1998). Additionally, focus group discussions are expected to shed light on a few areas of concern.

3.4.4 Research Question Four - What MSD Trends can be Observed at AGL?

Research question four will be addressed through a statistical analysis of the AGL database, which contains secondary data on the occurrence rates, locations, and nature of MSDs over the past five years across seven distinct meat processing plants with varying MSD rates. The MSD data will be extracted and compiled in MS Excel format, then analysed using MS Excel statistical software to identify any discernible trends. Data Harmonization, as described by Bradwell et al. (2022), was employed to accommodate datasets from the various plants, each exhibiting known variations in data formats, scales, staffing, and processing differences, among others. Data Harmonization entails standardising and transforming the data, ensuring they can be effectively compared and analysed. This critical step ensures compatibility and reliability during integration. To address data with missing or incomplete values, the researcher compared these values with incident report data collected from all plants. (Bradwell, et al., 2022).

3.4.5 Research Question Five - Which MSD Prevention Interventions have been Effective in Addressing MSD at AGL?

To answer research question five, the researcher will identify trends and conduct a focus group discussion with all available Health and Safety managers, advisors, and injury management personnel. The focus will be on discussing variations between processing plants. These differences are expected to provide insights into which interventions or injury prevention strategies may be more effective in preventing MSD.

3.4.6 Research Question Six - What Barriers to MSD Prevention Exist at AGL?

Research question six will identify barriers to MSD prevention at AGL by conducting a focus group discussion with all key Health and Safety managers and advisors, including all injury management personnel. Findings from research question three (barriers to MSD prevention in NZ meat processing) and outcomes from research question four (MSD prevention interventions, variations, and trends) will be key areas for discussion during the focus group session (Nyumba, Wilson, Derrick, & Mukherjee, 2018).

3.4.7 Research Question Seven - Which Factors Need to be Considered when Developing a Systematic MSD Prevention Program?

To answer research question seven, secondary data analysis and reviews (Bero, et al., 1998) in conjunction with the outcomes of all the previous research questions, will be considered when developing a systematic MSD prevention program.

3.5 Chapter Summary

This chapter outlined the methodology employed to effectively address the research questions and identify the optimal strategy for preventing MSDs in the meat processing industry. Subsequently, the following chapter presents the research findings derived from the study.

Chapter 4 - Results

The preceding chapter presented a comprehensive overview of the methodology employed to address the research questions effectively and identify the optimal strategy for managing MSDs in the meat processing industry.

4.1 Overview

The initial section of this chapter will analyse the MSD injury data gathered from the AGL database. Research question four will be addressed through statistical analysis of the AGL database, which includes secondary data pertaining to the occurrence rates, locations, and nature of MSDs over the past five years across seven meat processing plants characterised by varying MSD rates. The extracted MSD data was collected in MS Excel format and analysed with MS Excel statistical software to identify any existing trends.

As the data analysis progressed and the researcher conducted plant visits as part of his formal role at AGL, significant variation became apparent between the different plants. The dataset faced limitations due to significant variations across the seven plants, including differences in size (270 to 2000 employees), production line personnel (28 to 120), processing lines (one to six), hours worked, shift patterns, processing season length (6-11 months), plant and equipment design, task rotation, and species processed (Ovine, Bovine, Cervine). These variations impacted production line speeds and overall operations. Consequently, each plant was treated as a business unit, focusing on injury clusters to identify patterns. The data tables provide insights that inform practice. While many tables include data that are not statistically significant, they still indicate injury trends that guide practice. Detailed explanations of these limitations were provided in the methodology section.

The researcher acknowledges the complex and diverse nature of the meat processing industry, emphasising the need to consider these variations when analysing data and forming conclusions. These factors are crucial for effectively preventing MSDs and must be carefully integrated into the study's analysis and recommendations. For this reason, each Plant was analysed individually rather than comparing “apples with pears.” This led the researcher to focus on single plant variations of high injury areas or incident clusters rather than look for statistical differences between the respective plants.

This preliminary phase of the study aimed to create a comprehensive profile of MSD injury data at AGL. This effort aimed to identify the tasks frequently associated with reported MSD cases, allowing us to prioritise them for deeper analysis in the next stage of the study.

4.1.1 Aims of this chapter

1. To examine patterns and trends in MSD injury data.

2. To determine the activities or tasks that exhibit the highest correlation with MSD occurrences and to utilise this evidence as a foundation for identifying the specific tasks to prioritise while developing an MSD injury prevention plan.

3. To identify a preliminary agenda for the focus group discussion. Answers to research question five will become evident once trends in the AGL data have been identified.

4. To identify any issues for consideration in further research.

4.1.2 Analysis of Alliance Group MSD injury data

It was essential to define the different divisions and categories in which the injuries may be entered to enable the researcher to analyse the AGL injury database. Each division will have different departments with different roles (or tasks performed) within the departments. In a concise summary, the organisation consists of seven processing plants, each of which is strengthened by a corporate sector that provides vital support in terms of management, logistics, procurement, marketing, and sales functions for the products generated by these plants. To facilitate analysis, the injury data will be alphabetically categorised by division, sector, and plant. Within each division, injuries will be further classified based on the department and the specific tasks or roles performed. This analytical framework will enable the identification of trends and clusters associated with high injury risks across the various processing plants.

The injury dataset comprises all injury data recorded from 1 October 2016 to 11 August 2021. The data was extracted from AGL's CURO database, which serves as the company's injury records repository. Data from five seasons were included to identify any potential seasonal changes. This approach aimed to identify any potential seasonal changes that might have occurred. It is essential to note that variations in the duration of the season(s) were observed across different plants due to demographic disparities and differences in livestock availability.

To facilitate meaningful comparisons of injury data between the various plants, the researcher adopted a "best fit" season approach. This involved including all injury data recorded between 1 October and 30 September of the corresponding season, ensuring consistency in the seasonal timeframes used for analysis.

In the context of this study, it is crucial to establish a clear distinction between the concept of a musculoskeletal incident and a musculoskeletal disorder (MSD). It is necessary to clarify the specific definitions and interpretations associated with each term to accurately analyse and interpret the study's findings. According to the CDC, musculoskeletal disorders can be defined as injuries or disorders that involve the muscles, nerves, tendons, joints, cartilage, spinal discs, and other supporting structures of the human body (Centers for Disease Control and Prevention, 2020). In the scope of this study, when referring to musculoskeletal disorders, the data entry points encompass muscle aches and pains, general discomfort, Occupational Overuse Syndrome (OOS), musculoskeletal diseases, sprains, and strains. It is important to note that fractures and injuries resulting from bruising and crushing while involving musculoskeletal tissues are not considered part of the MSD category in this study.

To enable AGL to manage MSDs effectively, it will be necessary to identify the right safety metrics to track. These indicators will give valuable insights into what areas to focus on to maximise the outcomes and improve the company's safety performance. In other words, "fishing where the fish are" as put by the company CEO (Willie Wiese, personal communication, November 9, 2022). These metrics include leading and lagging indicators. Lagging indicators are key performance indicators (KPIs) that examine historical statistical data. At AGL, lagging indicators are referred to as recordable (MTI & LTI) injuries. Leading indicators (discomfort reporting, aches and pains, sprains and strains) offer proactive insights into these behaviours and conditions, helping to prevent future incidents. Combining both types of indicators provides a comprehensive view of safety performance, enabling the identification of MSD prevention opportunities and areas for improvement.

Another metric that will be used to identify potential risks for inter-plant comparisons is the lead-lag ratio. This metric is based on Heinrich's theoretical model. The model illustrates the proportional relationship between different types of workplace incidents to predict injuries and accidents (Yorio & Moore, 2018).

This reactive approach examines the number and severity of incidents in an organisation. Although it is necessary to track lagging indicators, they provide less insight into the behaviours and conditions that precede these incidents. It is imperative that lagging indicators are reviewed along with leading indicators (National Safety Council, 2015; Vector Solutions, 2020).

AGL's key metric for monitoring its safety performance is the Total Recordable Incident Frequency Rate (TRIFR). The TRIFR indicates the rate of recordable injuries per million hours worked. Lost time injuries + Medical Treatment Injuries + Occupational Illnesses, multiplied by one million hours and divided by the number of work exposure hours (Auckland Transport, 2016).

Leading indicators are a predictive system of measurement that focuses on continuous improvement. According to Jonathan Thomas, director of safety management solutions for the National Safety Council (NSC), leading indicators measure safety events or behaviours that occur before an incident (Vector soultions, 2020). In a white paper produced by the NSC's Campbell Institute, safety specialists defined leading indicators as:

"Preventative measures that monitor and provide current information about the effective performance, activities, and processes of an EHS management system …." (National Safety Council, 2015, p. 4).

Utilising leading and lagging indicators enables organisations to establish a comprehensive measurement system that effectively anticipates potential incidents and determines the appropriate preventive measures. This approach ensures that organisations are equipped with early warning signals while also facilitating the identification of proactive actions to mitigate risks.

4.2 Review of AGL Corporate Division five season injury data

The Alliance Group employs individuals across various processing plants and departments, including corporate offices and livestock teams. The corporate division, which includes the livestock team members, is considered a single business sector for data analysis. The main corporate offices are in Invercargill and Christchurch, while most livestock agents work in the field.

In corporate offices, people hold management, administration, finance, human resources, marketing, and sales positions. These roles support the company's overall functioning, ensuring effective communication, coordination, and decision-making at the organisational level. Due to the administrative nature of these positions, injury rates can be expected to be lower compared to the processing plants.

On the other hand, the livestock agent roles are more physically demanding and involve significant travel and on-farm activities, which may make them prone to musculoskeletal disorders compared to corporate office employees. Livestock agents act as intermediaries between farmers and the Alliance Group, facilitating livestock procurement for processing and sale.

Livestock agents' primary responsibility is establishing relationships with farmers and understanding their specific livestock requirements. They work closely with farmers to assess and evaluate the quality and quantity of livestock available for sale. This includes conducting on-site visits to farms, inspecting the animals, and providing guidance on best practices for animal husbandry to ensure the delivery of high-quality livestock.

Livestock agents also inform farmers about market conditions, pricing trends, and quality standards set by the Alliance Group. They assist farmers in understanding animal health, welfare, and traceability requirements. This support helps farmers meet the necessary standards for supplying livestock to the Alliance Group, ensuring compliance with industry regulations.

The dataset encompassed five seasons and documented 47 injuries within the corporate division. Table 4.1 presents the distribution of these seasonal injuries for the corporate division.

Table 4.1

Seasonal Injuries for the Corporate Division

Season	Number of injuries
16/17	16
17/18	9
18/19	11
19/20	10
20/21	2
Total injury count	**47**

It was interesting to note that two marketing team members reported two near misses for back injuries while performing supervisory tasks. This finding must be reported as it highlights a potential risk area when working in the corporate sector.

Figure 4.1 clearly shows that the livestock representatives within the corporate division are at the highest risk of injury.

Figure 4.1

Injury Breakdown by Department within the Corporate Division

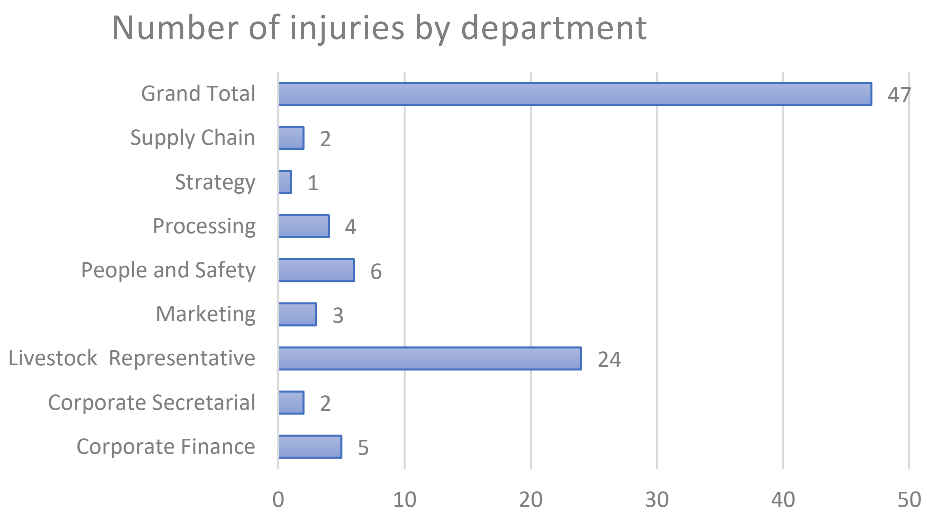
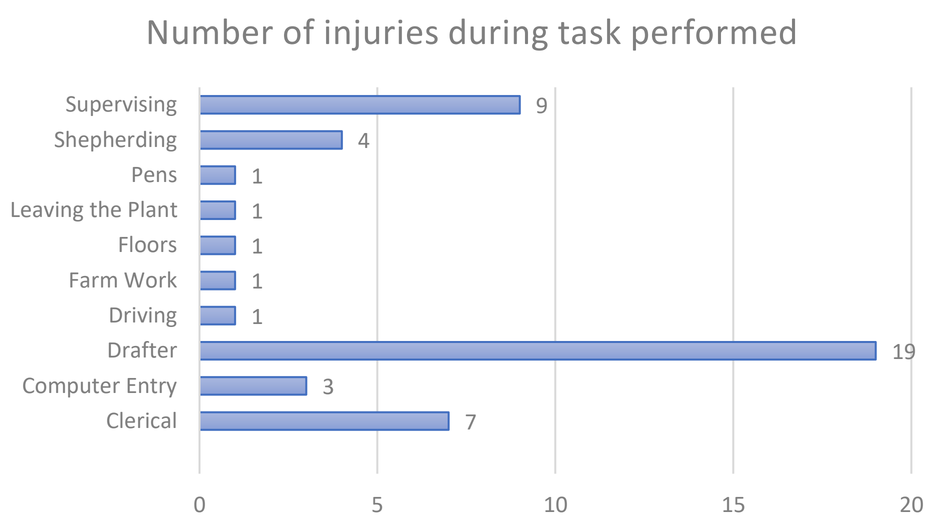


Figure 4.2 depicts the tasks performed when the injuries occurred. Drafting stock, supervising, and performing clerical work will most likely lead to an injury within the Corporate Division.

Figure 4.2

Injury Breakdown by Tasks Performed within the Corporate Division



Keeping their employees safe and sending them home injury free is a priority for AGL (Alliance Group Limited, 2021). Therefore, it is important to look at all the different injuries that occurred before isolating the musculoskeletal injuries from the rest since some may influence the occurrence of MSD. These factors may need to be considered when developing or identifying areas needing injury prevention strategies. Table 4.2 gives a description of the different injuries recorded during the past five seasons for the Corporate Division. It is noticeable that most injuries were sprains and strains, followed by discomfort and bruising/crushing-type injuries.

Table 4.2

All Seasonal Injuries Listed by Description for the Corporate Division

Injury Description	Number of injuries
Aches/pain - gradual	1
Aches/pain - specific	3
Bruising/Crushing	5
Discomfort	9
Fracture or Spine	1
Infection	1
Laceration - Dressing Only	1
Laceration - Sutures	1
Near Miss	2
Open Wound	1
Other	1
Puncture Wound	1
Sprain/Strain	19
Superficial	1
Total injury count	**47**

This study focuses on identifying MSDs and developing an injury prevention protocol to reduce the occurrence of these injuries. Table 4.3 lists all MSDs by description for the corporate division. Sprains and strains comprise the highest proportion (59.4%) of the MSDs.

Table 4.3

MSD listed by description for the Corporate Division

MSD by description	Number of injuries
Aches/pain - gradual	1
Aches/pain - specific	3
Discomfort	9
Sprain/Strain	19
Total injury count	**32**

MSDs account for 68.1% (32/47) of the injuries recorded for employees working in corporate departments. Examining the incident types associated with the injuries will provide valuable insights to the researcher regarding the severity of the MSDs. Table 4.4 shows the MSDs by incident type.

Table 4.4

MSD Listed by Incident Type for the Corporate Division

Incident type	Number of injuries
Discomfort	9
First Aid Injury	14
Lost Time Injury (LTI)	2
Medical Treatment Injury (MTI)	7
Total injury count	**32**

The data indicates that nine more severe injuries occurred, specifically MSDs, that resulted in lost time for two individuals and necessitated medical treatment for seven individuals. Noting the injured body area will provide information on where most loading occurs. This information will direct the researcher towards prevention strategies to reduce the impact of the workload on these areas.

Based on the data presented in Table 4.5, the knee was the body location most commonly associated with injuries within the Corporate Division, with six occurrences. This was followed by the shoulder region, which accounted for four injuries while performing these tasks.

Table 4.5

MSD Listed by Body Location for the Corporate Division

Injured body area	Number of injuries
Ankle	3
Arm	2
Back	3
Buttocks	2
Chest	1
Elbow	3
Fingers	1
Foot	1
Knee	6
Lower Limb	1
Multiple Locations	1
Neck	4
Shoulder	4
Total injury count	**32**

The analysis presented in Figure 4.3 reveals that the highest proportion of injuries within the Corporate Division was observed in the knee region (19%) and shoulder region (13%). Additionally, back injuries accounted for 9% of the total injuries. These findings suggest that when performing tasks within the Corporate Division, these specific areas of the body are more susceptible to injury.

Furthermore, when considering the department-wise distribution of injuries, it is noteworthy that Livestock representatives experienced the highest number of injuries. This alignment between the injury distribution and the expected musculoskeletal loading is consistent with the physical strain that Livestock representatives will likely encounter during drafting tasks, as depicted in Figure 4.4.

Figure 4.3

Injury Breakdown by Body Location within the Corporate Division

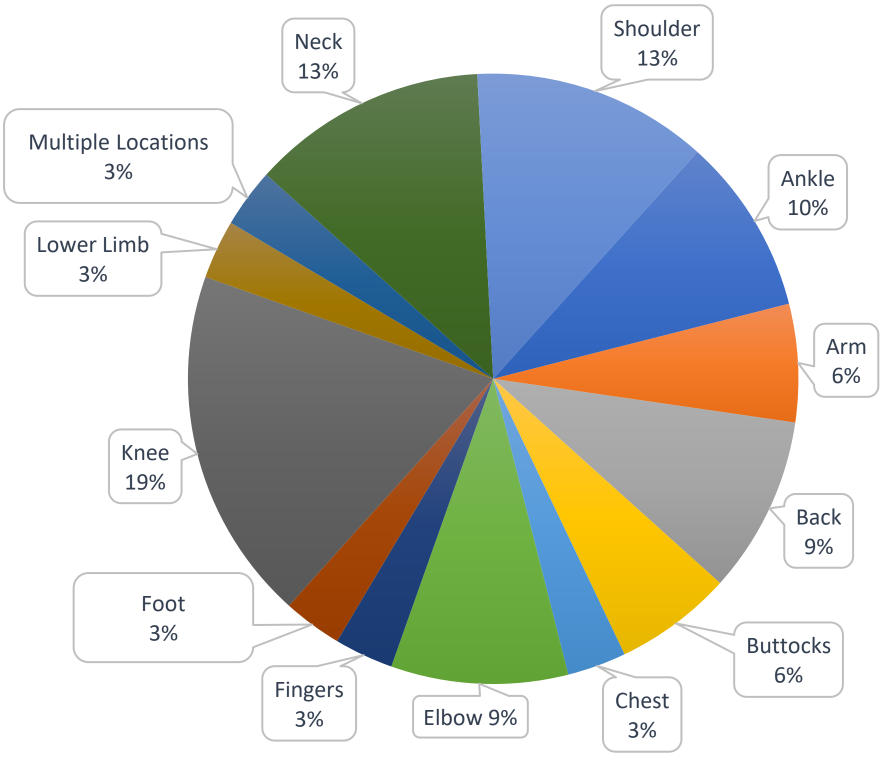
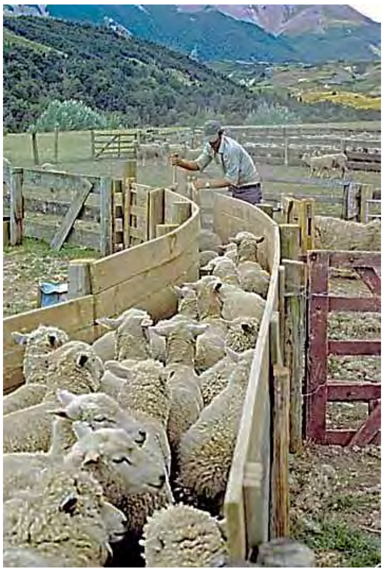


Figure 4.4

Drafting livestock is a very physical task that places increased musculoskeletal loading on the person's body (Te Ara, 2022)



4.3 Review of AGL Dannevirke plant five season injury data

The Alliance Dannevirke Plant is an ovine processing facility in Dannevirke, on the North Island of New Zealand. With a workforce of 270 employees, the plant operates for approximately 11 months per season (Alliance Group, 2023). The Dannevirke database comprises a comprehensive record of incidents, totalling 1,202 recorded cases. This data spans a period of five seasons, from October 1, 2016, to August 11, 2021. Table 4.6 provides an overview of the distribution of these injuries in the Dannevirke Plant.

This extensive dataset encompasses all recorded injury incidents and is organised based on injury classification, injury type, injury department, injury task, and the specific body location of the injuries. Through careful data analysis about the location, severity, and type of injuries, it becomes feasible to identify trends and distinguish between leading and lagging indicators. This analytical approach allows for a comprehensive understanding of the dataset, enabling valuable insights derived from the information collected. Notably, there has been a consistent decrease in injury frequencies across all injury types since the 2017/2018 season, with an unexpected increase observed during the 2020/2021 season.

Through careful examination of the data patterns, it is possible to pinpoint areas of concern and discover opportunities to enhance safety outcomes and mitigate the risk of injuries.

Table 4.6

Seasonal Injuries for the Dannevirke Plant

Season	Number of injuries
16/17	231
17/18	282
18/19	231
19/20	207
20/21	251
Total injury count	**1202**

4.3.1 Categorization of all Dannevirke Injuries: Unveiling Meaningful Patterns and Frequency Trends

Systematically categorising injuries based on their types makes it possible to discern meaningful patterns and trends in their frequency. As illustrated in Table 4.7, a notable observation is the upward trend in discomfort reporting, which could be advantageous if early reporting correlates with a reduction in incident severity. However, there is cause for concern regarding the increase in First Aid and Lost Time Injury (LTI) reporting during the 20/21 season. Additionally, the relatively low number of near misses recorded in the database raises concerns. This discrepancy may indicate potential resource allocation or prioritisation issues rather than a lack of reporting. It could also signify the need to evaluate the effectiveness of safety interactions within the organisation. These findings highlight areas that warrant further investigation and potential interventions to enhance workplace safety.

Table 4.7

Dannevirke Seasonal Incidents by Classification

	Season					
Injury Classification	**16/17**	**17/18**	**18/19**	**19/20**	**20/21**	**Total**
Discomfort	97	133	90	95	116	531
First Aid Injury	130	148	140	109	129	656
Lost Time Injury (LTI)	3	1	1	2	5	12
Medical Treatment Injury (MTI)	1			1	1	3
Grand Total	**231**	**282**	**231**	**207**	**251**	**1202**

As presented in Table 4.8, the incident analysis provides valuable insights for identifying the optimal starting points for injury prevention initiatives or pinpointing areas with the highest priority for intervention. This information is valuable for strategically allocating resources and implementing targeted injury prevention measures where needed. AGL can effectively prioritise and direct their injury prevention initiatives for maximum impact by focusing on departments with the highest incidents.

Table 4.8

Dannevirke Seasonal Incidents by Department

	Season					
Incident department	**16/17**	**17/18**	**18/19**	**19/20**	**20/21**	**Total**
All Depts General			2	1		3
Amenities	1		2	2		5
Cold Storage	4	3	1	3	2	13
Further Processing	78	122	71	76	63	410
Laboratory			2			2
Load Out	7	14	15	17	22	75
Maintenance	7	1	5	1		14
Packaging Store		1	1		1	3
Pelts	3	3	10	2		18
Plant Administration	1					1
Plant Services-Yard Gang	2	1	2	2	1	8
Pool Labour		4				4
Quality Control		1	2	2	1	6
S/Bd Chain 1	39	45	38	32	57	211
S/Bd Labourers	82	84	73	65	98	402
S/L Yards	7	3	7	4	6	27
Total	**231**	**282**	**231**	**207**	**251**	**1202**

A notable observation is the evident decline in the incidents associated with Further Processing. Based on this trend, it is recommended that efforts be prioritised in the Slaughterboard (S/Bd) department (with 613 incidents recorded, as highlighted in Table 4.8) and subsequently shift focus towards the Load Out department. To ensure a comprehensive understanding, it is crucial to consider the proportion of injuries relative to the workforce size in these departments. The data strongly indicates the need for targeted interventions to address the injuries during the load-out process. Allocating particular attention to this area can significantly contribute to mitigating risks and enhancing overall safety within the organisation.

Based on the findings presented in Figure 4.5, it is evident that within the injury departments of Dannevirke, a significant majority of injuries (96%) can be attributed to the top seven departments. Further Processing has the highest proportion of injuries, contributing to 35% of the total injury count. This highlights the importance of prioritising safety measures and injury prevention initiatives within the Further Processing department to address the predominant source of injuries in the plant effectively.

Figure 4.5

Dannevirke Top Seven Injury Departments (96%)

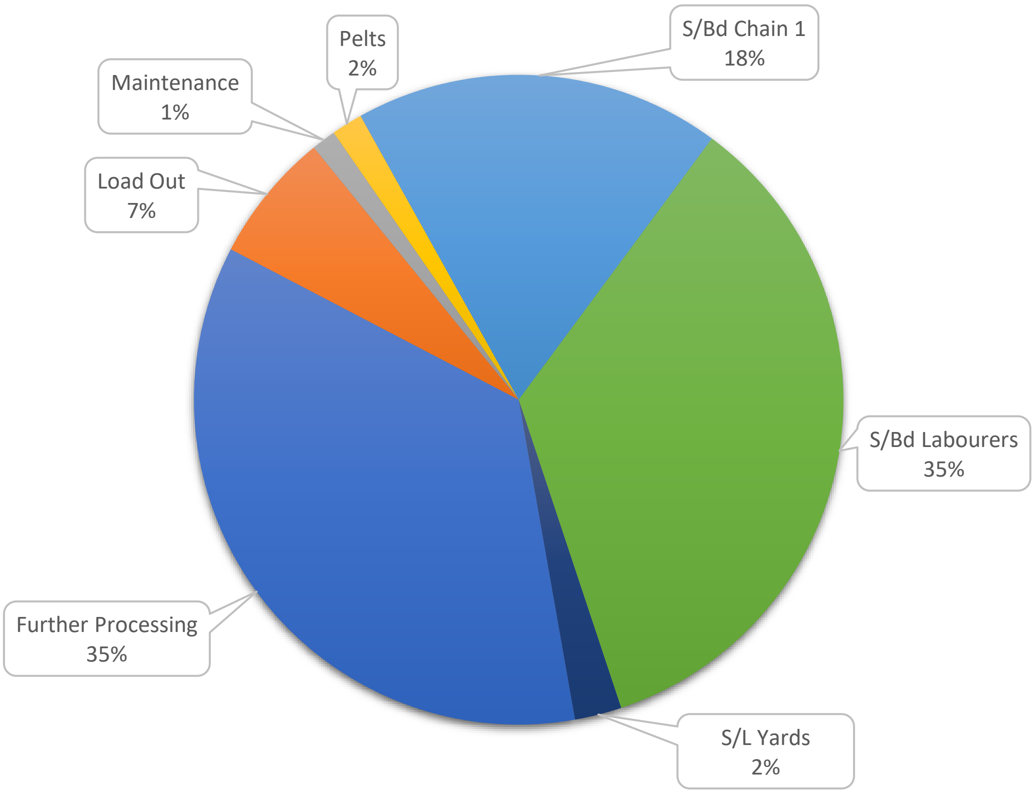


Table 4.9 provides valuable insights into lost-time injuries (LTI) and Medical Treatment Injuries (MTI), with MTIs being the more severe category. Notably, these injuries have transpired within the departments with the highest overall injuries. The injuries in the Cold Storage area during the recent period (20/21) are of particular interest. This observation highlights the need to thoroughly examine safety protocols and measures within the Cold Storage area to address injuries and potentially implement targeted interventions to enhance safety in this department.

Table 4.9

Dannevirke 5-season LTI and MTI Injury Departments (1.3 % of all incidents)

	Season					
Department	**16/17**	**17/18**	**18/19**	**19/20**	**20/21**	**Total**
Cold Storage					2	2
Further Processing 1	2	1		1	3	7
Maintenance Admin	1					1
Quality Control				1		1
S/Bd Labourers-139	1		1	1	1	4
Grand Total	**4**	**1**	**1**	**3**	**6**	**15**

Note: Shading highlights areas of higher frequencies that identify injury clusters.

High frequency; Medium frequency

Based on the data presented in Figure 4.6, it is evident that the incident rates of LTI and MTI for S/Bd Labourers have remained relatively stable over the past three seasons. These consistent figures enable us to project a reasonable expectation of one LTI/MTI incident for S/Bd Labourers in the upcoming season. However, there is cause for concern regarding the increase in LTI and MTI occurrences within the Further Processing departments. Consequently, it is crucial to prioritise safety improvements in both departments to address this upward trend and mitigate the risks associated with LTI and MTI incidents.

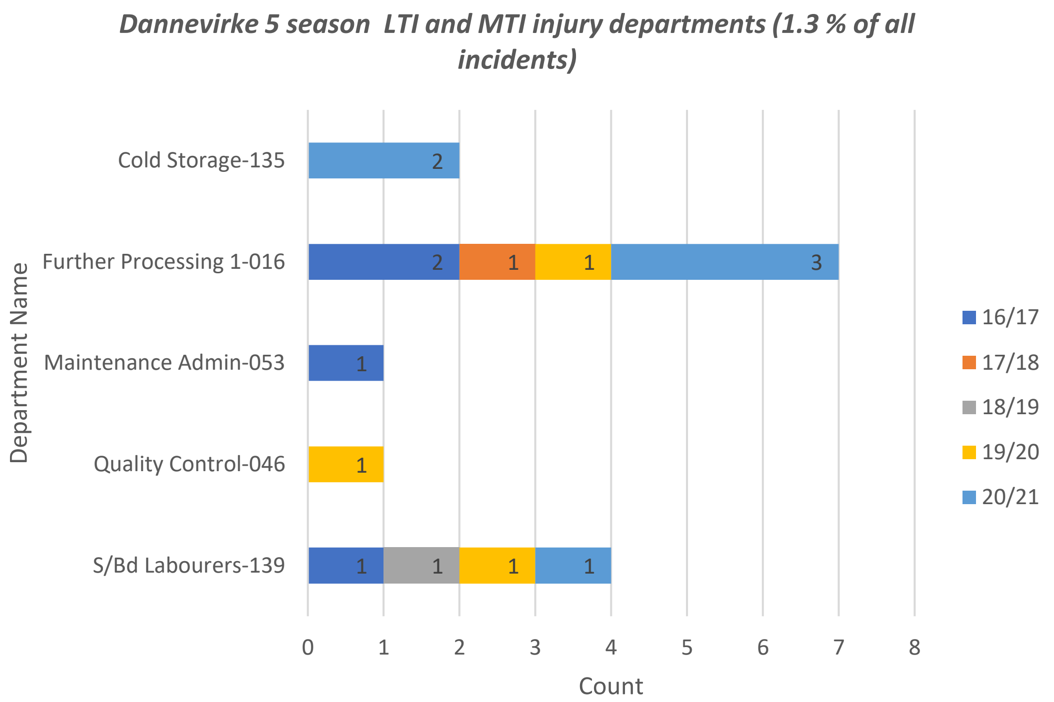
By carefully analysing the injury data, we can effectively identify the departments with a higher risk of injuries. To assess this risk, we calculate a ratio score by dividing the number of Lead indicators (non-recordable injuries such as First Aid and Discomfort type injuries) by the number of Lag indicators (recordable injuries such as MTI and LTI). A lower ratio score indicates a higher risk level.

For instance, when examining the incident rates within the Further Processing department during the 20/21 season, we observed a ratio of approximately one LTI or MTI occurrence for every 21 incidents (calculated as 63/3). This projection provides valuable insights into the relationship between incidents and the likelihood of more severe injuries.

Promoting and encouraging the reporting of discomforts and near misses is essential to enhance workplace safety further. Improved reporting in these areas can lead to better ratio scores, enabling a more proactive approach to identifying and mitigating potential risks within the work environment. This emphasis on comprehensive reporting contributes to a safer workplace and facilitates the implementation of preventive measures.

Figure 4.6

Dannevirke Seasonal Lost Time Injuries (LTI) and Medical Treatment Injuries (MTI) by Department



The findings presented in Table 4.10 highlight the risk of injuries within specific departments. Notably, smaller departments such as Cold Storage and Quality Control show the highest risk of injury, with an injury ratio of 6.5:1. This ratio indicates that for every 6.5 incidents, there is a likelihood of one LTI or MTI occurring in these departments.

Furthermore, the overall LTI or MTI ratio for the Dannevirke plant over the past five seasons stood at 80.1:1. This ratio implies that for every 80.1 reported incidents of Discomfort or First Aid, we can anticipate an LTI or MTI incident.

These insights highlight the departments with higher injury risks and provide valuable information for implementing targeted interventions and safety measures to mitigate risks and enhance workplace safety within the Dannevirke plant.

Table 4.10

Dannevirke Seasonal Injury Ratios: High-Risk Departments

	Injury ratio					
Incident Department	**16/17**	**17/18**	**18/19**	**19/20**	**20/21**	**Total**
Cold Storage	4:0	3:0	1:0	3:0	1:1	6.5:1
Further Processing 1	39:1	122:1	71:0	76:1	21:1	58.6:1
Maintenance	7:1	1:0	5:0	1:0	0	14:1
Quality Control	0	1:0	2:0	2:1	1:0	6:1
S/Bd Labourers	82:1	84:0	73:1	65:1	98:1	100.5:1

Note: Shading highlights ratios that identify injury risk. Lower ratios signal a greater risk. High risk; Medium risk

Table 4.11 presents an overview of the types of injuries that have occurred, revealing essential trends that warrant attention. Of particular note is the observed increase in lacerations, categorised as minor cuts. This finding calls for further investigation to identify the underlying factors contributing to this trend.

On a positive note, no severe lacerations require referral or sutures in the past two seasons. However, there has been a consistent rise in discomfort cases during the same period, with a notable increase in aches and pains reported during the 2020/2021 season. It is unclear from the injury data whether there has been a change in reporting activity or if any programs or activities may have influenced reporting behaviour during this time. This will be a good topic for the focus group discussion. These areas of concern require significant focus and attention to ensure appropriate preventive measures are in place.

Notably, discomforts (44.2%) and aches and pains (17.5%) collectively account for 61.7% of all injuries on-site. This highlights the importance of implementing initiatives to mitigate the factors contributing to these specific types of injuries. Targeted measures and interventions should be implemented to reduce discomfort, aches, and pains, aiming to enhance workplace safety and employee well-being.

Table 4.11

Dannevirke Seasonal Incidents by Injury Type

	Season					
Injury Type	**16/17**	**17/18**	**18/19**	**19/20**	**20/21**	**Total**
Aches/pain - gradual	1				2	3
Aches/pain - specific	31	44	53	33	49	210
Amputation	1					1
Bone Scratch	19	8	11	8	7	53
Bruising/Crushing	8	14	2	9	5	38
Burns	1			1	1	3
Burns - Chemical	1		2			3
Burns - Scald	2	3	4	5		14
Discomfort	97	133	90	95	116	531
Foreign Body	9	10	5	8	11	43
Fracture or Spine				1		1
Head Injury				2		2
Industrial Deafness					1	1
Laceration - Dressing Only	18	29	28	15	35	125
Laceration - Referral - GP/Hosp		1	1			2
Laceration – Steri strips	3	3	2	2	2	12
Laceration - Sutures				1		1
Open Wound	8	4	4	5	2	23
Other		2				2
Skin Disease			1			1
Sprain/Strain	1			1		2
Superficial	31	31	28	21	20	131
Grand Total	**231**	**282**	**231**	**207**	**251**	**1202**

Note: Shading highlights areas of higher frequencies that identify injury clusters.

High frequency; Medium frequency

When examining the incident numbers based on shifts, it is essential to consider staffing levels and the corresponding tally numbers for each shift. In meat processing, a tally number typically refers to a numerical count or record of a specific production item. It is commonly used to keep track of various aspects within the meat processing operations, such as the quantity of products processed, the number of units produced, or the occurrence of specific events or incidents. Incident numbers may also be influenced by the condition and size of the livestock processed during different shifts. If the shift variables are comparable (Table 4.12), the night shift might provide valuable insights that could reduce the overall number of injuries.

Table 4.12

Dannevirke Incidents by Shift

Incidents by shift	Number of incidents
Day	687
Night	512
Split	3
Grand Total	**1202**

Through careful analysis of injuries based on tasks, it becomes possible to identify high-risk tasks and gain insights into the underlying factors contributing to higher injury rates, as presented in Table 4.13. This information highlights the need for further investigation into these tasks to better understand the reasons behind their increased injury rates.

To address these concerns, the focus should be on various aspects such as task assessments, workstation design, work organisation, work postures, and quality training, as well as evaluating potential issues like inadequate training or insufficient strategies for recovery and fatigue management. It is crucial to conduct a thorough investigation specifically on tasks such as Viscera trays, Y-cut, Gutting, Rip down, and Gland removal, which have experienced a notable increase in injuries during the past season. These tasks collectively represent the top 20 injury causes, accounting for approximately 43.29% of all reported injuries.

The meat processing industry can significantly reduce injuries and promote a safer working environment by thoroughly examining and implementing appropriate measures for these high-risk tasks.

Table 4.13

Dannevirke's Top 20 Injury Causing Tasks During the Past Five Seasons

Injury Task	16/17	17/18	18/19	19/20	20/21	Total
Packing	19	28	22	23	12	104
Viscera Trays	11	14	6	10	19	60
Cartons	5	14	13	16	11	59
Y-Cut	10	6	10	11	19	56
Cleaning	18	10	11	6	9	54
Gutting	7	7	9	10	16	49
Boning	10	11	5	8	6	40
Rip Down	7	9	2	2	11	31
Broomie	5	5	10	6	4	30
Detain	14	3	3	4	5	29
Pre-op Clean Up	5	15	4	2	3	29
Offal	1	5	8	7	7	28
Sawyer	5	11	6	4	1	27
Yard	5	4	6	4	6	25
Packing Vacuumed	4	7	3	3	5	22
Packing B/Pack	5	11	2	3		21
Hang up Fore/Hind Leg	3	6	4	3	4	20
Gland Removal	1	1	7	2	8	19
Halal Slaughtering	3	6	2	1	6	18
Tail Removal	8	5	2	2	1	18
Grand Total	**95**	**67**	**138**	**137**	**82**	**519**

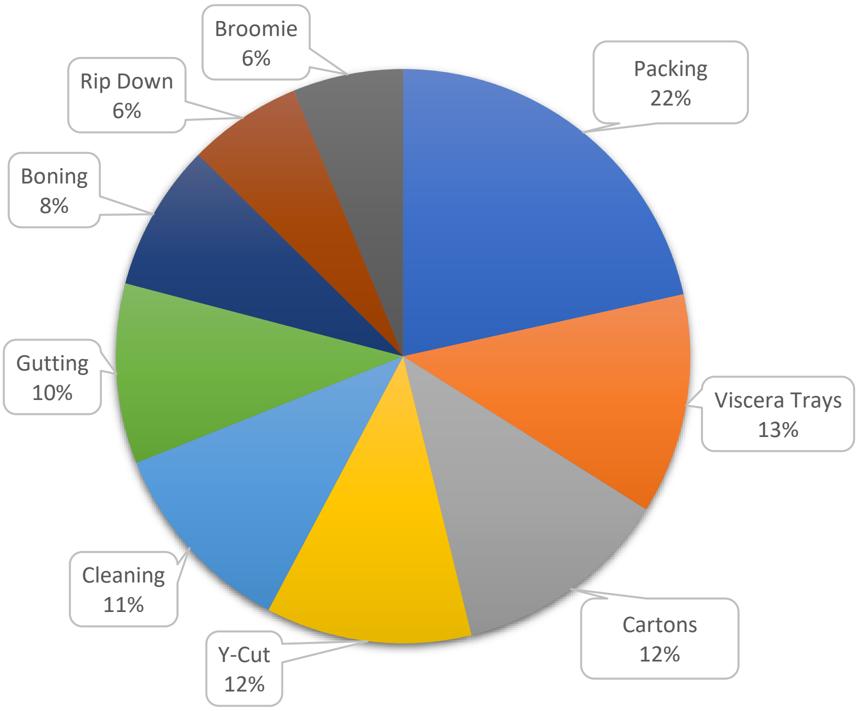
Note: Shading highlights top injury causing tasks ranked by frequency.

High frequency; Medium-high frequency; Medium

Examining the injuries according to specific tasks makes it possible to identify the tasks with higher risk (Figure 4.7) and investigate the underlying reasons for their elevated injury rates. Key areas of focus should include conducting task assessments, improving workstation design, enhancing work organisation, addressing poor work postures, providing quality training, and addressing any deficiencies in training. Notably, the top 10 tasks causing injuries account for 40.2% of all reported injuries, making them a priority for targeted interventions and safety improvements.

Figure 4.7

Dannevirke Top 10 Injury Causing Tasks (40.2%)



4.3.2 Categorization of Dannevirke MSD Injuries: Unveiling Meaningful Patterns and Frequency Trends

Classifying all types of injuries was crucial to identifying injuries specific to MSDs. This is particularly important because tasks within the relevant sector often contribute to developing MSDs. Furthermore, separating and analysing all injuries classified as MSDs is essential, enabling the researcher to monitor the occurrence rates and identify injury trends associated with MSDs. These efforts are valuable for effectively managing such injuries and identifying successful interventions implemented in this context.

After analysing incidents related to MSD, it is clear from Table 4.14 and Figure 4.8 that musculoskeletal injuries represent a significant portion, accounting for 62.1% of all incidents. This finding underscores the necessity of dedicating substantial time and resources to address the root causes contributing to these injuries. Various compounding factors must be considered, such as plant and equipment design, tally requirements, work organisation, and employee attributes, including an ageing workforce, fatigue, physical and mental well-being, and poor health habits. A comprehensive understanding of these factors will provide valuable insights into the initiatives or projects the company should prioritise and invest in to mitigate musculoskeletal injuries.

Furthermore, there is a notable concern regarding the observed increases across all injury types, indicating an urgent need for targeted interventions and safety measures. This emphasises the importance of implementing proactive measures to prevent injuries and ensure a safe working environment. Allocating resources towards addressing these concerns will be crucial in minimising the occurrence of injuries and promoting employees' overall well-being and safety.

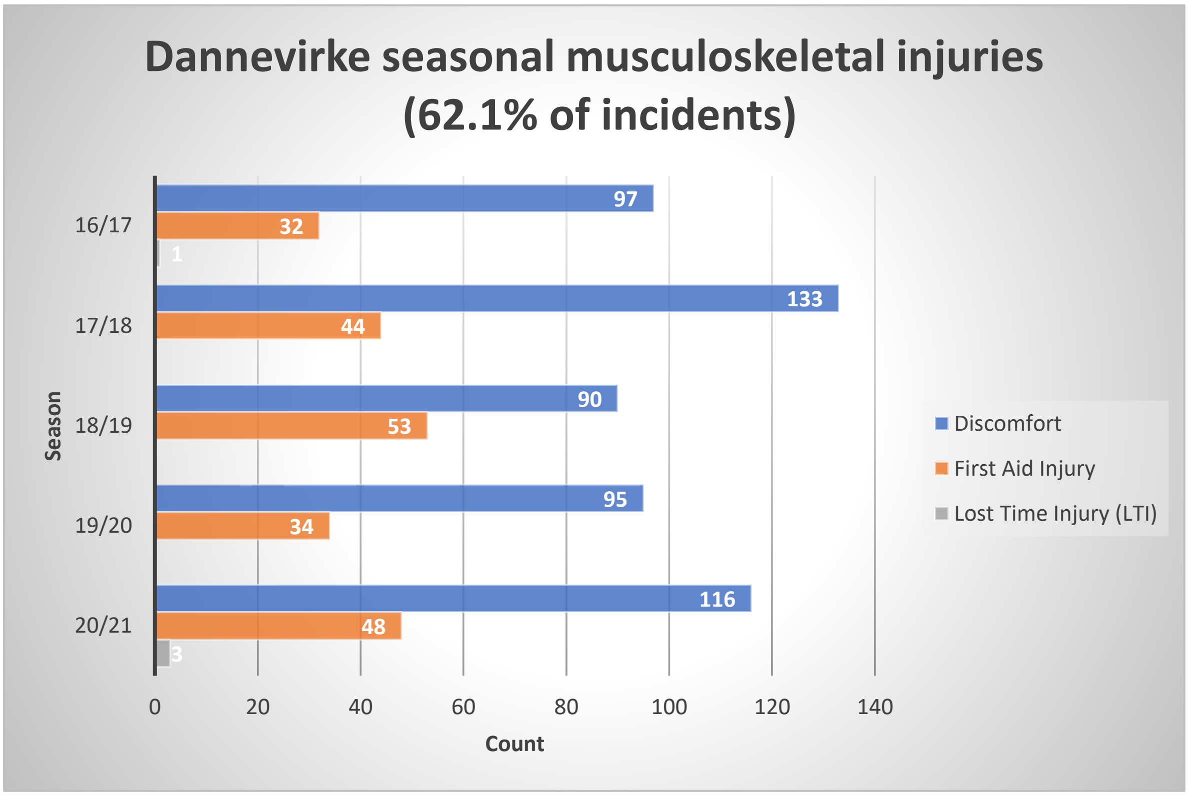
Table 4.14

Dannevirke seasonal musculoskeletal injuries (62.1 % of incidents)

	Season					
Injury Type	**16/17**	**17/18**	**18/19**	**19/20**	**20/21**	**Total**
Discomfort	97	133	90	95	116	531
First Aid Injury	32	44	53	34	48	211
Lost Time Injury (LTI)	1				3	4
Grand Total	**130**	**177**	**143**	**129**	**167**	**746**

Figure 4.8

Dannevirke seasonal musculoskeletal injuries (57.3% of incidents)



The upward trend observed in all injury types, particularly musculoskeletal injuries, during the 20/21 period warrants significant attention and prompt action. This emphasises the crucial need for proactive measures to address and mitigate the increasing incidence of injuries effectively.

A thorough examination of the tasks that serve as the primary causes of musculoskeletal injuries is essential to identify potential solutions for reducing injury rates. Additionally, analysing trends across different experience levels can offer valuable insights into the underlying factors contributing to the rise in injury rates. This information can serve as a foundation for implementing targeted interventions aimed at addressing these factors and ultimately reducing the occurrence of injuries in the workplace. Organisations can develop more effective strategies to safeguard employee well-being and enhance workplace safety by understanding the specific tasks and experience-related patterns associated with musculoskeletal injuries.

Table 4.15 examines the relationship between MSD injury-causing tasks and experience levels and offers valuable insights into the top 10 tasks responsible for approximately 49% of these injuries. For the complete analysis of the MSD injury data, specifically categorised by task and experience, please refer to Table D18 in Appendix D.

Furthermore, Figure 4.11 visually represents the seasonal occurrence of MSDs, classified according to years of experience. This figure overviews how injuries are distributed across different experience levels throughout the seasons.

By referring to these resources, researchers and stakeholders can gain a comprehensive understanding of the tasks that contribute significantly to MSD injuries and observe patterns related to experience levels. The data analysis presented in Table 4.1.5 highlights interesting findings regarding two specific tasks. Firstly, the Packing task (Figure 4.9) demonstrates an increasing level of challenge as employees gain more experience, with the highest occurrence rate observed in the over-five-year experience category. This suggests that the demands of the Packing task may become more physically demanding or complex over time, potentially leading to a higher risk of injuries among experienced (older) employees.

Figure 4.9

Employee Performing Packing Tasks at Dannevirke

Note. Packing tasks involve packing various products (“cuts”) into cartons to a set weight. This is a fast-paced task that involves much repetitive work.

Conversely, when examining the Viscera trays task (Figure 4.10), it is observed that the task is initially more strenuous during the first six months of experience. However, as employees become more familiar with the task demands, the injury risk associated with the Viscera trays task tends to decrease. This suggests that employees gradually adapt and develop the necessary skills to perform the task with reduced risk of injuries.

These insights shed light on the dynamic nature of task demands and the relationship between experience levels (Figure 4.9) and injury risks. By understanding these patterns, organisations can implement targeted strategies such as appropriate training, task modifications, and ergonomic considerations to effectively manage the challenges associated with different tasks and optimise employee safety and well-being.

Figure 4.10

Employee Performing Tasks Related to the Viscera Trays

Note. Tasks performed in the Viscera trays area include separating the liver, heart, kidney, and 'white' offal (intestines and stomach), placing them into specific chutes and transporting the product to the Offal and Tripe departments.

This knowledge aids in developing targeted interventions and strategies to minimise such injuries, promote employee well-being, and enhance workplace safety.

There are three distinct perspectives to consider when analysing this data. Firstly, it is crucial to assess the impact of ageing on injury rates, particularly for physically demanding tasks, under the assumption that older individuals possess more experience. This perspective helps in understanding how age and experience may influence injury rates. Secondly, analysing the time required to attain proficiency in a task is valuable in identifying physically demanding tasks, such as Packing and Carton Handling. This information aids in determining appropriate task placement and training requirements for both new and existing employees, considering the physical demands of each task. Lastly, comparing the number of staff across different experience categories is essential. This analysis provides insights into the distribution of experience levels within the workforce, enabling informed decision-making regarding task allocation, training strategies, and resource distribution.

Considering these multiple perspectives, the organisation can comprehensively understand the relationship between MSD injuries, task complexity, experience levels, and workforce composition. This knowledge facilitates informed decision-making and the implementation of targeted interventions to mitigate injury risks and promote a safer working environment.

Figure 4.11

Dannevirke Five-Season Musculoskeletal Injury Occurrence by Years of Experience

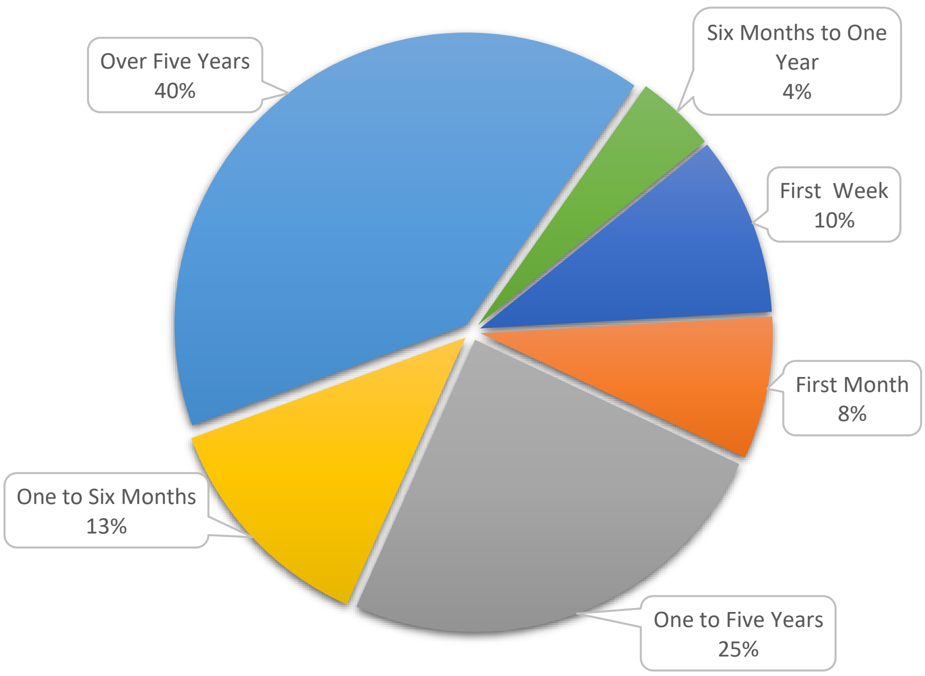


Table 4.15

Dannevirke Top 10 Musculoskeletal Injury Causing Tasks and Employee Experience

	Experience						
Task Description	**Over Five Years**	**One to Five Years**	**Six Months to One Year**	**One to Six Months**	**First Month**	**First Week**	**Grand Total**
Packing	38	20	1	9	6	6	80
Cartons	10	9	4	10	6	9	48
Viscera trays	6	6	3	12	10	7	44
Gutting tasks	17	12		5	2	6	42
Y-Cut	23	7		4	1	2	37
Boning	19	4	2	2		3	30
Rip Down	14	5		2	1	2	24
Sawyer	16	4	1	1	1		23
Broomie	8	2	2	6	1	2	21
Packing vacuumed product	8	8		1		2	19
Grand Total	**159**	**77**	**13**	**52**	**28**	**39**	**368**

Upon analysing the data pertaining to the body location of musculoskeletal injuries, as depicted in Table 4.16 and Figure 4.12, it is clear that the upper limbs (including the hand, wrist, and shoulder) and the spine collectively account for a significant proportion of injuries. According to the data analysis, the incidence of musculoskeletal injuries can be categorised as follows: hand injuries comprise 9% of the total injuries, wrist injuries account for 22%, shoulder injuries contribute to 20%, and injuries to the spine collectively represent 23% of all reported musculoskeletal injuries.

This underscores the importance of prioritising the protection of these areas to mitigate the risk of musculoskeletal injuries effectively. Focusing on measures that specifically target the upper limbs and spine can significantly contribute to reducing the incidence of musculoskeletal injuries in the workplace.

Several measures can be implemented to address this risk. Firstly, adopting ergonomic devices and designing workstations that alleviate musculoskeletal strain on these specific body locations can significantly reduce the risk of injuries. Ergonomic work environments promote correct body alignment and reduce excessive stress on the upper limbs and spine.

Secondly, optimising work organisation and rotations can be crucial in minimising or redistributing the loading on these vulnerable body areas. Careful planning of work shifts and task rotations can help prevent overexertion and fatigue, reducing the likelihood of musculoskeletal injuries.

Moreover, it is essential to consider the selection of employees for roles that pose a risk to these specific body locations, especially if individuals have any pre-existing musculoskeletal conditions. Assessing employees' physical capabilities and ensuring adequate training and support are essential to preventing injuries and promoting employee well-being.

By implementing these proactive measures, the organisation can effectively protect employees' upper limbs and spine, mitigate the risk of musculoskeletal injuries, and create a safer and healthier work environment.

Table 4.16

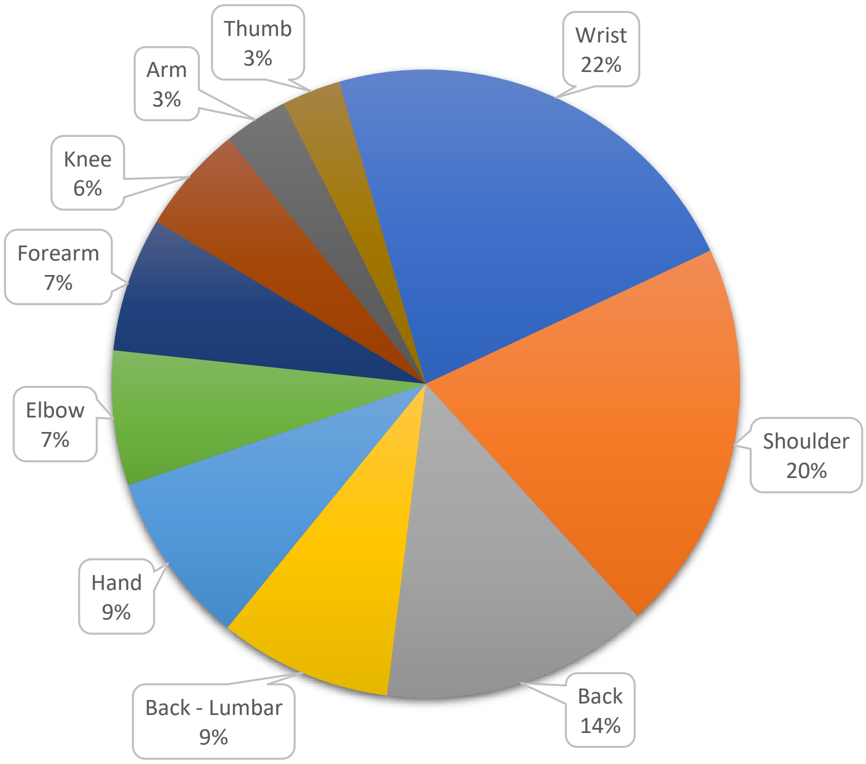
Dannevirke Musculoskeletal Injuries by Body Location

Body Location	Number of injuries
Ankle	8
Arm	22
Back	91
Back - Lumbar	62
Buttocks	3
Chest	3
Elbow	46
Face	2
Fingers	19
Foot	5
Forearm	46
Groin	1
Hand	59
Hip	5
Knee	37
Lower Limb	12
Neck	13
Ribs	2
Shoulder	134
Thigh	2
Thumb	20
Toe	1
Trunk	1
Upper Limb	3
Wrist	149
Grand Total	**746**

Note. The highlighted body locations with the highest injury frequency include wrist injuries, accounting for 22%. Additionally, shoulder injuries contribute to 20% of the total incidents, while injuries to the spine collectively represent 23% of the recorded musculoskeletal injury sites. High frequency; Medium-high frequency; Medium frequency

Figure 4.12

Dannevirke Top 10 MSD Injury Locations



For those at risk, implementing targeted work hardening programs aimed at strengthening and protecting the musculoskeletal injury sites at risk can be beneficial in improving their physical abilities. These programs may include pre-season, off-season, and in-season interventions. Implementing targeted stretching protocols can also be advantageous. Moreover, in high-risk areas, it is essential to consider additional staffing when there is an increase in workload, such as during high tally periods. Allowing a seasonal lead-in time for physically demanding tasks can also help mitigate the risk. The same principles should apply when overtime work and extended hours are required.

4.4 Review of AGL Levin plant five season injury data

The Levin Plant, situated in Levin on the North Island of New Zealand, specialises in processing ovine (sheep) and bovine (cattle). Operating for 11 months annually, the plant employs approximately 360 staff members (Alliance Group, 2023). The recorded injuries totalled 764 in the five-season data, covering all injury categories.

By examining the departments with high injury rates and categorising injuries based on severity and type, it becomes feasible to identify trends and differentiate between lead and lag indicators. Analysing the patterns within the data allows for identifying problematic areas and presents opportunities for enhancing safety outcomes and mitigating the risk of injuries. It is worth noting that all injury categories have demonstrated a decreasing trend over the past three years, indicating positive progress in reducing injuries. This signifies that efforts aimed at injury reduction have yielded favourable results.

4.4.1 Categorization of all Levin Injuries: Unveiling Meaningful Patterns and Frequency Trends

Table 4.17 displays the Levin seasonal incidents categorised by their classification, enabling the observation of trends and insights into incident occurrence patterns. Notably, a positive trend is observed as the number of discomforts consistently decreases each season, indicating progress. Similarly, there is a positive movement in the count of first aid injuries. However, a cause for concern arises from the relatively low number of near misses recorded in the database. This issue could be linked to resourcing or priority challenges rather than a lack of reporting. It is recommended that this be investigated to determine if this is connected to safety interactions within the organisation.

Table 4.17

Levin Seasonal Incidents by Classification

	Season					
Injury Classification	**16/17**	**17/18**	**18/19**	**19/20**	**20/21**	**Total**
Discomfort	63	28	97	59	40	287
First Aid Injury	81	50	100	132	71	434
Lost Time Injury (LTI)	2	8	9	6	4	29
Medical Treatment Injury (MTI)	4	3	1	1	4	13
Near Miss			1			1
Grand Total	**150**	**89**	**208**	**198**	**119**	**764**

Table 4.18 displays the Levin seasonal incidents categorised by injury type. Analysing the data reveals notable trends in the types of injuries observed.

Table 4.18

Levin Seasonal Incidents by Injury Type

	Season					
Injury type	**16/17**	**17/18**	**18/19**	**19/20**	**20/21**	**Total**
Aches/pain - gradual	3	3	3	9	2	20
Aches/pain - specific	6	8	19	30	15	78
Amputation			1			1
Bone Scratch	8	1	1	1	1	12
Bruising/Crushing	15	4	11	25	14	69
Burns	2	1	3	4		10
Burns - Chemical	2		2	1	1	6
Burns - Electrical			1			1
Burns - Scald	1	1		1	1	4
Discomfort	63	28	97	59	40	287
Dislocation					1	1
Foreign Body	1		2			3
Head Injury			2		1	3
Industrial Deafness			1			1
Infection			1			1
Laceration - Dressing Only	24	26	29	36	22	137
Laceration - Referral - GP/Hosp		1	2	2	2	7
Laceration - Steri Strips		5	10	2	3	20
Laceration - Sutures		1	2	2	5	10
Leptospirosis				1		1
Multiple				1		1
Musculoskeletal Disease			1			1
Occupational Overuse Syndrome		1				1
Open Wound	6	1	7	1	2	17
Other	5		1	5	1	12
Other Fracture			1		1	2
Puncture Wound	2	1			1	4
Skin Disease			1			1
Sprain/Strain	6	6	6	4	2	24
Superficial	6	1	4	14	4	29
Grand Total	**150**	**89**	**208**	**198**	**119**	**764**

Note. The highlighted injury types are the areas of most concern. High frequency; Medium-high frequency; Medium frequency

There has been a significant improvement in lacerations, precisely minor cuts, which may be attributed to the introduction of mesh or other preventive measures, resulting in fewer incidents. However, severe lacerations requiring referral or sutures have not been substantially improved. The same can be said for the number (9.3%) of injuries caused by Bruising and Crushing incidents. Despite a decreasing trend in discomfort numbers each season, it remains a critical area of focus. Discomforts account for 37.6% of injuries, while aches and pains contribute 12.8%, totalling 50.4% of all on-site injuries. Targeted initiatives will be necessary to reduce the factors contributing to these injuries.

According to Levin, figure 4.13 illustrates the top 10 injury departments, constituting 92% of all injury departments on the site. For a comprehensive overview, Table 4.19 presents a complete ranking of all injury departments arranged in descending order. The top five injury departments are highlighted for emphasis.

Figure 4.13

Levin Top 10 Injury Departments (92%)

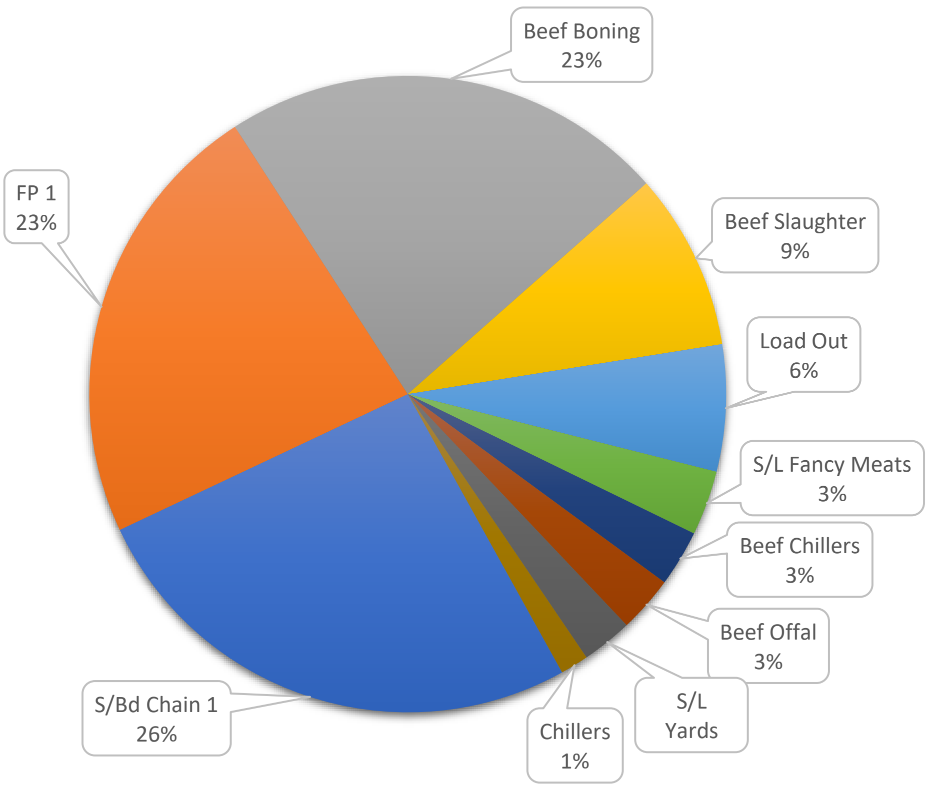


Table 4.19

Levin Plant Seasonal Incidents by Department

Incident department	Season 16/17	17/18	18/19	19/20	20/21	Total
S/Bd Chain 1	29	25	54	47	27	182
Further Processing 1	34	15	44	46	21	160
Beef Boning Room 1	49	15	38	34	22	158
Beef Slaughter	14	9	13	12	15	63
Load Out	3	6	7	22	7	45
S/L Fancy Meats	1	2	12	6	2	23
Beef Chillers	1	2	5	6	6	20
Beef Offal	1	1	9	5	4	20
S/L Yards	10	4	2	2		18
Chillers		1	6		3	10
Beef Tripe	1	2	1	2	3	9
Quality Control	3		3	1		7
Rendering	1	2	1	2	1	7
Amenities		1	1	2	1	5
S/L Tripe		2	1	1	1	5
Maintenance Admin	1	1	1		1	4
Fitters			1	2		3
Further Processing 2			1	1	1	3
Plant Administration		1	2			3
Cattle Yards				1	1	2
Cooling Floor	2					2
Plant Services -Yard Gang			1	1		2
Skin Processing			1	1		2
All Depts General					1	1
Bag Room				1		1
Bobby Calves Offal			1			1
Bobby Calves Slaughter			1			1
Bobby Calves Yards			1			1
Electricians				1		1
Garage					1	1
Gut shed					1	1
Main Store			1			1
Packaging Store				1		1
Safety				1		1
Grand Total	**150**	**89**	**208**	**198**	**119**	**764**

Note. The highlighted departments are the areas of most concern. High frequency; Medium-high frequency; Medium frequency

Table 4.19 shows a significant decline in injury data, indicating a noteworthy downward trend. It is crucial to underscore the importance of prioritising injury prevention efforts for the Slaughter board department, followed by FP1 and Beef Boning. However, it is essential to consider the personnel count in each department when evaluating the injury numbers. Additionally, special attention should be dedicated to addressing injuries associated with load-out tasks.

Table 4.20 provides an overview of the data concerning more severe lost-time injuries (LTI) and medical treatment injuries (MTI). Interestingly, the departments with the highest incidence of injuries are the same departments where these LTI and MTI cases occurred. This observation highlights a correlation between the occurrence of severe injuries and the departments with a higher overall injury rate.

Table 4.20

Levin Seasonal LTI and MTI Injury Departments (5.5 % of all Incidents)

	Season					
Department	**16/17**	**17/18**	**18/19**	**19/20**	**20/21**	**Total**
Beef Boning Room 1	3	4	2	1		10
Beef Chillers					1	1
Beef Offal			1			1
Beef Slaughter		4		3	3	10
Further Processing 1	2	1	2	1	1	7
Load Out			1			1
Rendering				1		1
S/Bd Chain 1	1	1	2	1	2	7
S/L Fancy Meats			1		1	2
S/L Tripe			1			1
S/L Yards		1				1
Grand Total	**6**	**11**	**10**	**7**	**8**	**42**

Note. The highlighted departments are the areas of most concern. High frequency; Medium-high frequency

Figure 4.14 represents the incident rates for lost-time injuries (LTI) and medical treatment injuries (MTI), accounting for 5.5% of all incidents at Levin. Notably, Beef slaughter department data provide valuable insights for forecasting future incidents, suggesting that we can expect approximately 3-4 LTI/MTI incidents in the upcoming season. As a result, it is crucial to prioritise safety enhancements within this department to mitigate the risk and promote a safer working environment.

Figure 4.14

Levin Seasonal Lost Time Injuries (LTI) and Medical Treatment Injuries (MTI) by Department

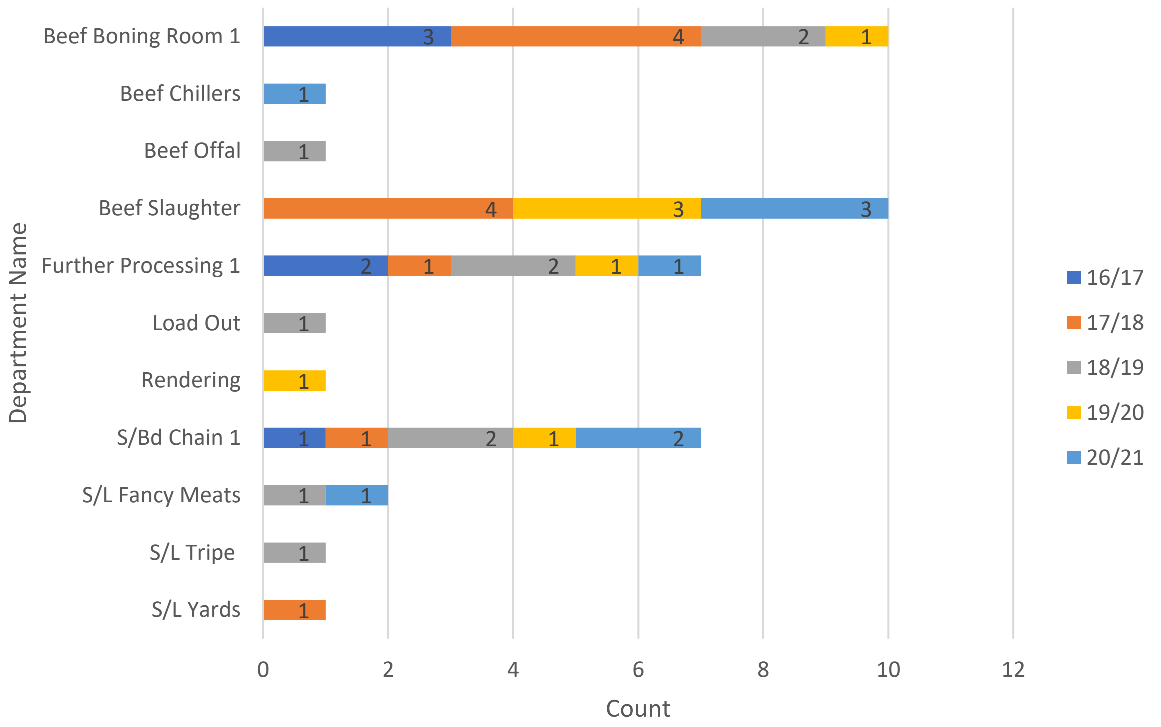


Table 4.21 displays the Levin seasonal injury ratios, which can help identify departments with the highest risk of injuries. The lower the ratio score, the higher the risk of injury becomes. Analysing the data makes it possible to estimate the number of incidents that may occur before an MTI or LTI is expected. For instance, referring to the incident rates for beef slaughter during the 20/21 season, it can be projected that there will be an LTI or MTI for every five incidents. Prompt reporting of discomforts and near misses contributes to improved ratios. Over the past five seasons, the LTI or MTI ratio for the Levin plant has been 18.2:1, indicating that for every 18.2 discomfort or first aid incidents, an LTI or MTI can be anticipated.

Table 4.21

Levin Seasonal Injury Ratio – High Risk Departments

	Injury ratio					
Incident department	**16/17**	**17/18**	**18/19**	**19/20**	**20/21**	**Total**
Beef Boning Room 1	16.3:1	3.8:1	19:1	34:1	22:0	15.8:1
Beef Slaughter	14:0	2.25	13:0	4:1	5:1	6.3:1
Further Processing 1	17:1	15:1	22:1	46:1	21:1	22.8:1
S/Bd Chain 1	29:1	25:1	27:1	47:1	13.5:1	7.9:1
S/L Fancy Meats	1:0	2:0	12:1	6:0	2:1	11:5

Note: Shading highlights ratios that identify injury risk. Lower ratios signal greater risk. High risk; Medium risk

Table 4.22 provides a comprehensive breakdown of Levin incidents categorised by shift, enabling an exploration of potential associations between injuries and shift-related factors. To effectively analyse the incident numbers across shifts, it is essential to compare staffing levels and the corresponding incident tallies for each shift. Additionally, considering the condition and size of the processed livestock during different shifts is crucial, as these factors may contribute to the incident numbers. If the variables across shifts are comparable, focusing on the night shift data may yield valuable insights for reducing overall injury rates. Investigating the data specifically from the night shift holds the potential to unveil effective strategies for mitigating injuries across all shifts.

Table 4.22

Levin Incidents by Shift

Incidents by shift	**Number of incidents**
Day	563
Late	14
Night	181
Rotating	5
Split	1
Grand Total	**764**

Analysing injuries by task enables the identification of high-risk tasks and a deeper investigation into the reasons behind the increased injury rates. It is noteworthy that three out of the top five injury-causing tasks involve the use of knives. Blunt knives result in an increased cutting force that will ultimately contribute to the MSDs. The insights gained from this data analysis will inform the implementation of strategies to prevent MSDs. These strategies will prioritise task assessments, workstation design, work organisation, work postures, and quality training and address potential deficiencies in knife training, insufficient recovery periods, and fatigue management. It is worth highlighting that Table 4.23 demonstrates that the top 20 tasks responsible for injuries collectively account for 67.9% of all reported incidents.

Table 4.23

Levin's Top 20 Injury Causing Tasks During the Past Five Seasons

	Season					
Injury task	**16/17**	**17/18**	**18/19**	**19/20**	**20/21**	**Total**
Knife work	37	27	25	10	4	103
Packing	13	9	29	29	18	98
Trimming	4	1	12	26	7	50
Carton Handling	5	7	11	9	4	36
Boning	2	2	10	14	7	35
Carcase Handling	7	6	10	2	7	32
Floors	14	1	2	2	4	23
Offal recovery			6	7	6	19
Band Saw	1	1	5	5	2	14
Gutting		2	3	3	6	14
Y Cutting	2	1	1	6	3	13
Clean Up (Wash downs)		2	2	6	2	12
Animal	3	2	4		2	11
Chillers		1	5	3	2	11
Vacuum Machines			4	5	2	11
Cleaning Between Shifts		1	2	6	1	10
Pushing up carcases		2	4	2	2	10
Bones	6	2		1		9
Hide Pulling	1		3	1	3	8
Grand Total	**95**	**67**	**138**	**137**	**82**	**519**

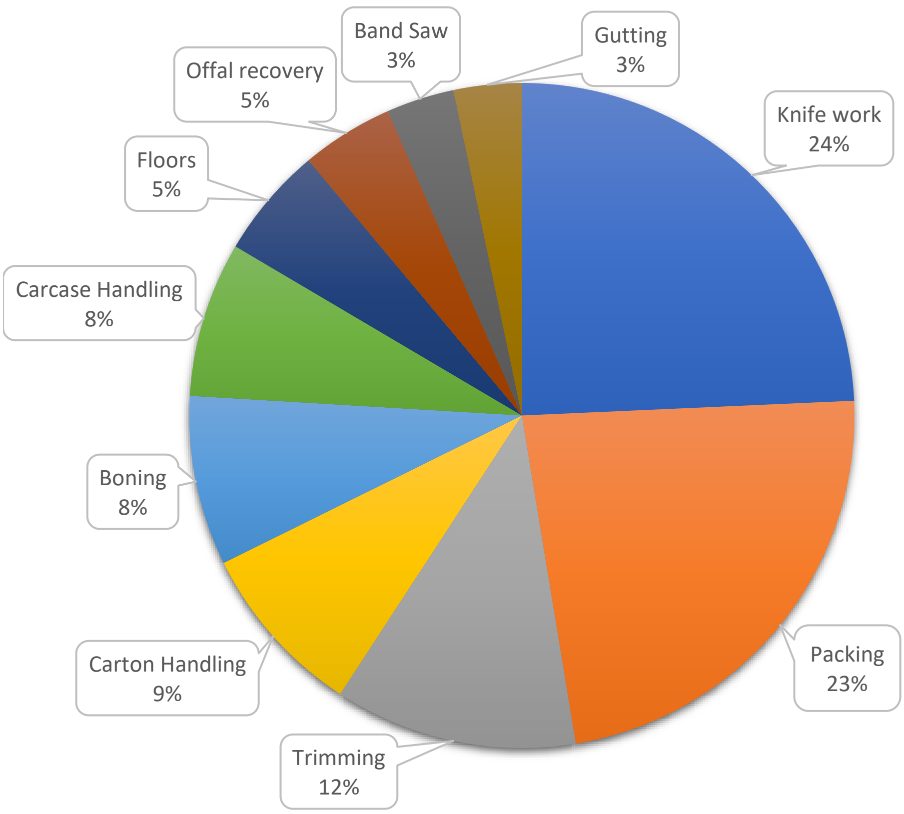
Note: Shading highlights top injury causing tasks

High frequency; Medium-high frequency; Medium

Figure 4.15 illustrates the top 10 injury-causing tasks in Levin, which account for 55.5% of reported injuries. Examining injuries based on specific tasks makes it possible to identify high-risk tasks and investigate the reasons behind the elevated injury rates. The focus will be on conducting task assessments, improving workstation design, optimising work organisation, addressing work postures, implementing quality training initiatives, and addressing any deficiencies in training. Addressing these areas is crucial to mitigating the occurrence of injuries.

Figure 4.15

Levin Top 10 Injury Causing Tasks (55.5%)



4.4.2 Categorization of Levin MSD Injuries: Unveiling Meaningful Patterns and Frequency Trends

When examining the proportion of incidents related to musculoskeletal injuries (53.7% of incidents) in Table 4.24 and Figure 4.16, it becomes evident that a significant allocation of time and resources is necessary to improve contributing factors. Multiple compounding factors must be considered, including plant and equipment design, tally requirements, work organisation, and employee attributes such as an ageing workforce, fatigue, physical and mental well-being, and poor health habits. Understanding these factors provides valuable insight into the types of initiatives or projects the company should invest in. Observing a downward trend across all areas is encouraging, indicating progress in addressing musculoskeletal injuries.

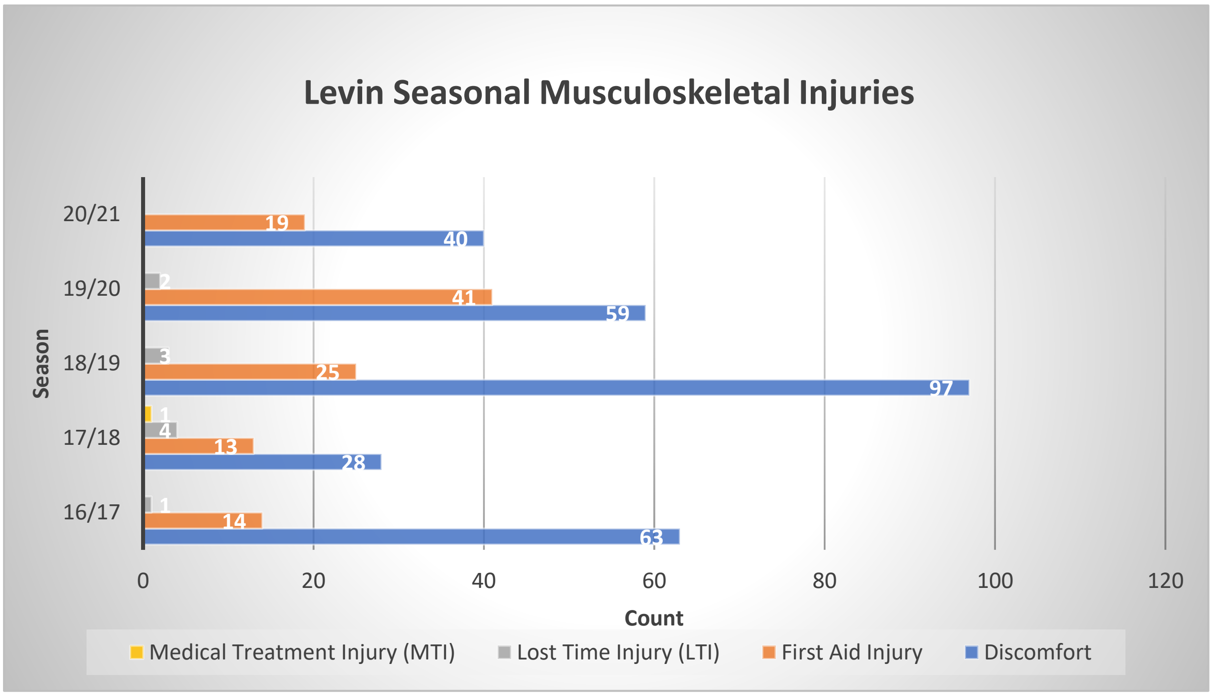
Table 4.24

Levin Seasonal Musculoskeletal Injuries (53.7 % of Incidents)

	Seasonal					
Injury Type	**16/17**	**17/18**	**18/19**	**19/20**	**20/21**	**Total**
Discomfort	63	28	97	59	40	287
First Aid Injury	14	13	25	41	19	112
Lost Time Injury (LTI)	1	4	3	2		10
Medical Treatment Injury (MTI)		1				1
Grand Total	**78**	**46**	**126**	**102**	**59**	**410**

Figure 4.16

Levin Seasonal Musculoskeletal Injuries (57.3% of Incidents)



By referring to these findings, researchers and stakeholders can understand the tasks that contribute significantly to MSD injuries and observe patterns related to experience levels. The data analysis presented in Table 4.25 highlights interesting findings regarding two specific tasks. The Packing and Trimming tasks (depicted in Figure 4.17) exhibit a notable escalation in difficulty as employees accumulate more experience, with the highest incidence rate observed in the category of one to five years of experience. This observation suggests that the demands associated with Packing and Trimming tasks may intensify in terms of physical exertion or complexity as time progresses.

Table 4.25 examines the relationship between MSD injury-causing tasks and experience levels and offers valuable insights into the top seven tasks responsible for 53% of these injuries. For the complete analysis of the MSD injury data, specifically categorised by task and experience, please refer to Table E28 in Appendix E. Moreover, Figure 4.18 visually portrays the seasonal occurrence of MSDs, categorised based on experience. This figure shows how injuries are distributed among different experience levels across the five-season timeline.

Figure 4.17

Employee Performing Trimming Tasks

Note. The task entails removing, or "trimming," undesired product matter from the carcass, including excessive fat and unwanted membrane tissue.

Table 4.25

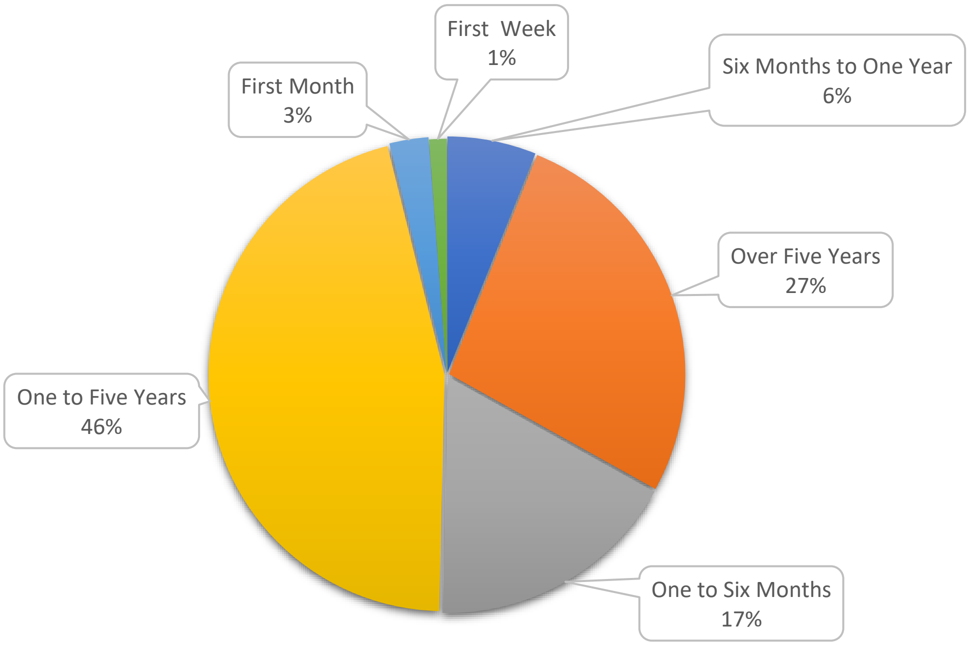
Levin Musculoskeletal Injuries by Task and Experience

	Experience						
Task Description	**Over Five Years**	**One to Five Years**	**Six Months to One Year**	**One to Six Months**	**First Month**	**First Week**	**Grand Total**
Packing	14	44		14		1	79
Trimming	11	15	2	1	1		30
Carton handling	4	10	1	13	1		29
Carcase handling	7	11	2	4	1		25
Boning	10	7	1	2			20
Knife work	11	6				1	18
Floors (slips)	5	8	1	3			17
Grand Total	**62**	**101**	**37**	**13**	**3**	**2**	**218**

Note. Packing, Trimming, Carton and Carcase handling tasks exhibit a notable escalation in difficulty as employees accumulate more experience, with the highest incidence rate observed in the category of one to five years of experience. This observation suggests that the demands associated with these tasks may intensify in terms of physical exertion or complexity as time progresses. Tasks that require knife work, such as Boning (a task that requires the removal of meat product from bone), become more challenging over time.

Figure 4.18

Levin 5-Season Musculoskeletal Injuries (all) by Years of Experience



When analysing the data, there are three distinct perspectives to consider. Firstly, one can assess the impact of ageing on injury rates for physically demanding tasks. One can also assume that individuals with more experience are less likely to injure themselves. Secondly, the data allows for examining the time required to become proficient at a task, aiding in planning training and skill development programs. Lastly, it enables the identification of more physically demanding tasks, such as packing and carton handling. A noteworthy finding is that three out of the top seven tasks associated with causing musculoskeletal injuries involve the use of knives. This highlights the significance of knife training in the prevention of injuries. Many of the observed MSDs may be attributed to inadequate knife sharpness and the excessive force required when using a dull knife. This information holds valuable insights for establishing suitable job placements and training requirements for new hires and existing employees. Moreover, it is crucial to analyse the staffing numbers across various experience categories to obtain a comprehensive understanding of the composition of the workforce.
To facilitate the researcher's identification of employees at an elevated risk of musculoskeletal injuries, the following data subset in Table 4.26 consists of employees who

have experienced two or more injuries within the previous two seasons or more than three injuries over the past five years.

Table 4.26

Levin Employees with Higher Musculoskeletal Injuries Rates Compared by Experience, Injury Description and Age (Five-Season Dataset)

Experience	Injury Description	Average Age	Count
First week	Discomfort	55.0	1
First week total		**55.0**	**1**
First month	Discomfort	32.0	2
First month total		**32.0**	**2**
One to six months	Aches/pain - specific	40.5	2
	Discomfort	34.0	12
	Sprain/Strain	55.0	1
One to six months total		**36.3**	**15**
Six months to one year	Aches/pain - gradual	48.0	1
	Aches/pain - specific	37.0	2
	Discomfort	58.3	3
Six months to one year total		**49.5**	**6**
One to five years	Aches/pain - specific	38.5	4
	Discomfort	39.7	15
	Sprain/Strain	51.5	2
One to five years total		**40.6**	**21**
Over five years	Aches/pain - gradual	41.0	1
	Aches/pain - specific	59.7	3
	Discomfort	47.0	9
	Sprain/Strain	48.0	2
Over five years total		**49.3**	**15**
Grand Total		**42.5**	**60**

According to the injury data presented in Table 4.26, it is observed that 40% of employees with higher musculoskeletal injury rates sustain injuries within their first year of employment, with the most significant work discomfort experienced between one and six months of employment. Older employees (with a mean age of 50.8) exhibit a higher prevalence of sprains and strains. The data further suggests that older employees are more likely to be injured in the category of employees with over five years of experience, possibly due to the physical demands imposed by meat processing tasks on an ageing workforce. This finding supports the necessity of implementing work-hardening programs for employees who may struggle to meet the demanding physical requirements of their work.

Table 4.27 and Figure 4.19 present Levin's musculoskeletal injuries categorised by body location. It is important to note that when examining the body location of these injuries, it becomes evident which areas are at the most significant risk: the upper limbs (from hand to shoulder) and various neck and spine areas. Protecting these vulnerable areas is crucial in reducing the risk of MSDs. Several approaches can be implemented to achieve this goal.

Several strategies should be considered to address the risks associated with musculoskeletal injuries. First and foremost, implementing ergonomic devices and workstation designs is essential to minimise strain on vulnerable body locations. Secondly, work organisation and rotations can effectively limit or reduce the loading on these at-risk areas. Thirdly, it is crucial to exercise caution when assigning employees to roles that may put them at risk, particularly if they have pre-existing musculoskeletal conditions. For individuals with such conditions, targeted work hardening programs should be provided to improve their physical abilities, including pre-season, off-season, and in-season programs. Moreover, targeted stretching protocols should be considered as part of injury prevention measures. In high-risk areas, additional staffing should be evaluated when injury tallies increase and a lead-in time should be provided for all physically demanding tasks during the seasonal transition. Similar principles should apply to overtime and extended hours, as and when required.

Table 4.27

Levin Musculoskeletal Injuries by Body Location

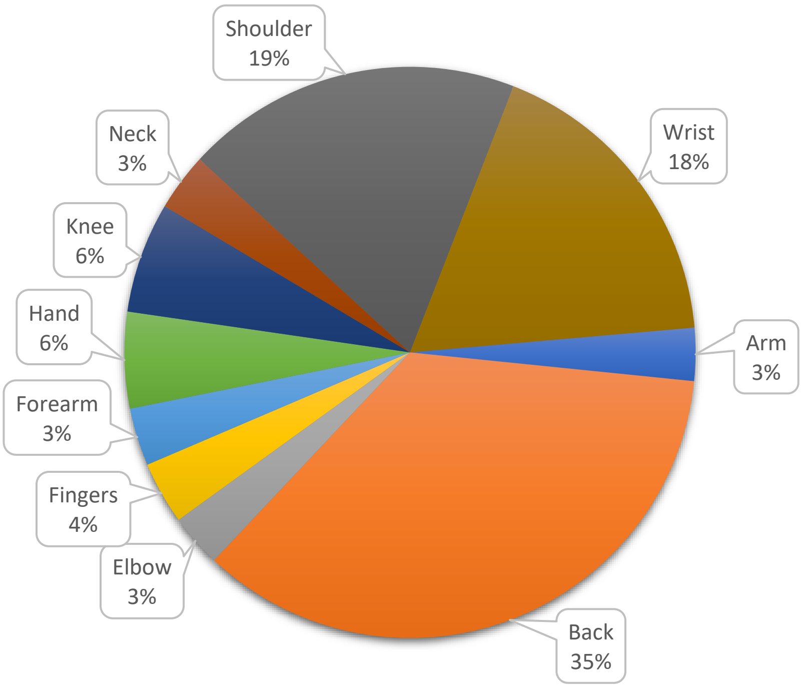
Body location	Number of injuries
Abdomen	1
Ankle	7
Arm	11
Back	62
Back - Cervical	2
Back - Lumbar	64
Back - Sacrum	2
Back - Thoracic	2
Buttocks	2
Chest	2
Elbow	11
Fingers	13
Foot	4
Forearm	12
Groin	3
Hand	20
Hip	1
Knee	23
Lower Limb	2
Multiple Locations	1
Neck	10
Ribs	3
Shoulder	70
Thumb	8
Trunk	1
Upper Leg	2
Wrist	65
Grand Total	**404**

Note. The highlighted areas indicate the top 10 body locations with the highest incidence of injuries. The spine represents the most significant vulnerability among these locations, accounting for approximately 35% of all reported musculoskeletal injuries.

High frequency; Medium-high frequency; Medium

Figure 4.19

Levin's Top 10 Musculoskeletal Injury Locations



An examination of musculoskeletal injuries reveals that certain areas, specifically the upper limbs (from hand to shoulder) and the spine, are prone to damage. Prioritising safeguarding these vulnerable regions is vital to successfully minimising the risk of musculoskeletal injuries. This can be accomplished by implementing various strategies, including using ergonomic devices and optimising workstation design to reduce strain on these specific body areas.

In addition, limiting or minimising the workload in vulnerable areas can be achieved by effectively organising work schedules and rotations. It is crucial to exercise caution when assigning employees to roles that may pose a risk, particularly if they have pre-existing musculoskeletal conditions. Their physical capabilities and limitations should be carefully considered to avoid exacerbating their injuries. Implementing targeted work-hardening programs can yield significant benefits for at-risk individuals by enhancing their physical abilities and reducing the likelihood of injuries. These programs can encompass a range of initiatives, including pre-season, off-season, and in-season activities. Additionally, organisations can focus on employee well-being initiatives that aim to improve physical well-being, offsetting the potential adverse effects of ageing on musculoskeletal health.

Targeted stretching protocols can also prevent injury by promoting flexibility and resilience in muscles and connective tissues. Incorporating regular stretching routines into work routines can help reduce the risk of strain-related injuries.

In high-risk areas where injury rates are elevated, it is advisable to consider additional staffing to ensure a manageable workload and minimise the chances of injuries. Moreover, allowing for a seasonal lead-in time for physically demanding tasks and adopting a similar approach for overtime work and extended hours, when necessary, can be beneficial in reducing the risk of musculoskeletal injuries.

In order to promote a safer work environment and minimise the risk of musculoskeletal injuries, organisations can adopt several strategies. These include prioritising the implementation of ergonomic measures, carefully organising work schedules, making informed employee selections, implementing targeted work hardening programs to strengthen vulnerable joints and body areas at higher risk of injury, promoting physical well-being, incorporating stretching protocols, considering additional staffing, and allowing sufficient adjustment time for employees to acclimate to the physical demands of their roles. By implementing these comprehensive measures, organisations can reduce musculoskeletal injuries and foster a safer workplace for their employees.

4.5 Review of AGL Lorneville plant injury data over the past five seasons

The Alliance Lorneville Plant, located near Invercargill on the South Island of New Zealand, is one of the country's largest meat processing plants. It handles the processing of sheep, cattle, and deer. With a processing season that lasts for ten months each year, the plant employs approximately 2000 workers (Alliance Group, 2023). The recorded data for Lorneville spans five seasons, from October 1, 2016, to August 11, 2021, totalling 5185 incidents.

4.5.1 Categorization of all Lorneville Injuries: Unveiling Meaningful Patterns and Frequency Trends

Table 4.28 provides a comprehensive overview of incidents classified by injury type at the Lorneville plant over a five-season period. The largest category of injuries falls under the First Aid classification, with 3210 incidents recorded during the specified timeframe.

Figure 4.20 presents the proportion of injuries attributed to each classification. This allows for a comparative analysis of the injury distribution across different plants within AGL, irrespective of variations in plant size and equipment. A notable observation from the data analysis is the higher proportion of First Aid reporting at Lorneville (63%) compared to Dannevirke (55%) and Levin (57%) plants. This suggests that more employees are experiencing injuries at Lorneville than at the other plants. While at this stage, it is speculative to conclude that this discrepancy is solely due to a poor safety culture, further investigation is warranted. Other factors or explanations may emerge as the analysis progresses, shedding light on the underlying causes of this disparity.

Analysing seasonal incidents based on their classification allows for identifying trends and patterns in incident occurrence. However, it is essential to note that there is significant variation in the spread of injury data, with limited discernible direction regarding overall incident occurrence rates. This inconsistency raises concerns and indicates the need for further investigation.

Furthermore, the relatively low number of recorded near misses in the database is a cause for concern. This issue may be attributed to challenges related to resource allocation or priorities rather than a lack of reporting. It is recommended to explore whether this issue is connected to organisational safety interactions to ensure appropriate preventive measures are implemented.

Table 4.28

Lorneville Plant Five Season Incidents by Classification

	Season					
Injury classification	**16/17**	**17/18**	**18/19**	**19/20**	**20/21**	**Total**
Discomfort	331	437	245	295	357	1665
First Aid Injury	662	483	695	655	715	3210
Lost Time Injury (LTI)	48	30	57	36	39	210
Medical Treatment Injury (MTI)	12	8	15	21	32	88
Near Miss	2	1	2	1	6	12
Grand Total	**1055**	**959**	**1014**	**1008**	**1149**	**5185**

Figure 4.20

Proportional Spread of Lorneville Five Season Injuries by Classification

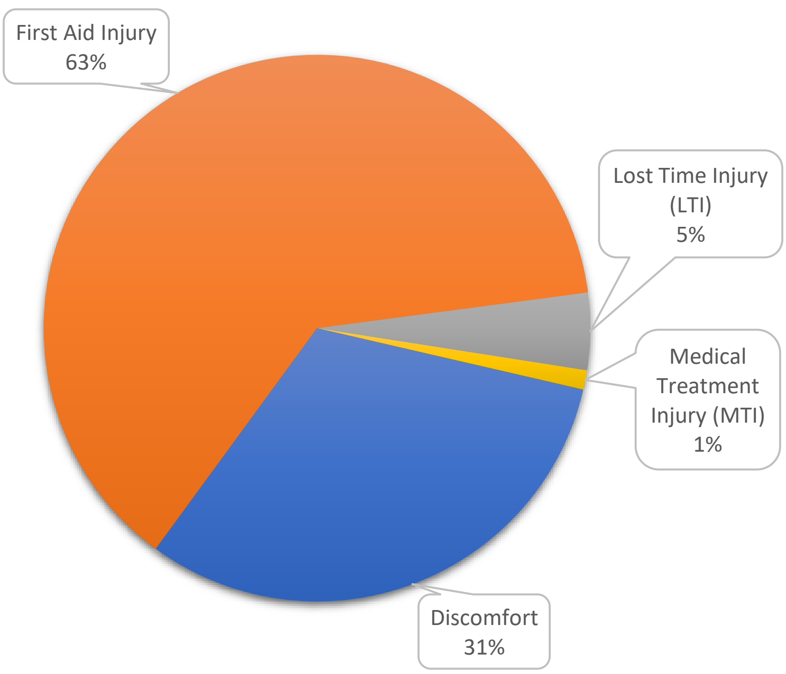


Table 4.29 displays the top 10 Lorneville seasonal incidents, which account for 90.4% of all on-site incidents, categorised by injury type. For a comprehensive list of the injuries, please refer to Table F32 in Appendix F. Analysing the seasonal data reveals notable trends in the

types of injuries. Determining which areas the injury prevention strategies should focus on is also valuable.

Table 4.29

Lorneville Top 10 Seasonal Incidents by Injury Type

	Season					
Injury Type	**16/17**	**17/18**	**18/19**	**19/20**	**20/21**	**Total**
Discomfort	331	437	245	295	357	1665
Aches/pain - specific	153	67	188	151	138	697
Bruising/Crushing	132	116	119	153	160	680
Sprain/Strain	71	70	157	105	158	561
Laceration - Dressing Only	72	43	78	55	15	263
Laceration - Steri Strips	57	59	58	53	30	257
Aches/pain - gradual	55		52	62	69	238
Foreign Body	48	38	16	21	29	152
Superficial skin injuries	14	9	4	18	49	94
Occupational Overuse Syndrome	17	11	15	16	23	82
Grand Total	**950**	**850**	**932**	**929**	**1028**	**4689**

Note. The highlighted injury types are of utmost concern, as they are preventable and capable of causing significant distress to employees. Addressing and mitigating these specific injury types is essential to ensuring the well-being and safety of the workforce.

Over the past three seasons, there has been a notable improvement in the occurrence of lacerations, particularly minor cuts. This positive trend can be attributed to implementing preventive measures, such as introducing mesh or other similar safety measures, resulting in decreased related incidents. However, the same level of improvement has not been observed for Bruising and Crushing injuries or Occupational Overuse Syndrome. Additionally, there is concern regarding Sprains and Strains, which continue to pose a risk. On the other hand, there has been a steady increase in discomfort injuries, which could serve as a valuable leading indicator for MSDs if reported early enough.

Figure 4.21 provides an overview of the proportional distribution of the top seven injury types at Lorneville. Discomforts account for 38% of the reported injuries, while aches and pains contribute 24% of all on-site injuries. Implementing targeted initiatives that address the factors contributing to these specific types of injuries is crucial to effectively reducing their occurrence.

Figure 4.21

Proportional Spread of Lorneville's Top Seven Injury Types

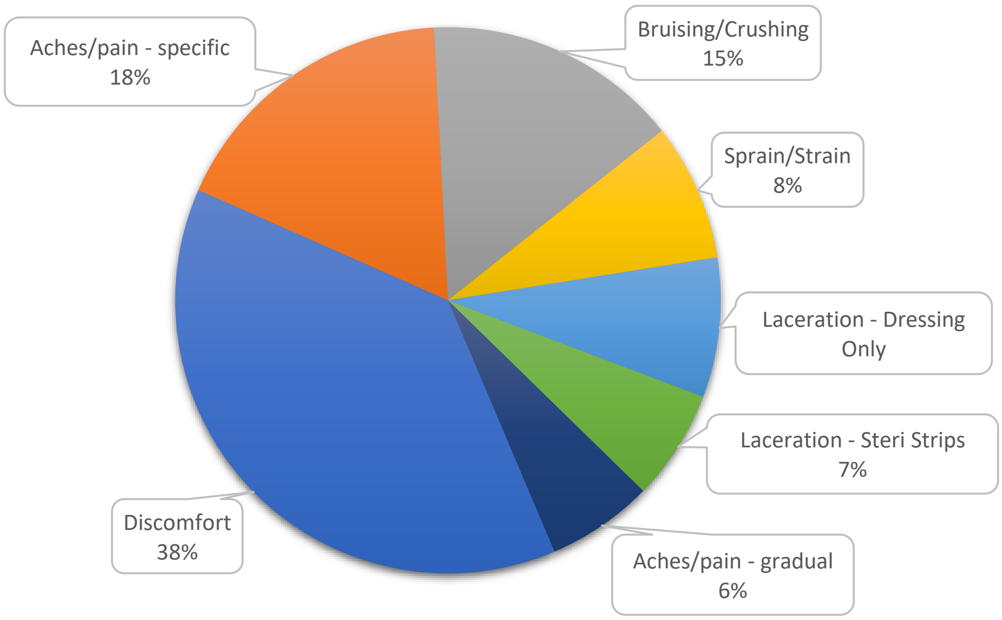


Table 4.30 displays the top 20 Lorneville seasonal incidents by department, which accounts for 93.4% of all incidents departments on site. Please refer to Table F33 in Appendix F for a comprehensive list of departmental injuries.

Figure 4.22 visually represents the proportional distribution of the top 10 injury departments at Lorneville, collectively accounting for 79% of all injury departments on the site. Table 4.30 presents a complete ranking of all injury departments in descending order to provide a comprehensive understanding. Notably, the top three injury department cohorts are highlighted with similar colour schemes to draw attention. It is worth mentioning that the Fancy Meats cohort, which accounts for 14% of the injury departments in Figure 46, includes smaller areas that did not make it to the top 20 list but are involved in processing red and white offal. These departments hold significance as they often experience a considerable number of MSDs. Despite their smaller size and fewer employees, it is essential to prioritise safety measures in these sometimes overlooked areas.

Table 4.30

Lorneville Top 20 Seasonal Incidents by Department

	Season					
Department Name	**16/17**	**17/18**	**18/19**	**19/20**	**20/21**	**Total**
Further Processing 1	166	152	280	251	310	1159
S/Bd Labourers	181	154	165	137	116	753
Further Processing 2	85	104	68	112	123	492
S/Bd Chain 1	75	56	75	90	99	395
Further Processing 4	106	113	53	49	58	379
Fellmongery	47	55	34	33	35	204
S/Bd Chain 4	44	38	37	31	38	188
S/L Fancy Meats	43	34	38	21	28	164
Palletised Stores	40	23	32	23	39	157
S/Bd Chain 2	33	35	21	34	24	147
S/Bd Chain 3	23	19	21	25	35	123
Venison Boning	19	18	17	18	35	107
Amenities	24	14	9	22	17	86
Further Processing 5	13	8	6	23	34	84
Rendering	6	10	21	18	24	79
S/L Yards	9	14	15	20	14	72
Venison Slaughter	3	12	22	15	17	69
Casings	26	15	15	6	5	67
Yard Gang	18	14	9	13	9	63
S/L Tripe	16	10	7	9	15	57
Grand Total	**977**	**898**	**945**	**950**	**1075**	**4845**

Note. Comparable (by task) injury departments are highlighted in the same colour.

Despite a steady decline in incidents among Slaughterboard Labourers over the past three seasons, as evidenced in Table 4.30, it remains the second-highest source of injuries. This observation highlights a significant downward trend in the occurrence of incidents. To effectively address this issue, it is crucial to emphasise the importance of prioritising injury prevention efforts for the Slaughter Board department and the Further Processing rooms. Taking proactive measures in these areas is essential to maintain and further drive the downward trend in incidents.

Figure 4.22

Lorneville Proportional Top 10 Injury Departments (79%)

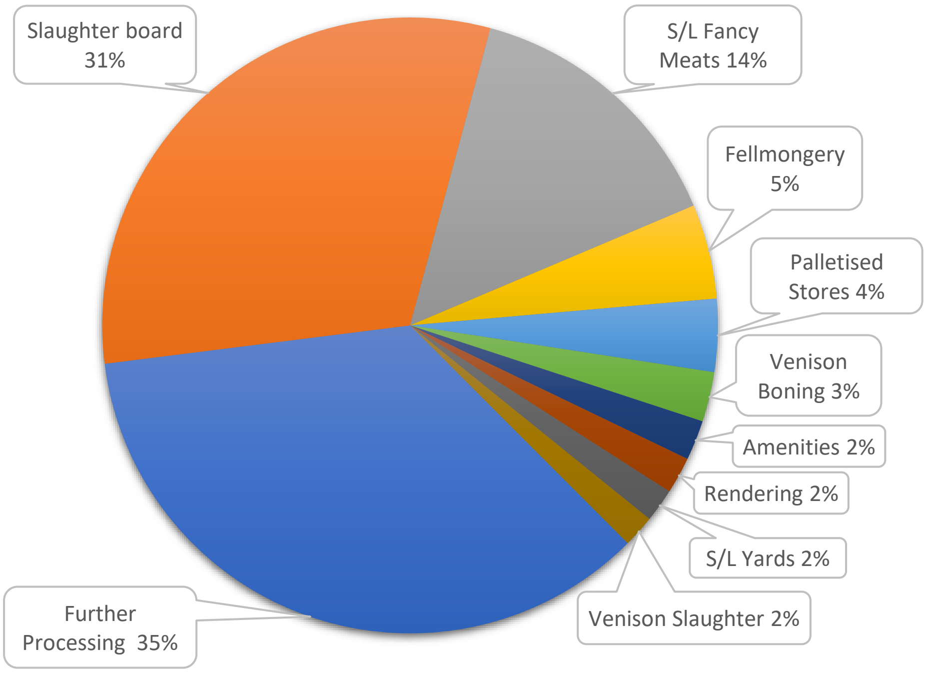


Table 4.31 presents a comprehensive overview of LTI and MTI, considered more severe indicators. These injury types can be regarded as lag indicators, reflecting severe incidents. Interestingly, the departments with the highest overall injury rates also demonstrate the highest incidence of LTI and MTI cases. This correlation suggests a link between the occurrence of severe injuries and departments with a higher overall injury risk. Leveraging this data allows for the prediction of expected injury numbers. By calculating an injury ratio, it becomes possible to assess which departments pose the most significant risk and consequently direct injury prevention strategies towards those areas.

Table 4.31

Lorneville Seasonal LTI and MTI Injury Departments (3.8 % of all Incidents)

	Season					
Department Name	**16/17**	**17/18**	**18/19**	**19/20**	**20/21**	**Total**
Amenities			1			1
Casings			1			1
Cooling Floor		1				1
Electricians	1					1
Engine Room					1	1
Fellmongery	4		3	2		9
Freezers			1			1
Further Processing 1	5	2	2	6	11	26
Further Processing 2	5	2	4	2	4	17
Further Processing 3		1	1			2
Further Processing 4	3	3	2	3	4	15
Further Processing 5	1		1	1		3
Gutshed					1	1
Main Store					1	1
Palletised Stores	4	1	3	2	7	17
Rendering			1		1	2
S/Bd Chain 1	5	1	7	6	3	22
S/Bd Chain 2		3	2	2		7
S/Bd Chain 3	1			2	2	5
S/Bd Chain 4		2	4	3	1	10
S/Bd Chain 5				1		1
S/Bd Labourers	9	2	5	5	3	24
S/L Fancy Meats	2		4	2	3	11
S/L Tripe		2			2	4
S/L Yards		2	1	3		6
Security			1			1
Soup Stock					1	1
Yard Gang	1	1	1	1		4
Grand Total	**41**	**23**	**45**	**41**	**45**	**195**

Note. Comparable injury departments are highlighted in the same colour.

The concern arises from the recorded incidents (Figure 4.23) within the Further Processing 1 department, which experienced 11 LTI/MTI injuries during the 20/21 season. Similarly, the Palletised Stores department had seven incidents of the exact nature during the same season. It is imperative to prioritise safety enhancements within these departments to mitigate the associated risks and foster a safer working environment.

Figure 4.23

Lorneville Seasonal Lost Time Injuries (LTI) and Medical Treatment Injuries (MTI) by Department

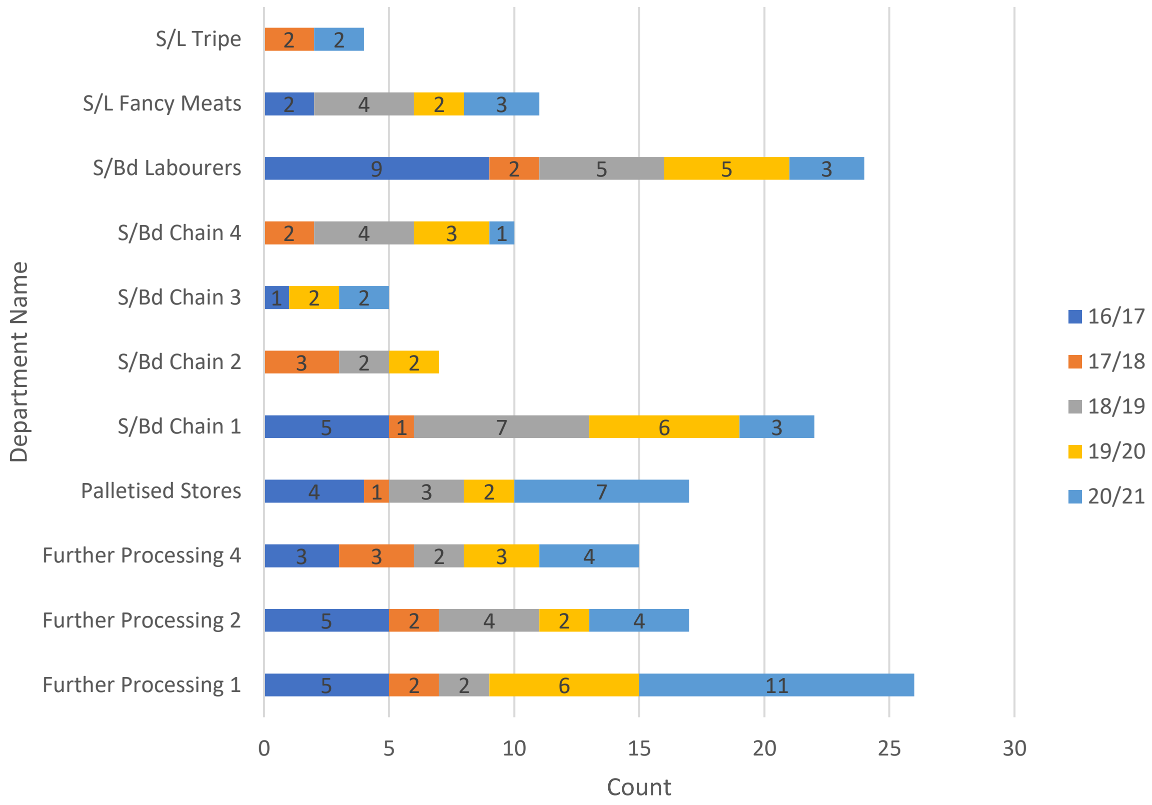


Table 4.32 provides an overview of the Lorneville seasonal injury risk ratios, which aid in identifying departments with a higher risk of injuries. A lower ratio score indicates a higher risk of injury. Analysing the data makes it possible to estimate the number of incidents that may occur before a medical treatment injury (MTI) or lost time injury (LTI) is expected. For example, based on the incident rates for the Palletised Stores department during the 20/21 season, it can be projected that an LTI or MTI may occur for every 5.6 incidents. Timely reporting of discomforts and near misses is crucial in enhancing ratios related to injury risks. It is worth highlighting that departments with high-risk ratios include the Palletised stores, Fancy Meats (red and white offal), and chains one and four on the Slaughter board. To effectively mitigate the associated risks and cultivate a safer working environment, it is essential to prioritise safety improvements within these departments. In the context of the Lorneville plant, the average LTI or MTI ratio over the past five seasons has been 16.4:1.

This indicates that, on average, for every 16.4 discomfort or first aid incidents, an LTI or MTI can be anticipated.

Table 4.32

Lorneville Seasonal Injury Ratio – High Risk Departments

	Injury ratio					
Incident department	**16/17**	**17/18**	**18/19**	**19/20**	**20/21**	**Total**
Further Processing 1	33.2:1	76.0:1	140.0:1	41.8:1	28.2:1	44.6:1
Further Processing 2	17.0:1	52.0:1	17.0:1	56.0:1	30.8:1	28.9:1
Further Processing 4	35.3:1	37.7:1	26.5:1	16.3:1	14.5:1	25.3:1
S/Bd Labourers	20.1:1	77.0:1	33.0:1	27.4:1	38.7:1	31.4:1
S/Bd Chain 1	15.0:1	56.0:1	10.7:1	15.0:1	33.0:1	18.0:1
S/Bd Chain 4	44.0:0	19.0:1	9.3:1	10.3:1	38.0:1	18.8:1
Palletised Stores	10.0:1	23.0:1	10.7:1	11.5:1	5.6:1	9.2:1
S/L Fancy Meats	29.5:1	22.0:1	9.0:1	15.0:1	7.2:1	13.0:1

Note. The injury risk ratio is derived by dividing the lead indicators (First Aid and Discomfort injuries) by the lag indicators (MTI and LTI). Shading highlights ratios that identify injury risk. Lower ratios signal greater risk.
High risk; Medium risk

Table 4.33 displays the incidents categorised by shift, which could potentially provide insights if the shifts were evenly distributed. However, due to significant variations in the number of individuals working per shift, fluctuations in stock levels (including species, size, and product type) make it challenging to identify reliable trends. Nevertheless, there have been instances where clusters of injuries have emerged, specifically associated with a particular shift. For instance, a notable increase in injuries occurred during the night shift while performing a specific task, such as the breakdown of Bobby calves (refer to Figure 4.24). Monitoring the variance across shifts made it possible to identify an outlier and determine the cause behind the injury cluster. Interestingly, in this case, it was attributed to new staff members starting the night shift, with significant variation in the training methods employed.

Table 4.33

Lorneville Incidents by Shift

Incidents by shift	Number of incidents
Day	3184
Late	29
Night	1972
Split	1
Grand Total	**5185**

Figure 4.24

Employees Performing Bobby Calf Breakdown Tasks

Note. The task is inherently challenging and known to cause injuries. Therefore, approximately 8-10 employees are expected to sustain injuries each season while performing this task.

It can be inferred that departments with a high risk of injury are likely to perform most high-risk tasks. Table 4.34 displays the top 20 tasks known to cause injuries at Lorneville. For a comprehensive list of all injury-causing tasks, please refer to Table F37 in Appendix F. Such lists offer valuable insights when seeking areas to mitigate injury risks and identify tasks within a high-injury task rotation that may provide a lighter workload for employees who face challenges with their current workloads.

Table 4.34

Lorneville Plant Top 20 Five Season Injury Tasks

	Season					
Task Description	**16/17**	**17/18**	**18/19**	**19/20**	**20/21**	**Total**
Packing	81	84	74	72	91	402
Boning	70	70	62	50	72	324
Cleaning	57	41	42	45	44	229
Cartons	45	37	38	32	48	200
General Labouring	28	27	22	26	88	191
Trimming	43	31	35	26	25	160
Gutting	38	25	19	41	36	159
Bagging	21	19	30	29	29	128
Racks	22	27	20	29	28	126
Pelting	23	22	21	30	20	116
Gut Trays	20	23	19	26	23	111
Sawyer	29	15	14	20	24	102
Y-Cut	16	22	20	19	23	100
Skirting	18	20	30	16	15	99
Wrapping	18	10	28	15	25	96
Butcher	11	25	24	10	7	77
Scales Operations	9	10	14	18	18	69
Detain	21	16	9	13	10	69
Sticking	11	9	19	19	7	65
Chillers	17	15	13	13	5	63
Grand Total	**598**	**548**	**553**	**549**	**638**	**2886**

Note. The highlighted tasks align with the departments experiencing many injuries, including tasks such as trimming and cleaning that are common across multiple departments.

The top 20 tasks that cause injuries at Lorneville account for 55.7% of all incidents that take place on-site. Examining the manner in which these tasks are performed and the workstations where they are carried out would serve as a valuable starting point for reducing the risk of injuries. Table 4.34 highlights the top injury tasks corresponding to their respective departments.

4.5.2 Categorization of Lorneville MSD Injuries: Unveiling Meaningful Patterns and Frequency Trends

In order to address the main objective of this study, which is to prevent and manage MSDs, it is crucial to identify and isolate all incidents related to MSDs. Table 4.35 provides a comprehensive overview of musculoskeletal injuries classified by injury type. However, it is worth noting that not all injuries may be musculoskeletal within the specific category of aches and pains. The selection of this category is based on the perception of the injury. For instance, an employee knocking their shin against a fixture or abdominal pain may be included in this category, even though it may not directly involve a musculoskeletal issue.

Table 4.35 shows that Musculoskeletal incidents constitute 62.2% of all incidents recorded at the Lorneville site. This figure can be further analysed to differentiate between recordable (LTI and MTI) injuries included in the plant's safety performance data. Of the five-season data set (n=214), recordable injuries account for 6.7% of musculoskeletal injuries. On the other hand, non-recordable injuries encompass Discomfort and First Aid cases (n=3010), representing 93.3% of all musculoskeletal injuries. These non-recordable injuries can serve as leading indicators, aiding the management team in identifying areas to prioritise when implementing injury prevention strategies.

An increase in early reporting of discomfort can be seen as a positive trend that can reduce the severity of injuries if appropriate actions are taken. One crucial action is to ensure that the affected employee promptly receives a medical assessment from a qualified healthcare professional. This assessment is essential for evaluating the nature and extent of the discomfort, allowing for early intervention to prevent the condition from worsening.

When an employee reports discomfort, alternative duties may be recommended to address the issue. One option is to consider temporary modifications to the employee's work assignments or tasks to reduce strain on the affected area. This can involve assigning lighter duties or adjusting the work schedule for adequate rest and recovery.

Table 4.35

Lorneville Plant Seasonal Musculoskeletal Incidents

Incident category	Injury Description	16/17	17/18	Season 18/19	19/20	20/21	Total
Discomfort	Discomfort	331	436	243	292	356	1658
Total		**331**	**436**	**243**	**292**	**356**	**1658**
First Aid Injury	Aches/pain - gradual	51		51	57	61	220
	Aches/pain - specific	144	64	174	138	125	645
	Occupational Overuse Syndrome	1	3	5	2	6	17
	Sprain/Strain	52	55	128	92	143	470
Total		**248**	**122**	**358**	**289**	**335**	**1352**
Lost Time Injury (LTI)	Aches/pain - gradual	2			4	3	9
	Aches/pain - specific	4	2	7	6	9	28
	Musculoskeletal Disease		1				1
	Occupational Overuse Syndrome	14	8	9	9	5	45
	Sprain/Strain	16	11	22	9	8	66
Total		**36**	**22**	**38**	**28**	**25**	**149**
Medical Treatment Injury (MTI)	Aches/pain - gradual	2		1	1	5	9
	Aches/pain - specific	4	1	3	5	2	15
	Occupational Overuse Syndrome	2		1	5	12	20
	Sprain/Strain	3	2	6	3	7	21
Total		**11**	**3**	**11**	**14**	**26**	**65**
Grand Total		**626**	**583**	**650**	**623**	**742**	**3224**

In cases where the injury is potentially linked to poor work performance, it becomes essential to provide training and education to employees. This training can focus on correct body mechanics, lifting techniques, and posture. By equipping employees with this knowledge, they can better understand how to perform their tasks to minimise the risk of discomfort or injury.
If necessary, the medical team can provide employees with appropriate personal protective equipment (PPE), including back supports, wrist braces, or knee pads. This measure aims to alleviate discomfort and offer additional support during work activities.

In cases where employees struggle with their workload, it is advisable to recommend more frequent task rotations or introduce and encourage micro pauses. These micro pauses can be achieved by encouraging employees to take regular breaks and perform stretching exercises, which help relieve muscle tension and improve blood circulation. It is important to incorporate stretching routines into the work schedule to prevent discomfort from worsening. Additionally, monitoring the employees' condition continuously and encouraging them to report any discomfort or signs of potential MSDs is crucial. Regular monitoring and reassessment of the effectiveness of implemented interventions are essential, and adjustments should be made as necessary. Implementing these measures can reduce the severity of early-reported discomfort, promote employee well-being and minimise the risk of developing more serious musculoskeletal conditions.

Upon reviewing the musculoskeletal recordable injury data presented in Table 4.35, observing the high number of Occupational Overuse Syndrome (OOS) injuries is concerning. These injuries could have been prevented if early reporting had been acted upon. Similarly, the number of gradual onset aches and pains raises concern. It is important to note that sprains and strains often occur when employees exceed their body limits. This particular issue is worrisome, considering Lorneville has an ageing workforce (G. Vincent personal communication, October 19, 2022). The combination of these factors highlights the need for proactive measures to address these concerns and prioritise the well-being of employees.

The appendix section, Table F39, provides a comprehensive overview of all the tasks performed at the Lorneville Plant that have resulted in 10 or more musculoskeletal injuries that account for 85.2% of all MSDs over the past five seasons. Additionally, this table includes information regarding the level of experience of the employees who were injured while performing these tasks. It serves as a valuable reference for understanding the tasks that pose a higher risk of musculoskeletal injuries within our organisation. Moreover, Table 4.36 presents a summarised version of the top 20 tasks (60.7% of all MSDs) that have been identified as causing the most musculoskeletal injuries. This data is crucial for prioritising our efforts and implementing targeted interventions to mitigate the risks associated with these tasks and ensure the well-being of our employees.

Table 4.36

Lorneville Top 20 Musculoskeletal Injury Causing Tasks by Employee Years of Experience

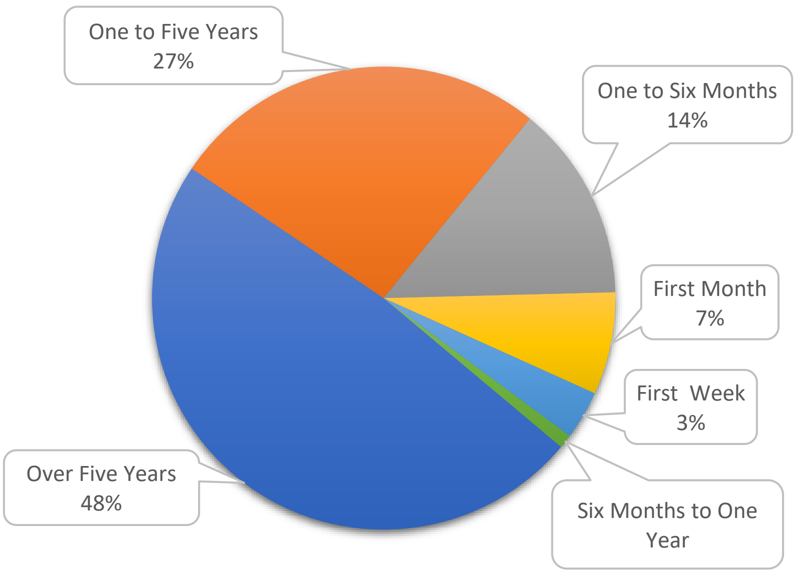
	Experience						
Task Description	**First Wk**	**First Mth**	**1-6 Mths**	**6 Mths to 1 Yr**	**1-5 Yrs**	**Over 5 Years**	**Total**
Packing	25	41	69	2	88	68	293
Boning	4	11	21	2	84	132	254
Carton handling	10	16	16	3	38	44	127
Trimming	7	15	20	3	39	39	123
General Labouring	6	10	26		40	38	120
Bagging	8	13	31	1	27	25	105
Racks	9	16	25		40	13	103
Gutting	1	3	9	2	35	51	101
Cleaning		1	3		17	59	80
Pelting	1	1	9	1	18	47	77
Gut Trays	13	18	16	2	11	11	71
Sawyer			4		17	42	63
Wrapping	3	7	16		24	13	63
Y-Cut		3	3		12	43	61
Skirting	5	5	10		27	9	56
Scales Operations	1	2	8		23	18	52
Tripe Operator	3	4	5	1	18	17	48
Detain			2		12	33	47
Chillers		5	6		12	23	46
Butcher	1	3	3		4	29	40
Sticking	1	2	6		6	23	38
Grand Total	**98**	**176**	**308**	**17**	**592**	**777**	**1968**

Table 4.36 shows that tasks such as packing, trimming, carton handling, gutting, general labouring, and cleaning are increasingly challenging over time. The highest rates of injuries are observed among employees with one to five years of experience and those with more than

five years of experience. This observation (Figure 4.25) suggests that the demands associated with these tasks may intensify regarding physical exertion or complexity as employees gain more experience (or age). Moreover, tasks that involve knife work, such as Boning (which entails the removal of meat product from bone), become progressively more challenging as employees accumulate over five years of experience, exhibiting the highest injury rate in this category.

Figure 4.25

Lorneville 5-Season Musculoskeletal Injuries (all) by Years of Experience



These findings underscore the importance of appropriately addressing these tasks' increased risk and workload challenges, especially for employees with prolonged experience.

Table 4.37

Lorneville Musculoskeletal Injuries by Body Location in Relation to Employee Years of Experience

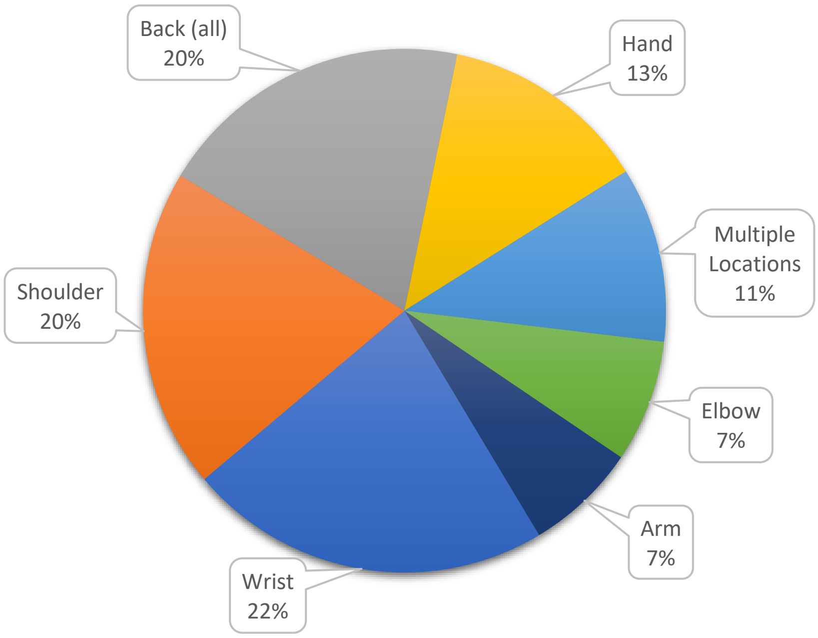
Body Description	First Wk	First Mth	1-6 Mths	6 Mths to 1 Yr	1-5 Yrs	Over 5 Yrs	Total
			Experience				
Wrist	36	48	94	1	182	210	571
Shoulder	8	40	54	5	137	258	502
Back (all)	18	27	79	4	131	239	498
Hand	19	43	65	3	94	102	326
Multiple Locations	19	29	45	5	80	97	275
Elbow	4	11	19	4	46	108	192
Arm	10	17	18	1	53	77	176
Fingers	4	11	20	2	23	40	100
Knee	3	7	8		18	60	96
Neck	1	4	11	1	18	54	89
Thumb	4	8	12		21	28	73
Forearm	4	6	10		29	24	73
Ankle		3	5		20	36	64
Lower Limb		1	3	1	7	23	35
Foot		3	2		8	18	31
Chest			3		8	19	30
Thigh					4	21	25
Groin					3	17	20
Hip			3		1	14	18
Ribs			2		3	5	10
Buttocks		1	1		1	6	9
Trunk				1	2	3	6
Toe						2	2
Grand Total	**130**	**259**	**454**	**28**	**889**	**1461**	**3221**

Table 4.37 provides an overview of Lorneville musculoskeletal injuries categorised by body location, considering the employees' years of experience. The data highlights the most injured areas, namely the wrist (22%), shoulders (20%), spine (20%), and hand (13%). Figure 50 displays the proportional representation of these frequently affected body areas to visualise the distribution better. Notably, many employees sustain injuries in multiple locations (11%), emphasising the need for comprehensive preventive measures. Furthermore, the data reveals that most of these injuries occur among more experienced employees, underscoring the

importance of targeted interventions and support for this particular group to mitigate the risk of musculoskeletal injuries.

Figure 4.26

Lorneville Musculoskeletal Injuries Proportional to the Body Locations Most Frequently Injured



A thorough analysis of musculoskeletal injuries highlights the vulnerability of specific areas, particularly the upper limbs (from hand to shoulder) and the spine, to potential damage. To effectively mitigate the risk of such injuries, it is essential to prioritise the protection of these susceptible regions. This can be achieved by implementing various strategies, such as utilising ergonomic devices and optimising workstation design to alleviate strain on these specific body areas.

Moreover, effective work schedule organisation and rotations can manage and minimise the workload exerted on these vulnerable regions. Particular attention should be given when assigning employees to roles that may pose a risk, especially if they have pre-existing musculoskeletal conditions. It is crucial to thoroughly assess their physical capabilities and limitations to prevent exacerbation of their injuries.

Furthermore, implementing targeted work-hardening programs for at-risk individuals can yield substantial benefits. These programs focus on enhancing their physical abilities and reducing the likelihood of injuries. They can encompass a variety of initiatives, including pre-season, off-season, and in-season activities designed to improve strength, flexibility, and overall conditioning. By prioritising the well-being of employees and implementing these proactive measures, musculoskeletal injuries can be significantly reduced, leading to a safer and healthier work environment.

4.6 Review of AGL Mataura plant injury data over the past five seasons

The Alliance Mataura Plant, situated in the township of Mataura near Gore on the South Island of New Zealand, is a beef processing facility that employs approximately 400 individuals (Alliance Group, 2023). The recorded incidents at Mataura span from 1 October 2016 to 11 August 2021, totalling 2068.

4.6.1 Categorization of all Mataura Injuries: Unveiling Meaningful Patterns and Frequency Trends

Table 4.38 and Figure 4.27 display the incidents categorised by injury type at the Mataura plant throughout five seasons. First Aid injuries emerge as the largest category among the various injury types, accounting for 1516 incidents (73.3%) within the specified timeframe. This finding is intriguing because the proportion of first aid injuries at Mataura is considerably higher than at other beef processing plants, such as Pukeuri (28%) and Levin (56.8%). The unique aspect of Mataura being a beef-only processing plant is likely a contributing factor. The larger carcasses processed at this plant increase the risk of sprain/strain injuries, which warrants further investigation.

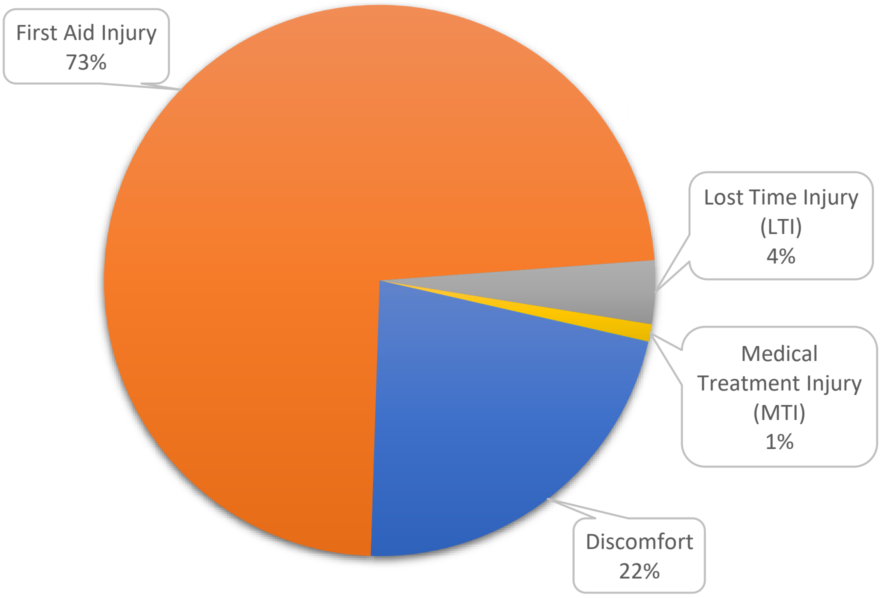
Table 4.38

Mataura Plant Five Season Incidents by Classification

	Season					
Injury classification	**16/17**	**17/18**	**18/19**	**19/20**	**20/21**	**Total**
Discomfort	75	65	172	71	70	453
First Aid Injury	308	345	251	299	313	1516
Lost Time Injury (LTI)	10	8	12	18	29	77
Medical Treatment Injury (MTI)	4		5	6	6	21
Near Miss	1					1
Grand Total	**398**	**418**	**440**	**394**	**418**	**2068**

Figure 4.27

Mataura plant five season incidents by classification



Upon examining the data presented in Table 4.39, which illustrates the incidents categorised by injury type at the Mataura plant over five seasons, specific trends become apparent. Firstly, the data indicates that sprains and strains (33.8%) are a cause for concern, as there is no noticeable decline in their occurrence rates. This area requires further investigation. On a positive note, the number of discomfort injuries has been decreasing over the past two seasons. It is also worth mentioning that bruising and crushing injuries (17.2%) display a promising downward trend. However, specific aches, pains, and lacerations fluctuate, while burns have plateaued over the last three seasons. These areas demand significant attention and focus. Figure 4.28 highlights that sprains and strains (33.8%), discomforts (22%), and bruising and crushing (17.2%) still account for a combined total of 73% of all injuries on site. Initiatives targeting the reduction of causative factors in these areas will be necessary.

Table 4.39

Mataura Plant Five Season Incidents by Injury Type

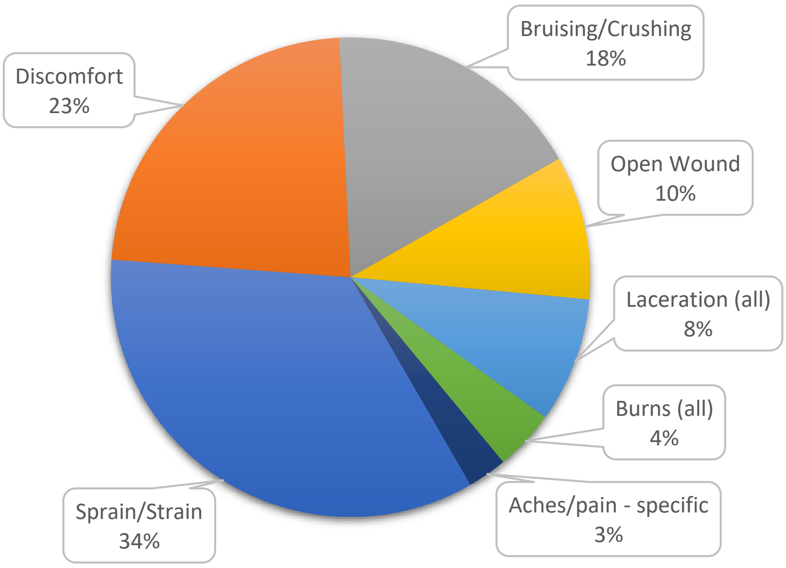
	Season					
Injury Type	**16/17**	**17/18**	**18/19**	**19/20**	**20/21**	**Total**
Sprain/Strain	124	159	77	154	185	699
Discomfort	75	65	172	71	70	453
Bruising/Crushing	69	78	86	68	55	356
Open Wound	31	50	25	27	50	183
Laceration - Dressing Only	38	13	19	14	16	100
Aches/pain - specific	2	3	16	23	6	50
Laceration - Steri Strips	14	9	9	12	2	46
Burns - Chemical	3	4	8	4	8	27
Burns - Scald	7	7	5	3	5	27
Other	12	5		2	7	26
Burns	6	7	5	3	2	23
Infection	3	5	3		3	14
Laceration - Referral - GP/Hosp	6	2	2	1	2	13
Aches/pain - gradual	1	3	4	4	1	13
Foreign Body	2	5		4	1	12
Head Injury	1	1	2	2		6
Bone Scratch	1	1	2		1	5
Industrial Deafness				2	2	4
Fracture or Spine			2			2
Skin Disease	1		1			2
Superficial			1		1	2
Near Miss	1					1
Amputation		1				1
Mental Disorder	1					1
Laceration - Sutures					1	1
Dislocation			1			1
Grand Total	**398**	**418**	**440**	**394**	**418**	**2068**

Note. Injury type by frequency es. High frequency; Medium-high frequency; Medium

Once the departments from which these injuries originate are identified, the subsequent step will involve implementing targeted injury prevention initiatives. To facilitate this process, Table 4.40 provides a comprehensive breakdown of the incidents by department at the Mataura plant over five seasons.

Figure 4.28

Mataura Plant Five Season Incidents Ranked by the Top Seven Injury Types



The Beef Boning and Beef Slaughter departments have the highest number of injuries. However, there is a positive trend to highlight in the case of Beef Boning, as injuries in this department have decreased over the past three seasons. Unfortunately, the 20/21 season has experienced a notable increase in injuries in the Beef Slaughter department, which may be linked to an elevated workload and increased overtime hours. On the other hand, the Beef Offal department has shown little change in injury rates, while the Freezers department has displayed a downward trend in injuries. These observations emphasise the need for further investigation and targeted measures to address the factors contributing to the increased injury rate in the 20/21 season while also acknowledging the positive progress made in reducing injuries in the Beef Boning department and the Freezers department.

Table 4.40

Mataura Plant Five Season Incidents by Department

	Season					
Incident department	**16/17**	**17/18**	**18/19**	**19/20**	**20/21**	**Total**
Beef Boning	217	187	190	158	156	908
Beef Slaughter	121	165	175	150	192	803
Beef Offal	7	6	21	25	21	80
Freezers	9	22	22	13	9	75
Hide Processing	6	10	3	8	7	34
Fitters	4	5	3	9	8	29
Chillers	13	2		3	3	21
Beef Tripe	4	2	5	3	2	16
Amenities		3		4	3	10
Cattle Yards	1	2	1	3	3	10
Engine Room	3	2	3	1	1	10
Quality Control	4	2		4		10
Transport	2	2	4	1	1	10
Beef Chillers	1	1		5	1	8
Waste Disposal	1	2		3	1	7
Water Services	1		3	2	1	7
Electricians		2	3		1	6
Boiler house	1		2	1	1	5
General services	1				3	4
Main Store	1	1		1	1	4
Medical Centre		2	1			3
Maintenance Admin					2	2
Palletised Stores			2			2
Laboratory					1	1
Plumbers	1					1
S/L Yards			1			1
Security			1			1
Grand Total	**398**	**418**	**440**	**394**	**418**	**2068**

Note. Incident frequency by department. High frequency; Medium-high frequency; Medium

In analysing the incident numbers across shifts, as presented in Table 4.41, it is crucial to consider the staffing and tally figures associated with each shift. It is also essential to consider that incident numbers may be influenced by the condition and size of the livestock being processed during different shifts. Notably, the night shift stands out as it accounts for 47% of the incidents while experiencing 6% fewer incidents than the other shifts.

This presents an intriguing opportunity for further investigation. By delving deeper into the dynamics of the night shift, valuable insights may be gained, which can contribute to reducing the overall number of injuries, especially during the day shift. Exploring potential factors contributing to the discrepancy in incident rates between shifts can help identify areas for improvement and guide targeted strategies to enhance safety across all shifts.

Table 4.41

Mataura Plant Five Season Incidents by Shift

Incident Shift	16/17	17/18	18/19	19/20	20/21	Total
Day	241	216	242	213	194	1106
Night	157	200	198	181	224	960
Grand Total	**398**	**418**	**440**	**394**	**418**	**2068**

4.6.2 Categorization of Mataura MSD Injuries: Unveiling Meaningful Patterns and Frequency Trends

Table 4.42 and Figure 4.29 provide a breakdown of incidents related explicitly to musculoskeletal injuries. The data underscores the necessity of dedicating time and resources to addressing the underlying factors contributing to these injuries. By presenting musculoskeletal injuries as a proportion (58.8%) of all injuries, their significance in the company's overall injury prevention strategy becomes apparent.

Among the musculoskeletal injuries, discomfort injuries account for 37.3% of the total, raising concerns regarding employee well-being. Additionally, 52.8% of the injuries are attributed to sprains and strains requiring particular attention. These types of injuries appear more prevalent when there is a larger workforce, which may be unique to a beef processing plant, given the handling of larger carcasses and heavier products. Notably, most recordable injuries fall within the sprains and strains category, emphasising the need for targeted interventions. These findings emphasise the importance of implementing measures to prevent and address musculoskeletal injuries, particularly discomfort injuries and sprains/strains. By understanding the unique challenges posed by the nature of the work in a beef processing plant and considering the implications of larger carcasses and products, tailored strategies can be developed to minimise the risk of these specific injuries. Allocating adequate resources and prioritising the well-being of employees will contribute to a safer and healthier work environment.

Figure 4.29

Mataura Plant Seasonal Musculoskeletal Injuries by Injury Type

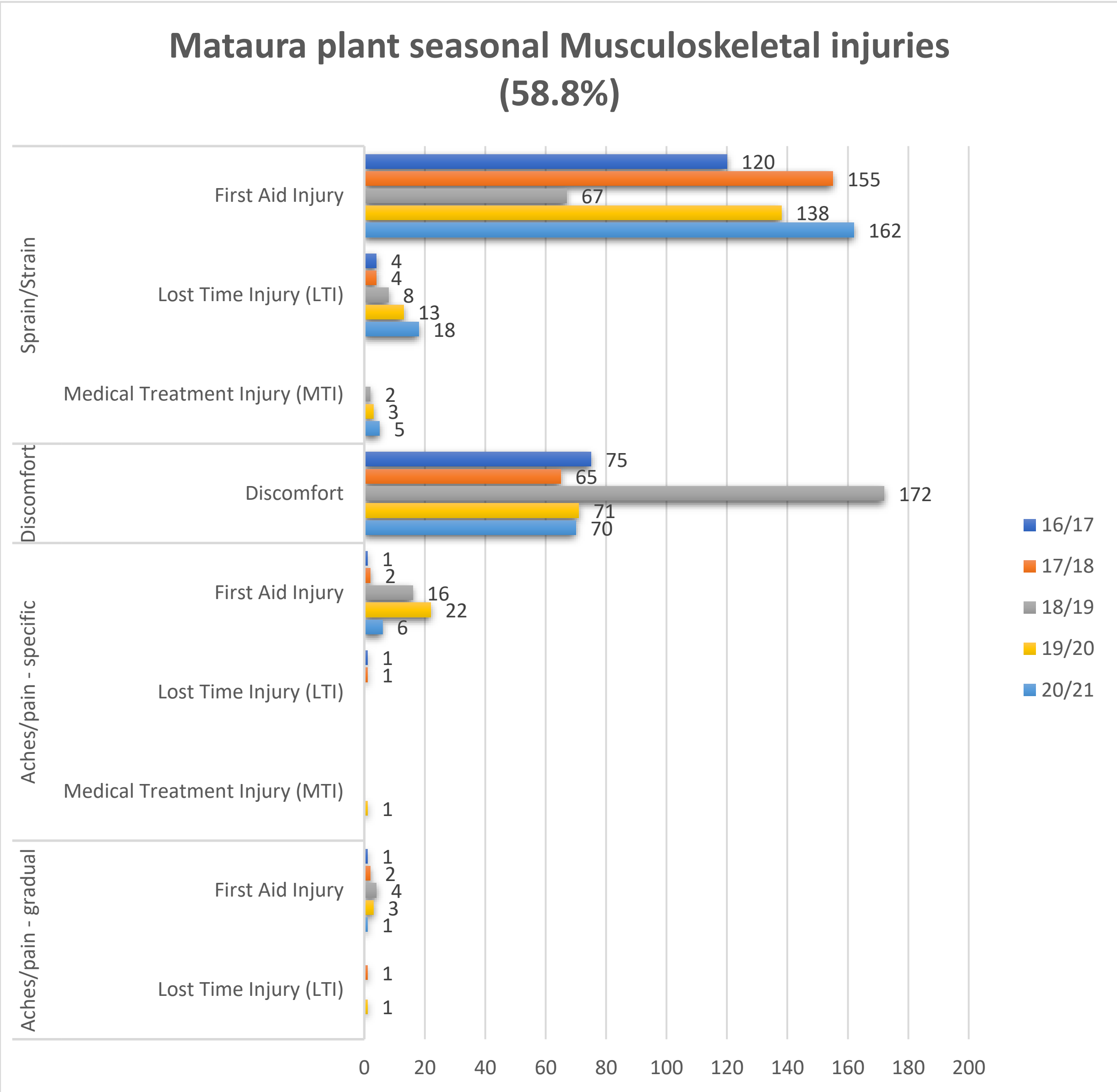


Table 4.42

Mataura Plant Seasonal Musculoskeletal Injuries

		Season					
Injury Description	**Incident Type**	**16/17**	**17/18**	**18/19**	**19/20**	**20/21**	Total
Sprain/Strain	First Aid Injury	120	155	67	138	162	642
	Lost Time Injury (LTI)	4	4	8	13	18	47
	Medical Treatment Injury (MTI)			2	3	5	10
Total		**124**	**159**	**77**	**154**	**185**	**699**
Discomfort	Discomfort	75	65	172	71	70	453
Total		**75**	**65**	**172**	**71**	**70**	**453**
Aches/pain - specific	First Aid Injury	1	2	16	22	6	47
	Lost Time Injury (LTI)	1	1				2
	Medical Treatment Injury (MTI)				1		1
Total		**2**	**3**	**16**	**23**	**6**	**50**
Aches/pain - gradual	First Aid Injury	1	2	4	3	1	11
	Lost Time Injury (LTI)		1		1		2
Total		**1**	**3**	**4**	**4**	**1**	**13**
Grand Total		**202**	**230**	**269**	**252**	**262**	**1215**

Note. Sprains and strains constitute the highest injury category and are responsible for the highest number of recordable injuries.

Upon examining both experience levels, as presented in Table 4.43 and Figure 4.30, it becomes evident that most injuries occur among the more experienced staff members in the 1-5 year and over 5-year experience categories. This finding aligns with the earlier mentioned observation that the higher risk of sprain/strain injuries at the plant is attributed to handling larger carcasses and heavier products. This can be seen in the injury data presented in Table 4.43, where tasks such as Carcass Handling in both the Beef Boning and Beef Slaughter departments account for a significant proportion (10.7%) of musculoskeletal injuries across these departments. Similarly, the trend persists for Packing tasks (21.5%) across the Boning, Slaughter, and Offal departments. For a comprehensive overview of the musculoskeletal injury tasks across different years of experience, please refer to Table G47 in Appendix G.

Figure 4.30

Mataura 5-Season Musculoskeletal Injuries (all) by Years of Experience

The risk of musculoskeletal injuries increases as individuals gain more experience, indicating that effectively managing workload and incorporating adequate recovery time can be crucial in reducing the occurrence of such injuries.

Table 4.43

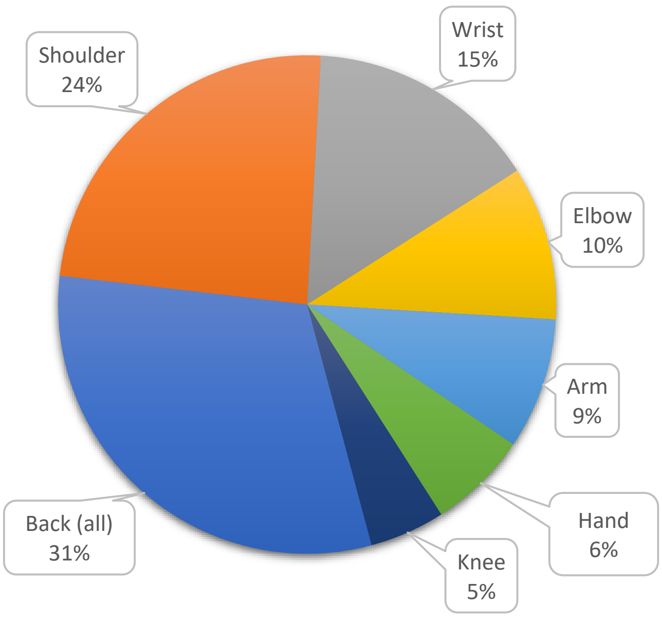
Mataura Top four Department Musculoskeletal Injury Causing Tasks across Years of Experience

		Experience						
Department	**Task Description**	**First Wk**	**First Mth**	**1-6 Mths**	**6 Mths to 1 Yr**	**1-5 Yrs**	**Over 5 Yrs**	**Total**
Beef Boning	Boning		3	3		27	47	80
	Carcase Handling			1		4	13	18
	Carton Handling	1		3		8	13	25
	Clean Up		3	6		10	3	22
	Floors		2	1		9	11	23
	Knife			11		13	15	39
	Packing	5	6	22		42	51	126
	Trimming	1	3	12		31	32	79
Total		**7**	**17**	**59**		**144**	**185**	**412**
Beef Slaughter	Carcase Handling	1		4		16	30	51
	Floors		2	10		5	10	27
	Halal Slaughtering			3		8	11	22
	Hide Pulling		1	2		2	12	17
	Knife	1	3	11	1	19	9	44
	Legging			2		13	24	39
	Packing		1	2		8	5	16
	Saws					7	10	17
Total		**2**	**7**	**34**	**1**	**78**	**111**	**233**
Beef Offal	Amenities			1		1		2
	Carton Handling					2		2
	Clean Up					1	1	2
	Doors			1			1	2
	Knife		1	1		1	1	4
	Offal			2		1	2	5
	Offal recovery		5	14		6	7	32
	Packing		1	3		3	2	9
Total			**7**	**22**		**15**	**14**	**58**
Hide Processing	Forklifts						2	2
	Hide Pulling		1	2		6	5	14
Total			**1**	**2**		**6**	**7**	**16**

Figure 4.31 provides an overview of the top seven body locations associated with the highest incidence of musculoskeletal injuries at the Mataura plant. Among these locations, the spine emerges as particularly vulnerable, accounting for approximately 31% of all reported musculoskeletal injuries. Notably, like Mataura, the Levin plant has also experienced a higher occurrence of spinal injuries than other non-beef processing plants. This finding emphasises the importance of implementing targeted measures aimed at addressing and mitigating the risk factors contributing to spinal injuries, specifically in beef processing plants. Such measures are crucial for enhancing workplace safety and reducing the overall prevalence of musculoskeletal injuries.

Figure 4.31

Mataura Seasonal Top Seven Musculoskeletal Injuries by Body Location



Musculoskeletal injuries resulting from physically demanding tasks or repetitive movements play a significant role in most MSDs. This data underscores the significant impact of work-related tasks on the development of MSDs, highlighting the urgent need for effective prevention and intervention strategies to address this widespread issue.

Numerous factors contribute to these injuries, including plant and equipment design, work organisation, tally requirements, and employee attributes such as an ageing workforce, fatigue, physical and mental well-being, and poor health habits. Considering these factors, the company must identify the most appropriate initiatives or projects to invest in to reduce musculoskeletal injuries.

Moreover, addressing the observed increase in all types of injuries is essential, as it raises concerns and demands further attention. This calls for a comprehensive approach that includes ongoing monitoring, regular risk assessments, employee training, and proactive measures to create a safe and healthy work environment. By addressing these factors and prioritising the well-being of employees, the company can effectively mitigate the risk of musculoskeletal injuries and enhance overall workplace safety.

4.7 Review of AGL Nelson plant injury data over the past five seasons

The Alliance Nelson Plant, situated in Stoke at the top of the South Island of New Zealand, specialises in sheep processing. With a workforce of 300 employees, the plant operates for approximately seven months per season (Alliance Group, 2023). The database contains a total of 918 recorded injuries from the five-season data.

4.7.1 Categorization of all Nelson Injuries: Unveiling Meaningful Patterns and Frequency Trends

Table 4.44 presents a comprehensive overview of all injury categories included in this dataset. Analysing the severity and type of injuries enables us to identify trends and differentiate between leading and lagging indicators. By carefully examining the patterns within the data, we can pinpoint areas of concern and identify opportunities to enhance safety outcomes and mitigate the risk of injuries. A noteworthy observation from Table 4.44 is that most injury categories have decreased over the past three seasons. This trend signifies positive progress in reducing the frequency and severity of injuries. It is encouraging to see this downward trend, as it suggests that the implemented safety measures and preventive strategies have effectively improved workplace safety.

However, it is essential to continue monitoring and analysing the injury data to ensure sustained improvement. By identifying any remaining problematic areas or emerging trends, we can focus on targeted interventions to enhance safety protocols and minimise the risk of injuries. This ongoing commitment to safety will contribute to the overall well-being and productivity of the workforce.

One noteworthy concern arises from the relatively low number of reported near misses in the database. This raises questions about allocating resources and priorities within the organisation rather than solely attributing it to a lack of reporting. It is essential to investigate whether any barriers or challenges hinder employees' access to reporting channels, leading to the underrepresentation of near misses in the database.

Moreover, examining the potential correlation between the number of safety interactions completed and the reported near misses is crucial. This relationship can provide valuable insights into the effectiveness of safety protocols and the level of engagement among employees. Suppose there is a discrepancy between the number of safety interactions and the reported near misses. In that case, it may indicate gaps in the reporting culture or a need for improved communication channels to encourage near-miss reporting.

Addressing these concerns requires a multi-faceted approach. First, resource allocation must be reviewed and adjusted to ensure that reporting mechanisms are easily accessible and promote a proactive reporting culture. Clear communication channels and supportive reporting systems should be established to encourage employees to report near misses without fear of reprisal. Additionally, providing adequate training and education on near-miss identification and reporting can further enhance the accuracy and completeness of the database.

By proactively addressing the low count of reported near misses and fostering a culture of open reporting, the organisation can gain valuable insights into potential hazards, prevent future incidents, and continuously improve its safety performance.

When injuries are classified by type, it becomes possible to observe the trends and direction of these incidents. It is encouraging to note that the number of Discomforts is decreasing each season. On the other hand, First Aid injuries have reached a plateau, with consistent numbers observed over the past three seasons.

Table 4.44

Nelson Seasonal Incidents by Classification

	Season					
Injury classification	**16/17**	**17/18**	**18/19**	**19/20**	**20/21**	**Total**
Discomfort	117	88	99	84	78	466
First Aid Injury	81	93	75	77	73	399
Lost Time Injury (LTI)	3	4	8	4	3	22
Medical Treatment Injury (MTI)	1	2	5	10	5	23
Near Miss	1	6	1			8
Grand Total	**203**	**193**	**188**	**175**	**159**	**918**

Table 4.45 presents the incidents by type throughout five seasons. By examining the types of injuries, we can observe the trends. Notably, lacerations have shown significant improvement, likely attributed to the introduction of mesh, resulting in fewer incidents. However, while discomfort numbers are decreasing each season, it remains a crucial area of focus. It is imperative to implement initiatives aimed at reducing the factors that contribute to discomfort incidents.

However, it is essential to acknowledge that although discomfort incidents have decreased each season, it remains an area that requires continued attention and focus. Recognising the significance of discomfort incidents, it is imperative to implement targeted initiatives to reduce the underlying factors that contribute to such incidents. By addressing the root causes of discomfort incidents and implementing measures to mitigate them, we can create a safer and more comfortable working environment for employees. This may involve ergonomic assessments, adjustments to workstations or equipment, and employee training on correct and body mechanics. Regular communication and feedback channels should also be established to encourage employees to report discomfort incidents promptly, allowing for timely intervention and resolution.

The sustained effort to address discomfort incidents will improve employee well-being and increase productivity and overall safety within the workplace.

Table 4.45

Nelson Seasonal Incidents by Injury Type

Incidents	Season					
Injury type	**16/17**	**17/18**	**18/19**	**19/20**	**20/21**	**Total**
Aches/pain - gradual		2	2	3	3	10
Aches/pain - specific	8	37	37	32	35	149
Bone Scratch	6	1		2		9
Bruising/Crushing	4	6	2	5	6	23
Burns			1		2	3
Burns - Chemical		1	1			2
Burns - Scald	2	4		1	1	8
Discomfort	117	88	99	84	78	466
Dislocation					1	1
Foreign Body	3	6	4	4	6	23
Head Injury		1		2		3
Industrial Deafness	1			1		2
Infection	1	1	1	1		4
Inhalation		1				1
Laceration - Dressing Only	40	23	21	19	9	112
Laceration - Referral - GP/Hosp		1	3	3	1	8
Laceration – Steri-strips	5	3			1	9
Laceration - Sutures			1			1
Multiple	1					1
Near Miss	1	5	1			7
Occupational Overuse Syndrome			1			1
Open Wound	1	2	2			5
Other		2	9	12	4	27
Puncture Wound	1	2				3
Sprain/Strain	6	1	3	5	6	21
Superficial	6	6		1	6	19
Grand Total	**203**	**193**	**188**	**175**	**159**	**918**

Note. Incident frequency by injury type. High frequency; Medium-high frequency; Medium

Despite being the smallest plant, Nelson's injury data shows a consistent downward trend. When examining the injury rates by department (please refer to Table 4.46), the Slaughterboard department stands out with the highest number of reported injuries, followed by Further Processing and the Yards. Interestingly, the top ten injury departments account for 97% (Figure 4.32) of all injury departments.

However, it is crucial to consider the number of employees working in each department to gain a comprehensive understanding of the injury numbers. Considering the department size helps provide context and allows for a more accurate interpretation of the injury rates. A higher number of injuries in a department with a larger workforce may not necessarily indicate a higher risk compared to a smaller department with fewer employees. Therefore, it is essential to calculate injury rates per employee or use other appropriate metrics to ensure a fair comparison across departments. Considering the department sizes when analysing the injury data enables a more precise assessment of the actual risk levels and facilitates the identification of targeted interventions to improve safety outcomes. This approach ensures a comprehensive understanding of the injury trends and assists in developing strategies to minimise the risk of injuries.

Figure 4.32

Nelson Top 10 Injury Departments (97%)

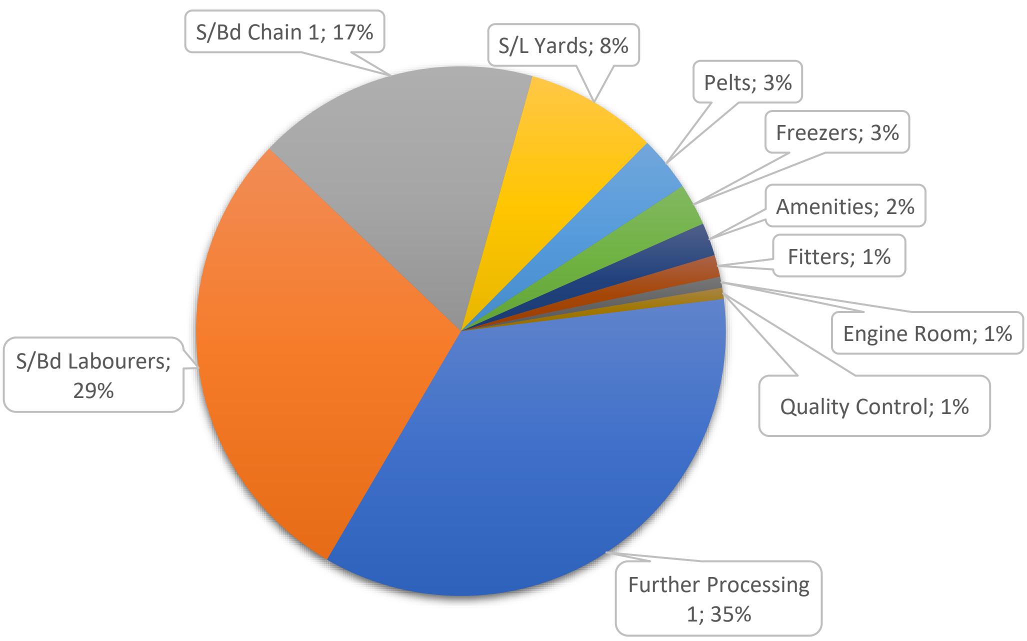


Table 4.46

Nelson Seasonal Incidents by Department

	Season					
Incident department	**16/17**	**17/18**	**18/19**	**19/20**	**20/21**	**Total**
Further Processing	80	60	65	49	62	316
S/Bd Labourers	47	56	44	63	46	256
S/Bd Chain	35	36	41	22	20	154
S/L Yards	13	8	9	22	20	72
Pelts	1	8	12	5	4	30
Freezers	4	4	8	3	4	23
Amenities	1	9	3	3	2	18
Fitters	2	6	2	2		12
Engine Room	3	1	1	1		6
Quality Control	1	2	2	1		6
Plant Administration	3			1		4
Skin Processing	3					3
S/L Skids & Gambels	3					3
Laboratory		2		1		3
S/L Tripe	2					2
Electricians	2					2
All Depts General	1	1				2
Medical Centre				2		2
S/L Fancy Meats	1					1
Processing					1	1
Farm			1			1
Cooling Floor	1					1
Grand Total	**203**	**193**	**188**	**175**	**159**	**918**

Note. Incident frequency by department. High frequency; Medium-high frequency; Medium

Table 4.47 provides an overview of the most severe injuries recorded, referred to as recordable injuries. This category includes Lost-Time Injuries (LTIs) and Medical Treatment Injuries (MTIs). What is intriguing is that the departments with the highest recordable injury profile also demonstrate the highest incidence of injuries.

An important observation is the correlation between the severity of injuries and the department with the highest incidence. It suggests these departments may have unique risk factors or work conditions contributing to more severe incidents. Understanding the underlying causes of these injuries is crucial for developing targeted prevention measures and enhancing safety protocols within those departments.

By analysing the data in Table 4.47, we can gain valuable insights into the areas where the most severe injuries occur. This information allows us to prioritise resources, implement appropriate safety measures, and provide targeted training to mitigate the risks associated with these departments. Focusing on reducing the severity and frequency of injuries in these high-incidence departments is crucial for overall workplace safety and the well-being of employees.

Table 4.47

Nelson Seasonal LTI and MTI Injury Departments (4.59 % of All Incidents)

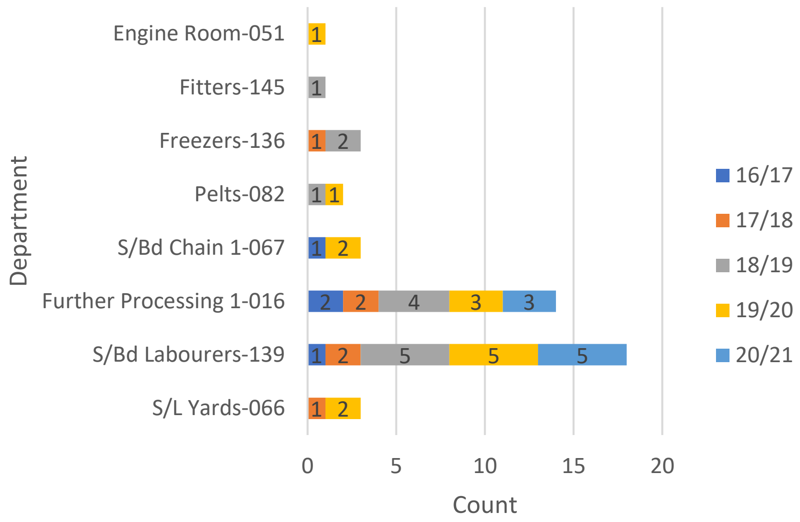
	Season					
Incident department	**16/17**	**17/18**	**18/19**	**19/20**	**20/21**	**Total**
Engine Room				1		1
Fitters			1			1
Freezers		1	2			3
Pelts			1	1		2
S/Bd Chain 1	1			2		3
Further Processing	2	2	4	3	3	14
S/Bd Labourers	1	2	5	5	5	18
S/L Yards		1		2		3
Grand Total	**4**	**6**	**13**	**14**	**8**	**45**

Figure 4.33 illustrates that the incident occurrence rates for LTIs and MTIs have remained consistent over the past three seasons in both FP1 and the S/Bd departments. Analysing these figures allows us to make informed predictions regarding the number of LTI/MTI incidents that may occur in the upcoming season.

Based on the observed trends, we can anticipate that FP1 will likely experience approximately 3-4 LTI/MTI incidents in the upcoming season. Similarly, the S/Bd department is projected to encounter around five such incidents. These projections indicate that both departments should be prioritised for safety enhancements and targeted interventions to reduce the risk of severe injuries.

Figure 4.33

Nelson Seasonal Lost Time Injuries and Medical Treatment Injuries by Department



By focusing on these departments, implementing appropriate safety measures, and providing targeted training, we can aim to mitigate potential incidents and promote a safer working environment. Allocating resources and efforts to these areas will help prevent the anticipated LTI/MTI incidents and improve overall safety outcomes.

By closely monitoring the incident rates and implementing proactive measures, we can work towards minimising severe injuries and fostering a safety culture throughout the organisation. Table 4.48 illustrates the injury ratios, calculated by dividing the reported injuries (discomforts or first aid injuries) by the lead indicators by the number of recordable injuries (LTI and MTI) considered lag indicators. This data enables us to identify departments with the highest risk of injuries. A lower ratio score indicates a higher injury risk, allowing us to estimate the number of incidents that may occur before an MTI or LTI is expected.

For instance, by examining the incident rates for FP1 in the 20/21 season in Table 4.48, we can anticipate an LTI or MTI incident for every 20.6 reported incidents. Smaller departments, such as the Engine room and the Freezers, have the highest injury risk ratios. Early reporting of discomforts and near misses can lead to better ratio scores and a reduction in the severity of the musculoskeletal injuries.

Table 4.48

Nelson Seasonal Injury Ratio – High Risk Departments

	Injury ratio					
Incident department	**16/17**	**17/18**	**18/19**	**19/20**	**20/21**	**Total**
Engine Room	3:0	1:0	1:0	1:1	0	6:1
Fitters	2:0	6:0	2:1	2:0	2:0	12:1
Freezers	4:0	4:1	4:1	3:0	4:0	7.7:1
Pelts	1:0	8:0	12:1	5:1	4:0	15:1
S/Bd Chain 1	35:1	36:0	41:0	11:1	20:0	51.3:1
Further Processing (FP1)	40:1	30:1	16.3:1	16.3:1	20.6:1	22.6:1
S/Bd Labourers	47:1	28:1	8.8:1	12.6:1	9.2:1	14.2:1
S/L Yards	13:0	8:1	9:0	11:1	20:0	24:1

Note: Shading highlights ratios that identify injury risk. Lower ratios signal greater risk. High risk; Medium risk

Over the past five seasons, the LTI or MTI ratio for the Nelson plant was 18.8:1. This suggests that, on average, for every 18.8 discomforts or first aid incidents reported, we can anticipate an LTI or MTI incident.

Table 4.49 illustrates the patterns of shift-related injuries. When examining the incident numbers based on shifts, it is essential to consider the staffing levels and the overall count of workers during each shift. Factors such as the condition and size of the livestock processed during different shifts could influence incident numbers.

Table 4.49

Nelson Incidents by Shift

Incidents by shift	Number of incidents
Day	582
Late	1
Night	331
Rotating	3
Split	1
Grand Total	**918**

When examining the injuries by task (refer to Table H53 in Appendix F for a complete list of all injury-causing tasks), one can identify high-risk tasks and further investigate the reasons behind the higher injury rates. Focusing on various aspects such as task assessments, workstation design, work organisation, work postures, quality training, and the potential lack of training becomes crucial. Table 4.50 shows the top 58.7% (all tasks with more than 15 incidents) of injury-causing tasks at the Nelson Plant. Addressing these areas will be essential in mitigating the risks associated with the identified high-risk tasks.

Table 4.50

Nelson Top Injury Causing Seasonal Incidents by Task Description

	Season					
Task description	**16/17**	**17/18**	**18/19**	**19/20**	**20/21**	**Total**
Amenities		10	3	2	3	18
Boning	14	12	11	3	6	46
Cartons	2	8	3	3	4	20
Chillers	1	6	6	5	3	21
Cleaning	21	8	10	19	9	67
Detain	2	4	3	6	2	17
Halal Slaughtering	3	4	7	7	4	25
Offal	6	4	8	10	12	40
Packing	11	10	16	12	14	63
Packing B/Pack	5	1	1	1	8	16
Rip Down	1	10	6	5	2	24
Sawyer	3	2	5	13	4	27
Shepherding	9	5	6	22	12	54
Skins	2	1	3	8	2	16
Supervising	1	5	11	4	5	26
Trimming	9	5	4			18
Y-Cut	9	6	12	5	8	40
Grand Total	**99**	**101**	**115**	**125**	**98**	**538**

Note. Top seasonal injury tasks. High frequency; Medium-high frequency

A comprehensive analysis of injuries categorized by task makes it possible to identify the top 10 high-risk tasks, which account for almost half (49%) of all injury-causing tasks, as depicted in Figure 4.34. By delving deeper into the factors contributing to the elevated injury rates, valuable insights can be gained to inform targeted safety interventions.

Attention and improvement are required in several key areas to effectively address and mitigate the risks associated with these high-risk tasks.

Firstly, thorough task assessments are essential to identifying potential hazards and developing appropriate preventive measures. This includes evaluating the physical demands of the tasks, identifying ergonomic risks, and considering factors such as repetitive movements or heavy lifting.

Secondly, workstation design is crucial in minimising the risk of injuries. Ensuring ergonomic principles are applied, such as adjustable equipment and correct work posture, can significantly reduce strain and discomfort for workers.

Thirdly, work organisation should be examined to identify any aspects contributing to increased injury rates. This involves evaluating workload distribution, task sequencing, and breaks to ensure they align with ergonomic principles and allow for adequate rest and recovery.

Work postures also merit attention, as incorrect or sustained awkward postures can lead to musculoskeletal issues. Providing training and guidance on correct body mechanics and encouraging regular stretching and movement breaks can help reduce the risk of injuries.

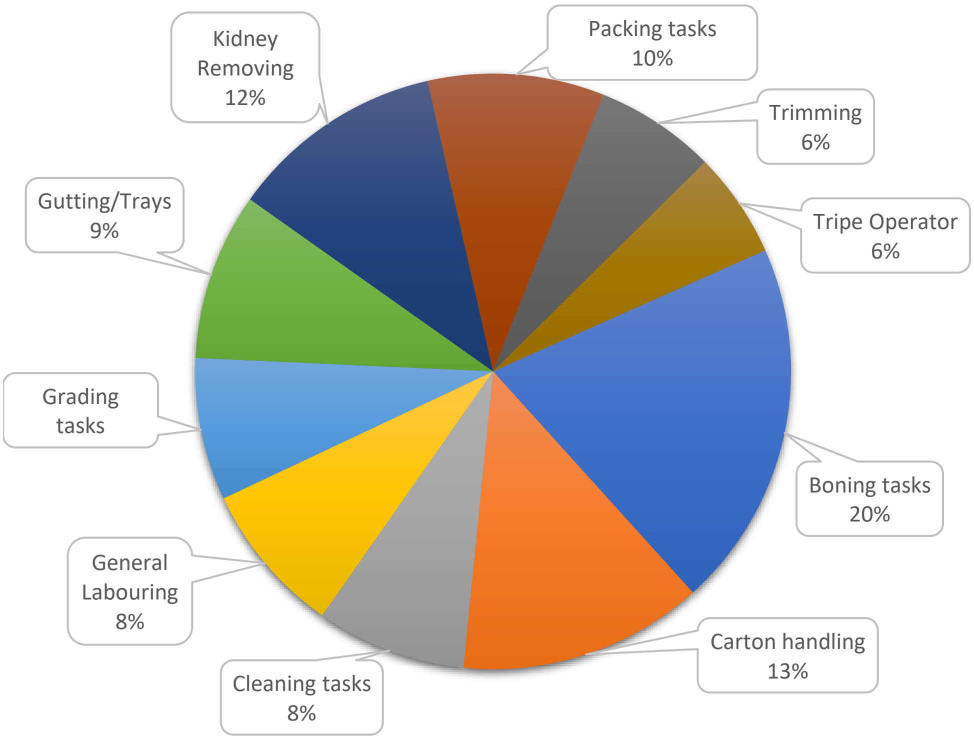
Quality training is essential for equipping workers with the necessary skills and knowledge to perform their tasks safely. Ensuring comprehensive training programs, including specific task-related training, can significantly enhance safety outcomes.

Lastly, the potential lack of training should be addressed to ensure all employees receive the necessary education and guidance to perform their tasks safely. This includes identifying gaps in training programs and implementing measures to fill those gaps effectively.

Focusing on these areas can help organisations proactively mitigate the risks associated with high-risk tasks and enhance overall workplace safety. A holistic approach encompassing task assessments, workstation design, work organisation, work postures, quality training, and addressing potential training gaps can effectively manage the identified high-risk tasks.

Figure 4.34

Nelson Plant Top 10 (49%) Injury Causing Tasks



4.7.2 Categorization of Nelson MSD Injuries: Unveiling Meaningful Patterns and Frequency Trends

When examining the proportion of incidents related to musculoskeletal injuries (as shown in Table 4.51 and Figure 4.35), it becomes evident that a significant amount of time and resources should be allocated to improving these factors. Several compounding factors must be considered, including plant and equipment design, tally requirements, work organisation, and employee attributes such as an ageing workforce, fatigue, physical and mental well-being, and poor health habits. Understanding these factors provides valuable insights into the type of initiatives or projects the company should invest in to address and improve the situation.

Table 4.51

Nelson Plant Seasonal Musculoskeletal Injuries (71% of Incidents)

	Season					
Injury type	**16/17**	**17/18**	**18/19**	**19/20**	**20/21**	**Total**
Discomfort	117	88	99	84	78	466
First Aid Injury	12	38	35	32	38	155
Lost Time Injury (LTI)	2	1	5	1	3	12
Medical Treatment Injury (MTI)		1	3	7	3	14
Grand Total	**131**	**128**	**142**	**124**	**122**	**647**

Note. There has been a consistent downward trend in the total number of incidents for all Musculoskeletal Injuries over the past three seasons.

Figure 4.35

Nelson Plant Seasonal Musculoskeletal Injuries (71% of Incidents)

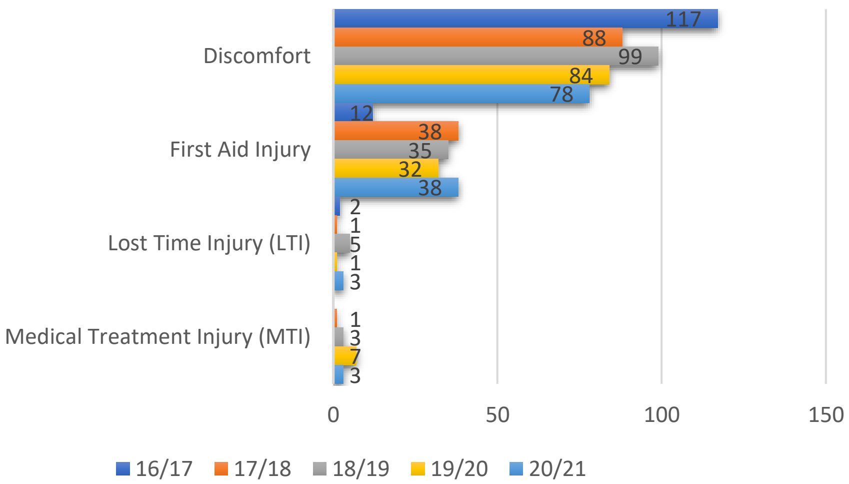


Table 4.52 highlights the top injury-causing tasks, specifically those with more than 15 incidents.

Table 4.52

Nelson Top Musculoskeletal Injury Tasks and Employee Work Experience

	Work Experience						
Task description	**First Week**	**First Month**	**1-6 Months**	**6 Months to 1 Year**	**1-5 Years**	**Over Five Years**	**Total**
Amenities			1	1	4	12	18
Boning		5	8	3	9	21	46
Cartons		3	3		7	7	20
Chillers		2	2	1	7	9	21
Cleaning	1	5	13	7	14	27	67
Detain		1		1	5	10	17
Halal Slaughtering		1		1	4	19	25
Offal	5	4	7	5	11	8	40
Packing	2	4	11	5	12	29	63
Packing B/Pack			3	1	4	8	16
Rip Down			3	1	6	14	24
Sawyer				1	8	18	27
Shepherding	2	12	7	5	14	14	54
Skins	2		3	1	10		16
Supervising						26	26
Trimming	1	1	2	3	7	4	18
Y-Cut			3		12	25	40
Grand Total	**13**	**38**	**63**	**36**	**122**	**226**	**498**

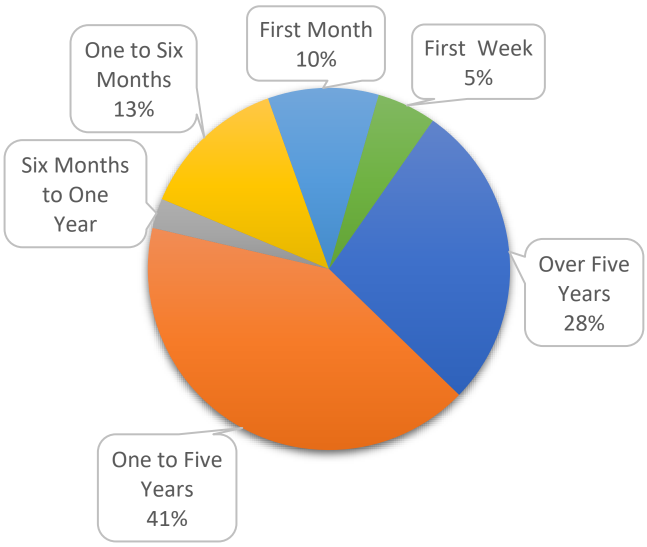
Note. Musculoskeletal injury causing task frequency. High frequency; Medium-high frequency; Medium

The risk of musculoskeletal injuries increases as individuals gain more experience, indicating that effectively managing workload and incorporating adequate recovery time can be crucial in reducing the occurrence of such injuries.

When analysing experience in relation to tasks and incidents (as shown in Table 4.52 and Figure 4.36), the data can be examined from three perspectives. First, we can explore the impact of ageing on injury rates for physical tasks, assuming that older individuals have more experience. Second, we can determine the duration required to become proficient at a task. Lastly, we can identify the physically demanding tasks. This information is valuable for determining new and existing employees' placement and training needs. Additionally, it is essential to compare the number of staff across different experience categories to gain further insights.

Figure 4.36

Nelson Plant Seasonal Musculoskeletal Injuries Proportioned to Years of Experience



When examining the body locations of musculoskeletal injuries (as depicted in Table 4.53 and Figure 4.37), it becomes apparent that certain areas are at a higher risk, namely the upper limbs (from hand to shoulder) and various neck and spine areas.

Table 4.53

Nelson Plant Musculoskeletal Injuries by Body Location

Body location	Number of injuries
Abdomen	8
Ankle	55
Arm	157
Back	189
Back - Lumbar	246
Back - Sacrum	7
Back - Thoracic	86
Buttocks	5
Chest	16
Elbow	187
Fingers	90
Foot	55
Forearm	164
Groin	14
Hand	211
Hip	15
Knee	136
Lower Limb	21
Neck	166
Ribs	10
Shoulder	651
Thumb	146
Toe	3
Trunk	6
Upper Leg	12
Wrist	492
Grand Total	**2656**

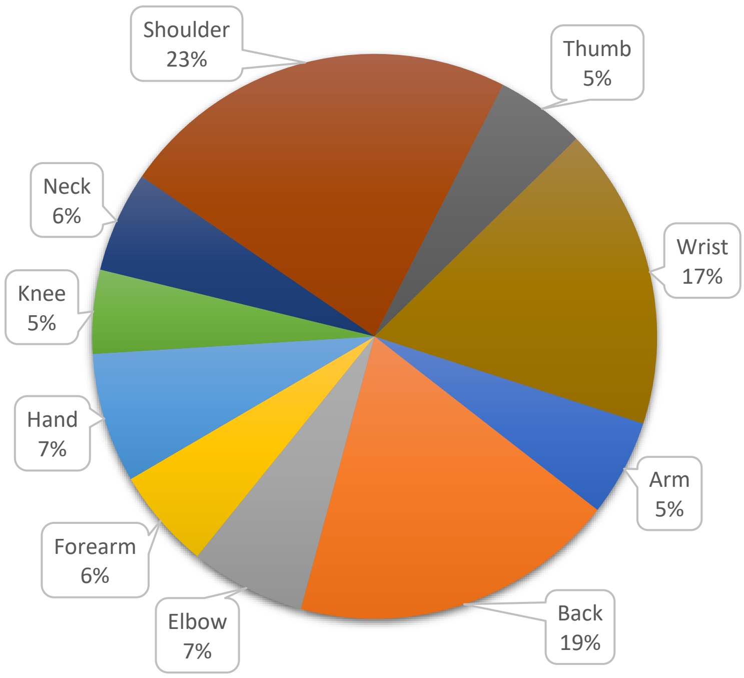
Note. Musculoskeletal injuries by body location. High frequency; Medium-high frequency; Medium.

Protecting these areas is crucial in reducing the risk of musculoskeletal injuries. Several strategies can be implemented to achieve this objective.

Firstly, ergonomic devices and workstation designs can be employed to minimise musculoskeletal strain on these vulnerable body locations. Secondly, work organisation and rotations can be implemented to limit or reduce the loading in these areas. Additionally, careful consideration should be given to selecting employees for roles where they may be at risk, particularly if they have any predisposing musculoskeletal conditions. Work-hardening programs can be implemented for at-risk employees to enhance their physical abilities, including targeted programs during the pre-season, off-season, and in-season periods. Implementing targeted stretching protocols can also be beneficial.

Figure 4.37

Nelson Plant Top 10 MS Injury Locations



In addition, it is crucial to consider the need for additional staffing in high-risk areas when there is an increase in tallies or workloads or when high levels of absenteeism are prevalent. This proactive measure ensures adequate support and a workforce to handle physically demanding tasks without overburdening individual workers.

Moreover, incorporating a seasonal lead-in time for physically demanding tasks is essential. Allowing sufficient time for workers to adjust and gradually ramp up their physical efforts can minimise the risk of musculoskeletal injuries. It allows the body to adapt and build up endurance, reducing the likelihood of strain or overexertion.

Furthermore, planning for overtime work and extended hours is crucial. When the demand necessitates longer working hours, it is essential to ensure that appropriate breaks, rest periods, and recovery time are factored into the schedule. This prevents excessive fatigue and allows workers to recuperate, reducing the risk of musculoskeletal injuries associated with extended work periods.

By considering these factors and implementing effective workforce management strategies, the risk of musculoskeletal injuries can be managed more effectively. It enables organisations to maintain a healthy and safe working environment while optimising productivity and minimising the adverse impact on workers' well-being.

4.8 Review of AGL Pukeuri plant injury data over the past five seasons

Pukeuri, located north of Oamaru, is the second largest plant within the Alliance group. Currently, the plant processes lamb, sheep, and cattle, and during the peak season, it employs approximately 900 individuals (Ryan, 2021). The data range for Pukeuri spans from 1 October 2016 to 11 August 2021, encompassing 4,385 recorded incidents.

4.8.1 Categorisation of all Pukeuri Injuries: Unveiling Meaningful Patterns and Frequency Trends

Table 4.54 provides a comprehensive overview of the incidents categorised by injury type at the Pukeuri plant over a five-season span. Among the various injury types recorded, discomfort represents the largest category, comprising 2,888 incidents within the specified timeframe.

The significant number of discomfort incidents highlights the importance of addressing and managing factors contributing to employee discomfort. These factors may include ergonomic issues, repetitive motions, prolonged periods of standing or sitting, and other work-related factors that impact the well-being and comfort of the workforce.

Understanding the high incidence of discomfort incidents allows the organisation to focus on implementing targeted measures to reduce their occurrence. This may involve conducting ergonomic assessments, introducing ergonomic equipment or workstation modifications, providing employee training on best body mechanics and posture, and encouraging regular breaks and stretching exercises.

Table 4.54

Pukeuri Plant Seasonal Incidents by Injury Type

	Season					
Injury type	**16/17**	**17/18**	**18/19**	**19/20**	**20/21**	**Total**
Aches/pain - gradual	17	3	2	1	1	24
Aches/pain - specific	42	6	2	5	4	59
Bone Scratch	5	7	9	6	6	33
Bruising/Crushing	23	32	42	51	35	183
Burns	13	4	15	5	3	40
Burns - Chemical	11	13	9	7		40
Burns - Scald	14	19	11	6	10	60
Digestive Disease	3	1	7	6	2	19
Discomfort	548	697	624	592	427	2888
Dislocation	2	1	1			4
Foreign Body	36	22	5	25	10	98
Fracture or Spine					1	1
Head Injury	5	1	3	4	1	14
Industrial Deafness		4	1	1	1	7
Infection	5	5	5	2		17
Infectious/Parasitic Disease	3	10	3	3	2	21
Inhalation	5			3	2	10
Laceration - Dressing Only	59	78	58	52	30	277
Laceration - Referral - GP/Hosp	2	4	5	17	8	36
Laceration - Steri Strips	47	34	23	19	6	129
Laceration - Sutures	8	4	1	1	2	16
Mental Disorder				1		1
Multiple	2		2	2		6
Near Miss	3	1	2	5	4	15
Occupational Overuse Syndrome				1	1	2
Open Wound	3	8	43	3	2	59
Other	1	6	4	5	3	19
Puncture Wound	1	4	1	3	2	11
Skin Disease	6	3	5	1		15
Sprain/Strain	3	37	84	91	46	261
Superficial	4	10	2	3	1	20
Grand Total	**871**	**1014**	**969**	**921**	**610**	**4385**

Note. Seasonal incidents by injury type. High frequency; Medium-high frequency; Medium.

After analysing various types of incidents, it is clear that several types are responsible for most injuries. These include bruising/crushing, burns, lacerations, sprains and strains, specific aches and pains, and injuries caused by exposure to foreign objects. These incident types account for a significant portion of the overall recorded injuries. By prioritising initiatives to address and mitigate the most prevalent incidents, the organisation can enhance employee well-being, improve productivity, and create a safer and more comfortable working environment. Additionally, monitoring the trends and ongoing evaluation of the effectiveness of implemented measures will help ensure sustained improvement in reducing discomfort incidents over time.

Figure 4.38 and Table 4.55 highlight the top ten injury departments that collectively account for 84% of the injuries at the Pukeuri plant. Notably, the ovine Slaughterboard department, followed by the ovine Further Processing department, experiences the highest number of injuries at the site. These two departments play a significant role in contributing to the overall injury incidents recorded and, hence, will be a good starting point for implementing injury prevention strategies.

Figure 4.38

Pukeuri Plant Top 10 Injury Departments

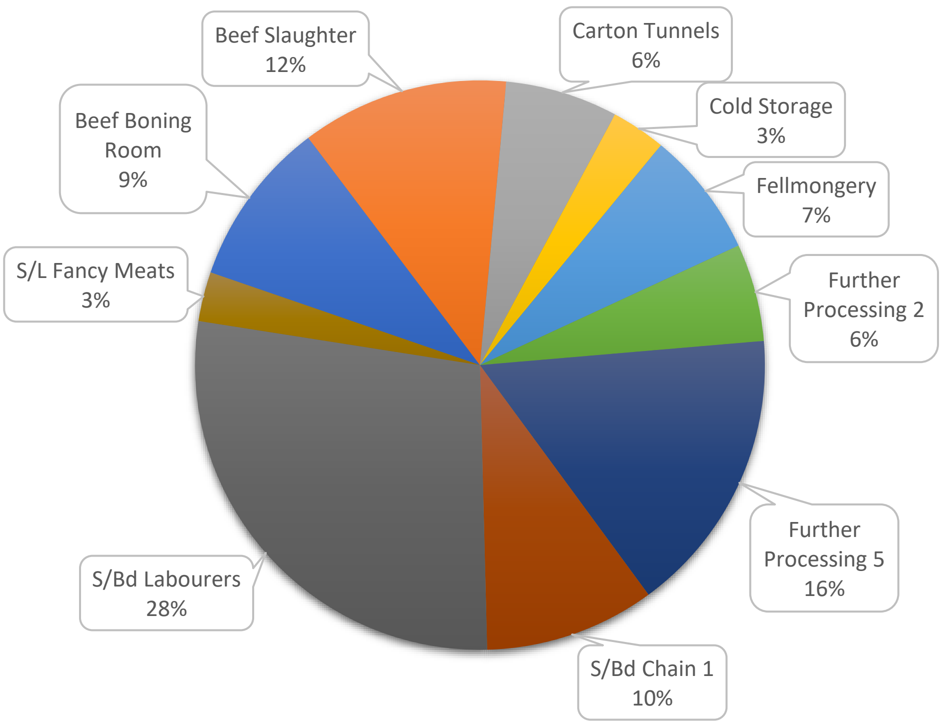


Table 4.55

Pukeuri Plant Top 10 Injury Departments

Injury Department	Number of incidents
Beef Boning Room	347
Beef Slaughter	427
Carton Tunnels	242
Cold Storage	116
Fellmongery	262
Further Processing 2	207
Further Processing 5	598
S/Bd Chain	357
S/Bd Labourers	1034
S/L Fancy Meats	102
Grand Total	**3692**

By classifying injuries according to their types, valuable insights can be obtained regarding patterns and trends in their frequency. Such insights can be derived from the information provided in Table 4.55. One notable observation is the decline in discomfort reports, which can prove beneficial if it correlates with a decrease in the severity of incidents. The severity of incidents can be reduced when a decrease in both LTI and MTI occurs. Unfortunately, this was not the case for the 19/20 season. However, this positive trend was actual for the 20/21 season. A notable area of concern is the relatively low number of recorded near misses in the database. This raises potential issues related to resource allocation or prioritisation within the organisation rather than being solely attributed to a lack of reporting. Investigating and evaluating whether safety resources are appropriately allocated and if safety priorities align with organisational goals is important.

Additionally, the effectiveness of safety interactions within the organisation should be examined. The low count of reported near misses may indicate a need for improvement in safety communication, engagement, and reporting channels. Encouraging employees to report near misses and fostering a culture of open communication about potential hazards can lead to a more comprehensive understanding of workplace risks.

These concerns emphasise specific areas that require attention and further investigation. By addressing resource allocation, prioritisation, and the effectiveness of safety interactions, the organisation can ensure the efficacy of safety measures and promote the overall well-being of employees. This comprehensive approach will help identify and address potential hazards and improve the organisation's safety performance.

Table 4.56

Pukeuri Plant Five Season Incidents by Classification

	Season					
Injury classification	**16/17**	**17/18**	**18/19**	**19/20**	**20/21**	**Total**
Discomfort	548	697	624	592	427	2888
First Aid Injury	282	278	302	223	143	1228
Lost Time Injury (LTI)	29	29	30	64	21	173
Medical Treatment Injury (MTI)	9	9	9	34	11	72
Near Miss	3	1	4	8	8	24
Grand Total	**871**	**1014**	**969**	**921**	**610**	**4385**

When analysing all incidents by type, as shown in Table 4.57, it becomes clear which injury types should be the primary focus. The most prevalent incident types include discomforts, sprains and strains, aches and pains, lacerations, burns, bruising, and crushing. Understanding this information enables the identification of the proportion of safety resources that should be allocated towards preventing these prevalent incidents. This prioritisation ensures that efforts and resources are appropriately directed to address the most frequent and impactful injury types, thereby maximising the effectiveness of safety initiatives. The availability of shift incident data, as presented in Table 4.58, can offer valuable insights into potential discrepancies between shifts, especially when comparing comparable shift metrics. Analysing this data can reveal differences in attitudes, staff experience, training variations, and other factors that may contribute to variations in incident rates between shifts.

However, it is crucial to acknowledge that the dataset encompasses numerous variables, making it challenging to draw definitive and reliable conclusions solely based on this data. Additional factors such as work environment, task allocation, and individual characteristics may influence incident rates but are not captured in the dataset.

Table 4.57

Pukeuri Plant All Incidents by Type

Incident type	Number of incidents
Aches/pain - gradual	24
Aches/pain - specific	59
Bone Scratch	33
Bruising/Crushing	183
Burns	40
Burns - Chemical	40
Burns - Scald	60
Digestive Disease	19
Discomfort	2888
Dislocation	4
Foreign Body	98
Fracture or Spine	1
Head Injury	14
Industrial Deafness	7
Infection	17
Infectious/Parasitic Disease	21
Inhalation	10
Laceration - Dressing Only	277
Laceration - Referral - GP/Hosp	36
Laceration – Steri-strips	129
Laceration - Sutures	16
Mental Disorder	1
Multiple	6
Near Miss	15
Occupational Overuse Syndrome	2
Open Wound	59
Other	19
Puncture Wound	11
Skin Disease	15
Sprain/Strain	261
Superficial	20
Grand Total	**4385**

Note. All incidents frequency by type. High frequency; Medium-high frequency; Medium.

It is essential to consider a broader range of data sources and conduct a more in-depth analysis to understand the factors influencing incident rates between shifts. This may include examining qualitative feedback from employees, conducting interviews or surveys, and considering other relevant contextual information.

By incorporating multiple data points and adopting a holistic approach, organisations can better identify potential disparities between shifts and develop targeted strategies to address them effectively. This comprehensive analysis ensures that conclusions are robust and can guide informed decision-making to improve overall safety performance.

Table 4.58

Pukeuri Plant Incidents by Shift

Incidents by shift	Number of incidents
Day	3185
Late	231
Night	792
Rotating	61
Split	116
Grand Total	**4385**

Examining all incidents based on tasks, as presented in Table I62 in Appendix I, makes it evident which tasks should be prioritised in injury prevention strategies. The highlighted tasks, such as Boning, Cartons, Kidney enucleator, Gutting, Detain, and Packing tasks, emerge as the most prevalent causes of injuries. It is important to note that an employee's skill level, such as Beef Slaughter A grade, or role description, like Broomie, is often used as their task description. However, this creates a gap in the injury data, as it fails to identify the specific task performed by an employee when they were injured. To accurately determine the primary areas that require focused efforts for injury prevention, it is crucial to have reliable injury data.

Figure 4.39 and Table 4.59 highlight the top 10 tasks responsible for causing injuries, collectively accounting for 51% of the reported injuries. Boning tasks (20%) and Carton handling are the top injury-causing tasks performed at Pukeuri. This data provides valuable insights into the specific tasks that require immediate attention to enhance safety measures and minimise the occurrence of injuries. By targeting these high-risk tasks, organisations can prioritise resources and implement preventive measures to address the root causes of injuries effectively.

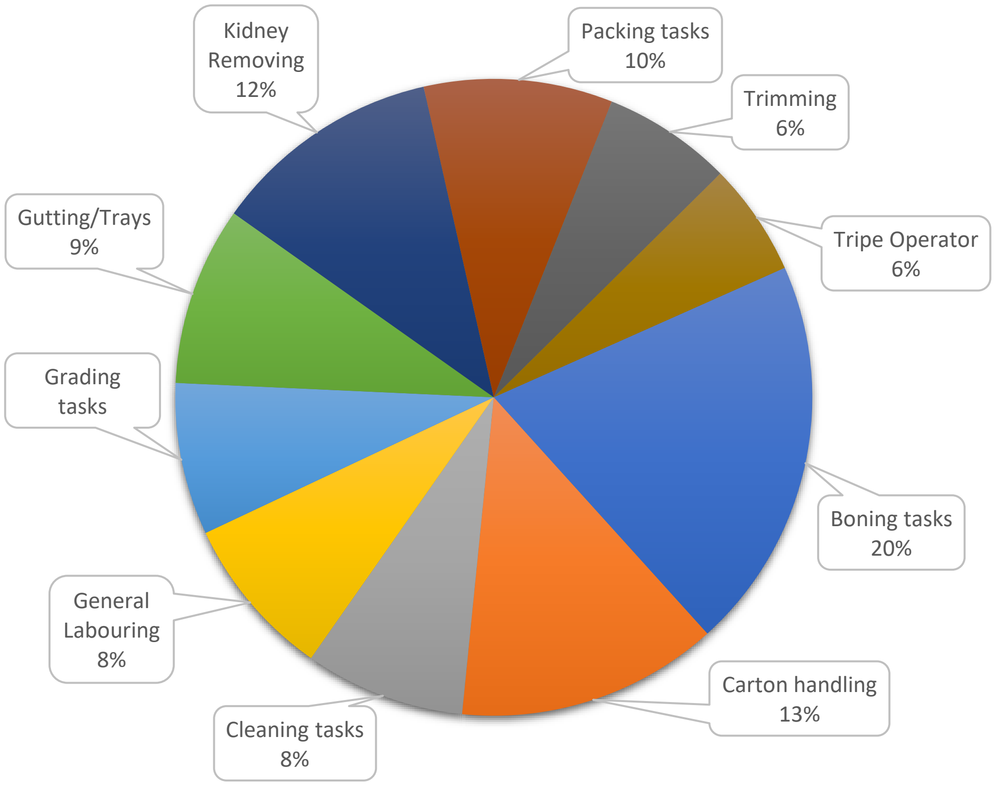
Table 4.59

Pukeuri Plant Top 10 Injury Tasks (51% Of Incidents)

Task	Number of incidents
Boning tasks	442
Carton handling	294
Cleaning tasks	180
General Labouring	183
Grading tasks	171
Gutting/Trays	201
Kidney Removing	258
Packing tasks	212
Trimming	145
Tripe Operator	127
Grand Total	**2213**

Figure 4.39

Pukeuri Plant Top 10 Injury Causing Tasks by Proportion



4.8.2 Categorisation of Pukeuri MSD Injuries: Unveiling Meaningful Patterns and Frequency Trends

Upon analysing the proportion of incidents related to musculoskeletal injuries, which account for 72% of all incidents, as observed in Table 4.60, it becomes evident that a significant allocation of time and resources is necessary to address the underlying factors contributing to these injuries. Several compounding factors must be considered, including plant and equipment design, tally requirements, work organisation, employee attributes such as an ageing workforce, fatigue, physical and mental well-being, and poor health habits. Understanding these factors will provide valuable insights into the type of initiatives or projects the company should invest in. It is worth noting that although the overall data shows a downward trend, it is equally important to recognise the seasonal increases in more severe injuries (such as sprains and strains and specific aches and pains) during the 2018/2019 and 2019/2020 seasons. Answering the causes behind these increases will be invaluable in determining prevention strategies and focus areas.

Table 4.60

Pukeuri Seasonal Musculoskeletal Injuries (72% Of Incidents)

	Season					
Injury	**16/17**	**17/18**	**18/19**	**19/20**	**20/21**	**Total**
Aches/pain - gradual	17	3	2	1	1	24
Aches/pain - specific	41	6	2	4	4	57
Discomfort	521	680	611	585	414	2811
Occupational Overuse Syndrome				1	1	2
Sprain/Strain	3	37	82	90	42	254
Grand Total	**582**	**726**	**697**	**681**	**462**	**3148**

Table I63 in Appendix I provides a comprehensive list of all musculoskeletal injury-causing tasks categorised by different experience levels. By examining the data from both experience levels, as presented in Table 4.61 and Figure 4.40, in relation to the tasks associated with incidents, multiple perspectives can be considered. The list of top 20 musculoskeletal injury-causing tasks at the Pukeuri plant includes familiar tasks such as Boning, Carton handling, Packing, and General labouring tasks, which have also been observed at other plants.

An interesting observation can be made when comparing the injured tasks with different experience levels. There is a consistent increase in injuries during the first six months, likely influenced by the initial learning curve and adjustment period for new employees. Following this period, the injury rates stabilise, potentially due to the completion of the first season and increased familiarity with the tasks.

However, a significant spike in injury occurrence rates is observed over the next five years among employees with more experience. This could be attributed to various factors, including complacency, repetitive strain, or accumulated wear and tear on the body. It is worth noting that the injury rates subsequently decrease by approximately 50% among the most experienced employees, potentially indicating a heightened awareness of safety measures and improved skill in task execution.

These insights highlight the importance of targeted interventions and training programs for employees at different experience levels. Implementing measures to address the initial learning phase and providing ongoing support and education to experienced workers can reduce musculoskeletal injuries. By understanding the patterns and trends associated with different experience levels, organisations can proactively prioritise resources and develop strategies to promote a safer work environment and minimise the risk of injuries.

Analysing the intersection of experience levels and the tasks linked to incidents allows a deeper understanding of the factors contributing to musculoskeletal injuries. It offers insights into the tasks that may pose higher risks for individuals with different experience levels. Considering these perspectives enables the organisation to develop targeted injury prevention and risk mitigation strategies.

Firstly, one can assess the impact of ageing on injury rates for physically demanding tasks, assuming that older individuals have more experience. Secondly, analysing the time required to achieve proficiency in a task is valuable. This analysis helps identify physically demanding tasks such as Boning, Grading, Carton handling, and enucleating kidneys. Such insights assist in determining appropriate placement and training requirements for new and existing employees. Thirdly, one can examine the varying incidents per task across different experience levels. Lastly, comparing the number of staff across different experience categories is essential. This comparison provides valuable insights into the distribution of experience levels within the workforce, enabling informed decision-making.

By tailoring interventions and training programs based on the tasks and the experience levels involved, organisations can address the unique challenges and vulnerabilities associated with specific tasks and experience levels.

This comprehensive approach, considering both experience levels and the tasks associated with incidents, helps to ensure the development of effective and customised injury prevention initiatives. It fosters a safer working environment while minimising the risk of musculoskeletal injuries across different levels of experience within the organisation.

Figure 4.40

Pukeuri Plant MS Injuries by Years of Experience

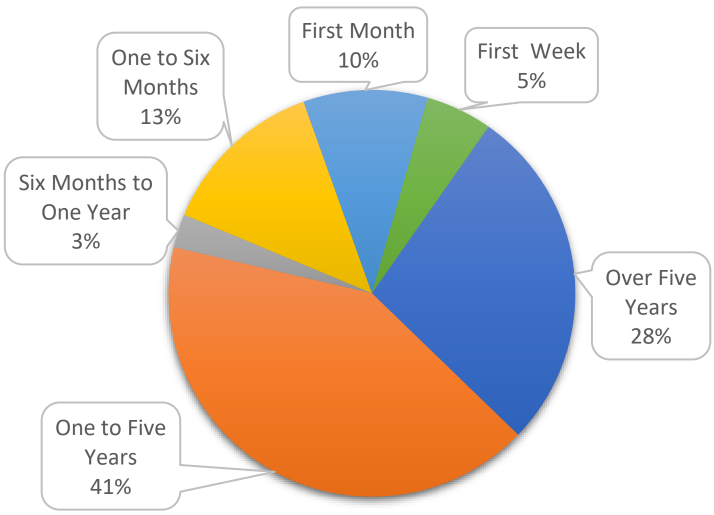


Table 4.61

Pukeuri Top 20 Musculoskeletal Injury Causing Task Occurrence Across Experience Levels

Tasks	Experience						
	First Week	First Month	1-6 Months	6 Months to 1 Year	1-5 Years	Over 5 Years	Total
Boning	10	26	40	9	163	96	344
Cartons	13	11	23	2	101	42	192
Packing	9	6	18	5	76	51	165
General Labouring	7	18	20	9	72	20	146
Kidney Enucleator	21	46	25	5	37	5	139
Tripe Operator	6	16	24	5	28	28	107
Trimming	5	6	9	2	49	29	100
Detain	6	3	8	2	47	25	91
Graders	2	9	13	1	45	17	87
Gutting	4	7	7	1	35	24	78
Gut Trays	10	14	13	1	21	16	75
Skins	2	3	7	1	31	29	73
Cleaning	4	4	6	1	33	17	65
Carton Tunnel	1	3	5		32	15	56
Butcher	1	3	5	1	22	21	53
Sawyer	1	3	3		25	18	50
Stringing	5	12	18	3	11		49
Kidney Pulling	5	17	8	1	13	3	47
Y-Cut	2	3	4	4	16	18	47
Chair and Shackle	3	11	16	3	10	2	45
Cooling Floor Grader		2	4	1	27	10	44
Grand Total	**117**	**223**	**276**	**57**	**894**	**486**	**2053**

Note. Top Musculoskeletal injury frequency across experience levels. High frequency; Medium-high frequency; Medium.

When analysing the body location of musculoskeletal injuries, as indicated in Table 4.62 and Figure 4.41, it becomes evident that the upper limbs (from hand to shoulder) and the spine are at the highest risk. Therefore, prioritising protecting these areas is crucial in mitigating the risk of musculoskeletal injuries. Several measures can be implemented to achieve this goal. Firstly, ergonomic devices should be introduced, and workstations should be designed to minimise musculoskeletal strain on these specific body locations. Secondly, optimising work organisation and rotations can help minimise or alleviate the loading on these vulnerable areas. Additionally, careful consideration should be given to selecting employees for roles that pose a risk to these body locations, particularly if individuals have any pre-existing musculoskeletal conditions.

Table 4.62

Pukeuri plant musculoskeletal injuries by body location

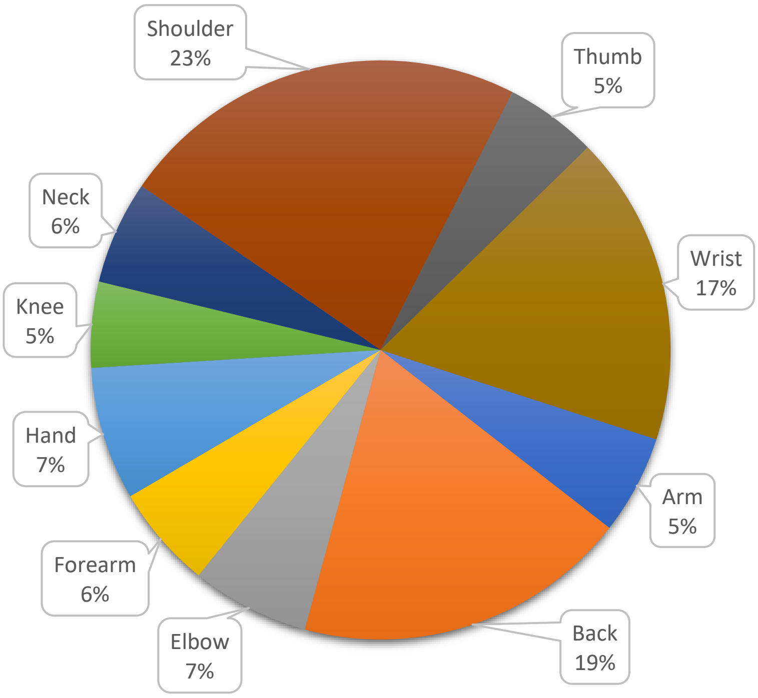
Body location	Number of injuries
Abdomen	8
Ankle	55
Arm	157
Back	189
Back - Lumbar	246
Back - Sacrum	7
Back - Thoracic	86
Buttocks	5
Chest	16
Elbow	187
Fingers	90
Foot	55
Forearm	164
Groin	14
Hand	211
Hip	15
Knee	136
Lower Limb	21
Neck	166
Ribs	10
Shoulder	651
Thumb	146
Toe	3
Trunk	6
Upper Leg	12
Wrist	492
Grand Total	**3148**

Note. Musculoskeletal injuries by body location. High frequency; Medium-high frequency; Medium.

The analysis of the Pukeuri plant data reveals similar trends to other plants, where specific tasks and body parts are prone to injuries. Notable variations in injury rates in selected tasks can provide insights into areas that may benefit from improved design or enhanced employee training. This offers an opportunity to explore potential injury prevention initiatives. Firstly, implementing ergonomic devices and workstation designs can help minimise musculoskeletal strain on vulnerable body locations.

Figure 4.41

Pukeuri Plant Top 10 Musculoskeletal Injury Locations



Firstly, implementing ergonomic devices and workstation designs can help minimise musculoskeletal strain on vulnerable body locations. Secondly, organising work and rotations to reduce loading in these areas can be effective. Additionally, careful consideration should be given to selecting employees for roles that may pose risks, particularly if they have pre-existing musculoskeletal conditions. Work-hardening programs can be introduced for at-risk individuals to improve their physical capabilities, including targeted programs during pre-season, off-season, and in-season periods. Furthermore, the implementation of specific stretching protocols can yield additional benefits in the prevention of musculoskeletal injuries. It is also crucial to consider the necessity for additional staffing in high-risk areas when workloads increase. Allowing for a seasonal lead-in time for physically demanding tasks and ensuring adequate planning for overtime work and extended hours, when required, are vital factors in effectively managing the risk of musculoskeletal injuries.

4.9 Review of AGL Smithfield plant five season injury data

The Alliance Smithfield Plant, situated in Timaru on the South Island of New Zealand, specialises in the processing of sheep and deer. The plant operates for 11 months of the year and, during its peak season, employs around 500 individuals (Alliance Group, 2023). Within the 5-season Smithfield database, a total of 1795 injuries were recorded. These injuries span across various categories, as displayed in Table 4.63.

4.9.1 Categorization of all Smithfield Injuries: Unveiling Meaningful Patterns and Frequency Trends

By classifying injury severity and type, it becomes possible to identify trends and distinguish between lead and lag indicators. Analysing the data patterns enables the identification of problematic areas and sheds light on opportunities to improve safety outcomes and reduce the risk of injuries. Notably, all injury categories exhibit a declining trend.

An area of concern is the relatively low number of reported near misses in the database. This could indicate issues related to resources or priorities rather than a lack of reporting. It is also plausible that difficulties accessing reporting avenues contribute to the low count. Additionally, it is essential to consider the potential correlation between the number of safety interactions completed and the reported injuries and near misses.

Table 4.63

Smithfield Seasonal Incidents by Classification

	Season					
Injury Classification	**16/17**	**17/18**	**18/19**	**19/20**	**20/21**	**Total**
Discomfort	54	188	143	141	79	605
First Aid Injury	254	206	230	228	170	1088
Lost Time Injury (LTI)	18	21	19	10	8	76
Medical Treatment Injury (MTI)	13	3	2	4	3	25
Near Miss	1					1
Grand Total	**340**	**418**	**394**	**383**	**260**	**1795**

Additionally, it is possible that the reporting of near misses may be linked to safety interaction reporting in a separate database, thereby impacting the recorded figures.

Tables 4.64 and 4.65 (by department) show the breakdown of the seasonal injuries for the Smithfield plant.

Table 4.64

Seasonal injuries for the Smithfield plant

Season	Number of injuries
16/17	340
17/18	418
18/19	394
19/20	383
20/21	260
Total injury count	**1795**

Notably, the number of injuries has consistently decreased since the 17/18 season. Exploring these trends further during the Health and Safety Focus Group discussion will provide valuable insights and generate interest in understanding the contributing factors.

It is encouraging to observe a downward trend across all areas. Another crucial aspect is the ratio of injury numbers to the number of employees in the highlighted departments. The significantly higher injury rates observed in the relatively smaller Fancy Meats department warrant a closer examination to identify potential causes for this occurrence.

Among the injury departments, the top ten highlighted in Figure 65 account for 83.2% of all reported injuries, with the Ovine slaughter board department reporting the highest number of incidents. Labouring tasks within the slaughter board department contribute to 24% of all injuries recorded.

Table 4.65

Smithfield 5 Season Incidents by Department

Incident Department	Season 16/17	17/18	18/19	19/20	20/21	Total
Amenities	8	6	10	1	1	26
Bag Room	2	2	3		1	8
Bobby Calves Slaughter					1	1
Carpenters	1	1	2		3	7
Carton Tunnels	4	4	5	7	1	21
Cold Storage	20	36	28	29	15	128
Company Meat Inspectors	19	21	30	26	12	108
Cooling Floor	6	8	7	14	6	41
Electricians	3	1		1	2	7
Engine Room	1	2	1	1	1	6
Fitters	6	4	4	5	5	24
Further Processing 1	51	60	51	56	39	257
Further Processing 2	20	38	24	22	13	117
Further Processing 4	1	3	2	6	1	13
Graders	2	1	1	2	1	7
Gut shed	1	2	1	2	3	9
Laboratory	1	1		1		3
Laundry	2	2		1		5
Main Store	1	1		2	1	5
Maintenance Admin	3		1		1	5
Medical Centre	1		1			2
Packaging Store	1		1		1	3
People and Safety		1				1
Plant Services-Yard Gang	6	7	9	6	4	32
Plumbers	1	1	2	1	2	7
Quality Control	1			3	2	6
Rendering	4	2	7	4	3	20
S/Bd Chain 1	27	34	35	30	22	148
S/Bd Chain 2	2	3	1			6
S/Bd Labourers	82	86	77	67	44	356
S/L Fancy Meats	21	31	40	37	27	156
S/L Tripe	3	8	8	3	3	25
S/L Yards	10	11	12	10	7	50
Skin Processing	2	5	2	3		12
Venison Boning	12	24	12	25	21	94
Venison Slaughter	15	12	17	18	17	79
Grand Total	**340**	**418**	**394**	**383**	**260**	**1795**

Note. Seasonal incidents by department. High frequency; Medium-high frequency; Medium.

The top ten injury departments (Figure 4.42) represent 83.2 % of all injury departments, with the Ovine slaughter board reporting the most incidents. The labouring tasks on the slaughter board accounted for 24% of all injuries. Examining which tasks expose employees to the most injury risk is essential.

Figure 4.42

Smithfield Top 10 Injury Departments (83.2%)

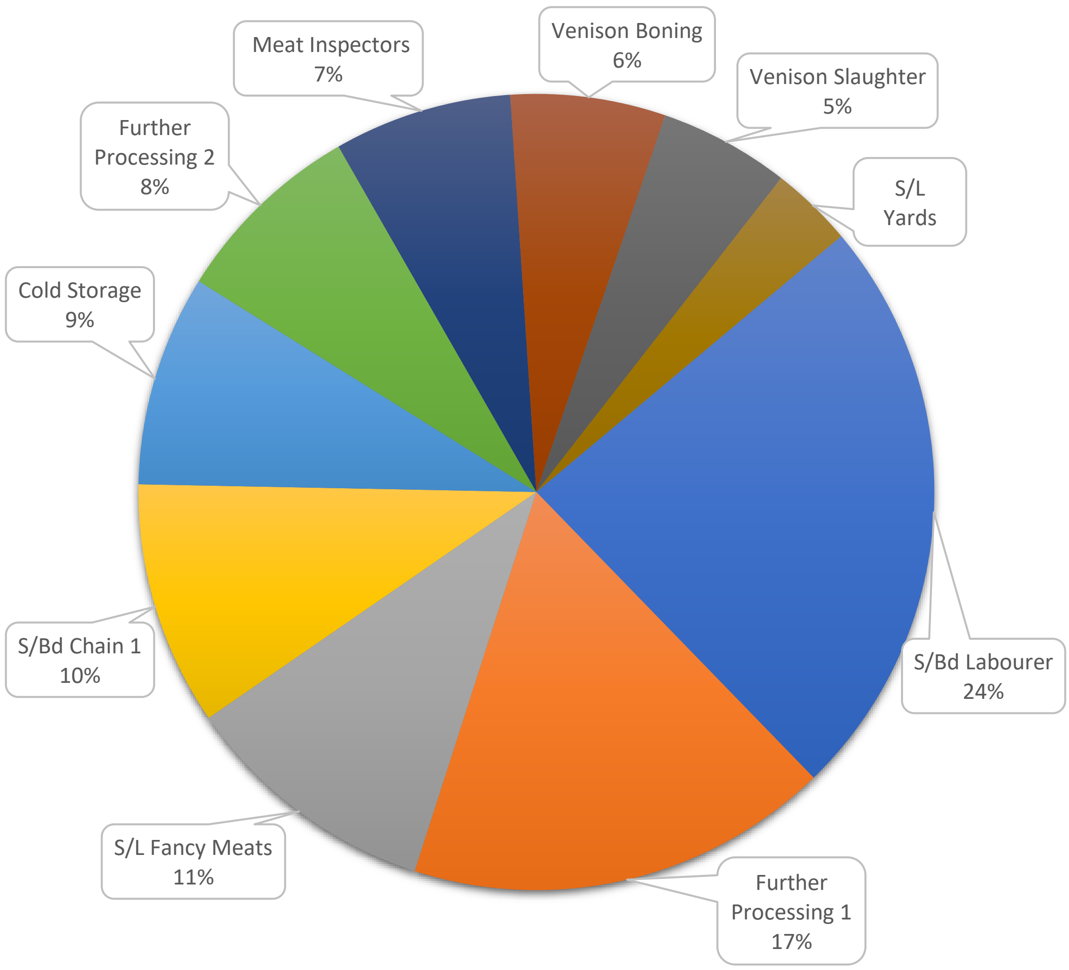


Table 4.66 displays the data for lost-time injuries (LTI) and medical treatment injuries (MTI), representing more severe injuries. Intriguingly, these injuries occurred in the same departments with the highest incidence of injuries. Of particular concern is the notable increase in injuries recorded in the S/Bd Chain 1 area during the recent 20/21 period. This specific trend warrants attention and further investigation to understand the factors contributing to increased injuries in this department.

Table 4.66

Smithfield 5-Season LTI and MTI Injury Departments (5.6 % Of All Incidents)

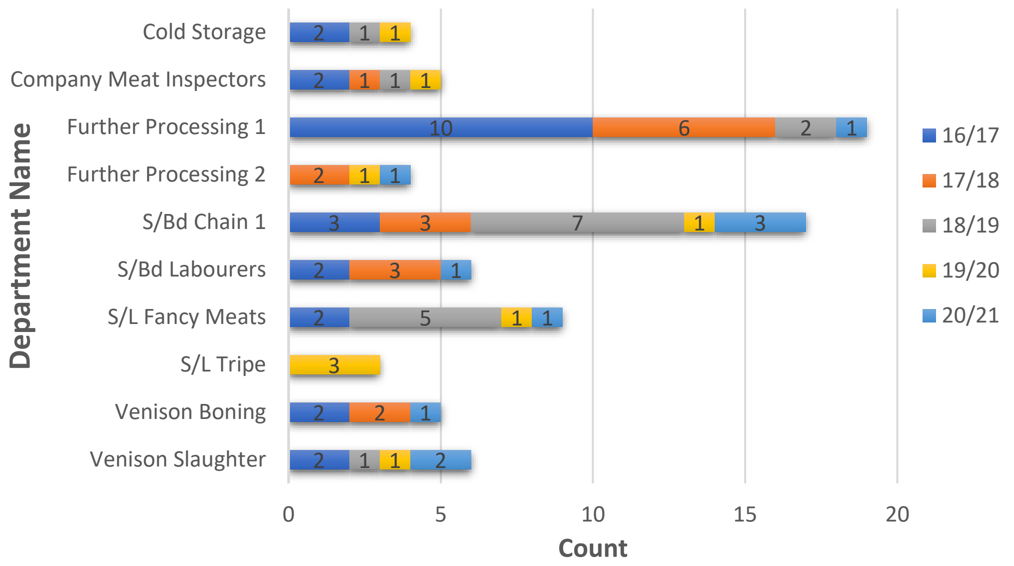
	Season					
Department	**16/17**	**17/18**	**18/19**	**19/20**	**20/21**	**Total**
Amenities		1			1	2
Cold Storage	2		1	1		4
Company Meat Inspectors	2	1	1	1		5
Electricians		1				1
Engine Room	1					1
Fitters	1	1				2
Freezers			2			2
Further Processing 1	10	6	2		1	19
Further Processing 2		2		1	1	4
Further Processing 4				1		1
Laboratory				1		1
Load Out		1				1
Medical Centre			1			1
Plant Services-Yard Gang	2			1		3
Plumbers				1		1
Rendering	1	1	1			3
S/Bd Chain 1	3	3	7	1	3	17
S/Bd Chain 2		1				1
S/Bd Labourers	2	3			1	6
S/L Fancy Meats	2		5	1	1	9
S/L Tripe				3		3
S/L Yards				1		1
Skin Processing	1	1				2
Venison Boning	2	2			1	5
Venison Slaughter	2		1	1	2	6
Grand Total	**31**	**24**	**21**	**14**	**11**	**101**

Note. Seasonal recordable injuries by department. High frequency; Medium-high frequency.

The incident occurrences among the company meat inspectors and S/L Fancy Meats employees have demonstrated consistency over the past 2-3 seasons, as depicted in Figure 4.43. Based on these numbers, it can be projected that at least one lost time injury (LTI) or medical treatment injury (MTI) incident may occur in these areas during the upcoming season.

Figure 4.43

Smithfield Seasonal Lost Time Injuries (LTI) and Medical Treatment Injuries (MTI) for Top 10 Departments



On a positive note, there has been a decrease in LTI and MTI incidents in the Further Processing 1 department, which is an encouraging trend. Investigating the reasons behind the improved injury performance in this department can provide valuable insights that can be applied to other departments within the organisation.

However, concerns arise from the injuries recorded in the S/Bd Chain 1 and Venison Slaughter departments. These areas present opportunities for targeted safety improvements to address the underlying factors contributing to injury occurrence. Analysing these departments and implementing specific measures can help reduce the risk of incidents and enhance safety outcomes.

By focusing on these areas of concern and implementing targeted safety enhancements, organisations can strive to reduce injuries, promote a safer work environment, and improve overall workplace safety.

Table 4.67 presents the seasonal injury ratios for high-risk departments at Smithfield. This data allows us to identify the departments with the highest injury risk. A lower ratio score indicates a higher likelihood of injury occurrence. By analysing these ratios, we can estimate the number of incidents expected to happen before encountering an MTI or LTI incident. This information aids in prioritising resources and implementing preventive measures to reduce the occurrence of injuries in these high-risk departments.

Table 4.67

Smithfield Seasonal Injury Ratio – High Risk Departments

	Injury ratio					
Incident Department	**16/17**	**17/18**	**18/19**	**19/20**	**20/21**	**Total**
Cold Storage	10:1	36:0	28:1	29:1	15:0	32:1
Company Meat Inspectors	9.5:1	21:1	30:1	26:1	12:0	21.6:1
Further Processing 1	5.1:1	10:1	25.5:1	22:0	13:1	13.5:1
Further Processing 2	20:1	19:1	24:0	22:1	13:1	29.3:1
S/Bd Labourers	41:1	28.6	77:0	67:0	44:1	59.3:1
S/Bd Chain 1	9:1	11.3.1	5:1	30:1	7.3:1	8.7:1
S/L Fancy Meats	10.5:1	31:0	8:1	37:1	27:1	17.3:1
S/L Yards	10:0	11:0	12:0	10:1	7:0	50:1
Venison Boning	6:1	12:1	12:0	25:0	21:1	18.8:1
Venison Slaughter	7.5:1	12:0	17:1	18:1	9:1	13:2

Note: Shading highlights ratios that identify injury risk. Lower ratios signal a more significant risk.

High risk; Medium risk

By examining the incident rates for Further Processing 1 in the 20/21 season, as depicted in Table 4.67, we can estimate that there will be approximately one LTI or MTI for every 13.5 incidents. It is important to note that early reporting of discomforts and near misses contributes to improving these ratios.

Based on the data, the highest-risk departments at Smithfield are identified as S/Bd Chain 1 and Further Processing 1. Over the past five seasons, the LTI or MTI ratio for the Smithfield plant has been calculated as 17.8:1. This ratio indicates that, on average, one LTI or MTI incident can be expected for every 17.8 discomfort or first aid incidents.

These ratios provide valuable insights into the relationship between incidents and the risk of more severe injuries. Understanding these ratios helps prioritise preventive measures and resource allocation to reduce the occurrence of LTIs and MTIs. Early reporting of discomforts and near misses becomes crucial to maintaining a safer work environment and improving safety outcomes.

By utilising this information, the organisations can implement targeted initiatives to address the underlying causes of incidents, promote a culture of early reporting, and strive for continuous improvement in workplace safety at Smithfield.

Table 4.68 shows the seasonal incidents at Smithfield categorised by injury type. Analysing the different types of injuries reveals specific patterns that warrant attention. It is concerning to note that there is no apparent downward trend in lacerations requiring Steri strips, indicating a specific area that requires further investigation to address the underlying causes.

On a positive note, discomfort numbers have decreased over the past four seasons, reflecting an improvement in this aspect. However, it is essential to highlight that specific aches and pains fluctuate, with gradual plateauing over the past three seasons. These areas require focused efforts for improvement.

Regarding the overall injury profile, discomforts account for 33.6% of all injuries, followed by aches and pains at 18.35% and sprains and strains at 15.9%. Together, these three injury types represent 67.9% of all on-site injuries. Implementing initiatives to reduce the causal factors associated with these injury types is crucial, as well as prioritising resources and preventive measures accordingly.

Addressing the factors contributing to lacerations, aches and pains, and sprains and strains can significantly improve workplace safety and reduce injuries. This comprehensive approach ensures that efforts are focused on the primary areas requiring improvement and fosters a safer and healthier work environment for Smithfield employees.

Table 4.68

Smithfield Seasonal Incidents by Injury Type

	Season					
Injury Type	**16/17**	**17/18**	**18/19**	**19/20**	**20/21**	**Total**
Aches/pain - gradual	15	24	12	14	12	77
Aches/pain - specific	113	40	23	45	31	252
Amputation	1					1
Bone Scratch	5					5
Bruising/Crushing	38	28	31	35	17	149
Burns	1			1		2
Burns - Chemical	5	6	3	2	1	17
Burns - Scald	1	6	7	3	5	22
Digestive Disease	6	4	4	4	3	21
Discomfort	54	188	143	141	79	605
Dislocation		1	1	1		3
Foreign Body	11	6	25	15	13	70
Fracture or Spine			1	1		2
Head Injury	1		2	4	1	8
Industrial Deafness	3		1			4
Infection	3	1	1			5
Infectious/Parasitic Disease			1	1	1	3
Inhalation		3	3	1	1	8
Internal (Trunk)		1	1			2
Laceration - Dressing Only	12	35	22	12	13	94
Laceration - Referral - GP/Hosp	2	8	3	2	1	16
Laceration - Steri Strips	13	9	9	9	10	50
Laceration - Sutures		1		2	3	6
Multiple	1	1				2
Occupational Overuse Syndrome			1			1
Open Wound	46	4		1		51
Other	2	3	7	5	2	19
Other Fracture		2		1	1	4
Puncture Wound	2	2	1	1	2	8
Sprain/Strain	5	44	92	82	64	287
Superficial		1				1
Grand Total	**340**	**418**	**394**	**383**	**260**	**1795**

Note. Seasonal incidents by injury type. High frequency; Medium-high frequency; Medium.

Table 4.69 displays the Smithfield incidents categorised by shift. When examining the incident numbers across different shifts, it is essential to consider each shift's staffing and tally numbers. Additionally, the incidents may be influenced by the condition and size of the livestock processed during each shift. If the shift variables are comparable, the night shift might hold valuable insights that could reduce the overall number of injuries.

Table 4.69

Smithfield Incidents by Shift

Incidents by shift	Number of incidents
Day	1595
Late	4
Night	187
Rotating	9
Grand Total	**1795**

Table 4.70 showcases Smithfield's top 20 injury-causing tasks over the past five seasons. Analysing the injuries in relation to these tasks allows for identifying high-risk tasks and further exploring the underlying reasons for their elevated injury rates.

To effectively address these high-risk tasks, a focused approach is necessary. This entails conducting thorough task assessments, ensuring the best workstation design, optimising work organisation, promoting ergonomic work postures, providing quality training, and investigating potential issues such as inadequate training or insufficient strategies for recovery and fatigue management.

It is essential to thoroughly investigate tasks like Broomie and Y-cut, which have shown either increased injuries or consistently high injury rates across previous seasons. Identifying the root causes of injuries associated with these tasks will inform targeted interventions and develop effective preventive measures.

It is noteworthy that these top 20 injury-causing tasks collectively account for 59.7% of all reported injuries. This emphasises the significance of addressing these tasks to mitigate the injury burden. Organisations can make substantial progress in reducing injuries and enhancing workplace safety by focusing resources and efforts on these high-risk tasks.

Table 4.70

Smithfield's top 20 injury causing tasks during the past five seasons

Row Labels	16/17	17/18	18/19	19/20	20/21	Total
Boning	19	44	46	38	26	173
General Labouring	7	4	15	40	32	98
Cleaning	22	18	23	22	5	90
Packing	15	28	15	14	12	84
Trimming	19	21	20	21	2	83
Company Meat Inspector	6	10	23	13	8	60
Lifting		24	16	10	10	60
Loading Out	18	12	10	15	3	58
Gutting	8	10	16	19	4	57
Carcass Relocating	6	6	15	8	3	38
Butcher	2	13	11	4	6	36
Runner	3	9	6	6	7	31
Shepherding	9	5	7	5	4	30
Y-Cut	7	6	6	5	6	30
Cartons	5	10	5	3	3	26
Supervising	6	6	6	5	3	26
Detain	4	8	5	5	3	25
Broomie	3	5	4	4	8	24
Tripe Operator	4	4	4	7	3	22
Forklift Driver	3	3	6	5	4	21
Grand Total	**166**	**246**	**259**	**249**	**152**	**1072**

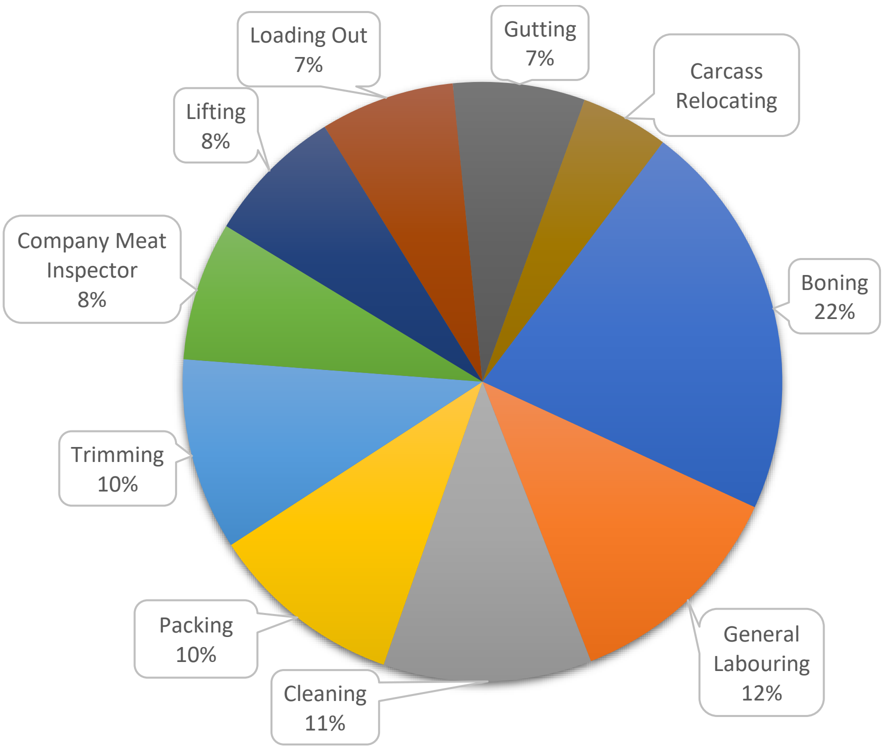
Note. Top seasonal injury causing tasks. High frequency; Medium-high frequency; Medium.

Through a comprehensive approach that encompasses task assessments, workstation design, work organisation, work postures, quality training, and addressing potential training and recovery management issues, organisations can prioritise safety measures and create a safer working environment for employees at Smithfield.

Figure 4.44 illustrates the top 10 injury causing tasks at Smithfield. By examining the injuries associated with each task, one can identify the tasks with higher risk levels and investigate the underlying factors contributing to the elevated injury rates. This calls for a focused approach to task assessments, workstation design, work organisation, work postures, quality training, and addressing any potential lack of training. The top 10 injury causing tasks collectively account for 44.6% of all reported injuries.

Figure 4.44

Smithfield Top 10 Injury Causing Tasks (44.6%)



4.9.2 Categorisation of Smithfield MSD Injuries: Unveiling Meaningful Patterns and Frequency Trends

Table 4.71 provides insights into Smithfield's seasonal musculoskeletal injuries, which account for 68% of all incidents. The proportion of incidents related to musculoskeletal injuries, as illustrated in Table 4.71 and Figure 4.45, makes it clear that a considerable amount of time and resources should be dedicated to mitigating the factors contributing to these injuries.

Table 4.71

Smithfield seasonal musculoskeletal injuries (68 % of incidents)

Injury Description	16/17	17/18	18/19	19/20	20/21	Total
Discomfort	54	188	143	141	79	605
First Aid Injury	119	97	119	138	104	577
Lost Time Injury (LTI)	8	10	8	3	3	32
Medical Treatment Injury (MTI)	5	1	1			7
Grand Total	**186**	**296**	**271**	**282**	**186**	**1221**

Multiple compounding factors must be considered when addressing this issue. These include plant and equipment design, tally requirements, work organisation, and various employee attributes, including an ageing workforce, fatigue, physical and mental well-being, and poor health habits.

Understanding these factors is essential for the company to make informed decisions regarding resource allocation and determine the appropriate initiatives or projects that warrant investment. By comprehensively considering these contributing factors, organisations can develop targeted strategies and interventions to reduce musculoskeletal injuries and promote a safer and healthier work environment for employees.

Figure 4.45 illustrates a noteworthy trend that deserves attention. It demonstrates a decline in discomfort injuries and all recordable injuries (LTI and MTI) since the 17/18 season.

Figure 4.45

Smithfield Seasonal Musculoskeletal Injuries (68% of Incidents)

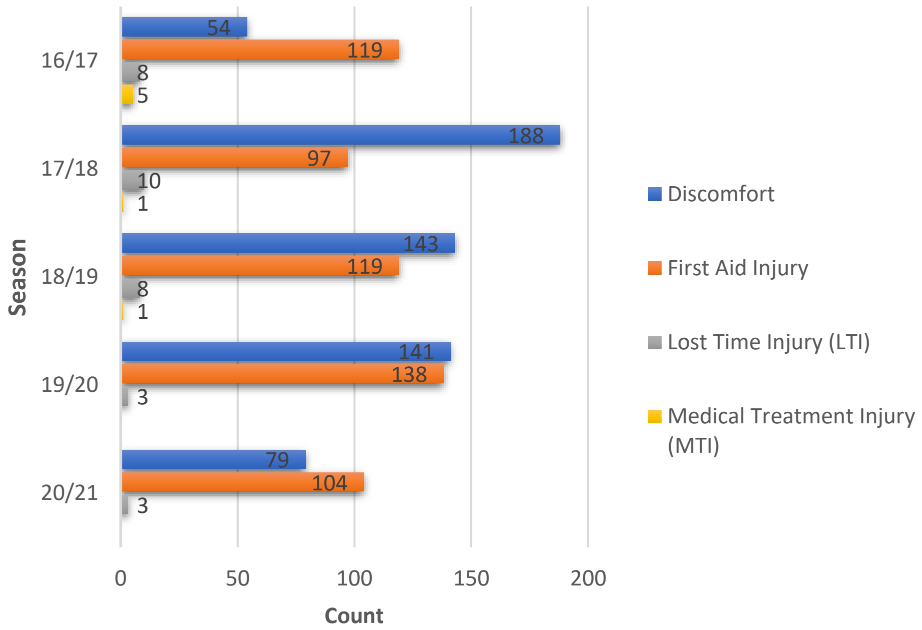


Table J75 in Appendix J provides a comprehensive overview of all musculoskeletal injuries at Smithfield, categorised by task and experience. Within Table 4.72, specific high-risk tasks are highlighted, considering different experience levels. By analysing the data from three distinct perspectives - experience (as depicted in Table 4.72 and Figure 4.46) and the tasks associated with incidents - valuable insights can be gained.

These insights include understanding the impact of ageing on injury rates for physically demanding tasks, identifying the time required to become proficient in a task, and recognising physically demanding tasks such as Packing and Boning. This information is instrumental in determining appropriate task placement and training requirements for new and existing employees, ensuring their safety and well-being.

Table 4.72

Smithfield High Musculoskeletal Injury Causing Tasks Against Work Experience

	Experience						
Task Description	First Week	First Month	1-6 Months	6 Months to 1 Year	1-5 Years	Over 5 Years	Total
Boning	1	5	14	3	76	40	139
Broomie			2	1	5	10	18
Butcher					13	7	20
Carcass Relocating			5	3	15	10	33
Cartons Handling			3		10	6	19
Cleaning			4	1	15	12	32
Company Meat Inspector			1	2	26	13	42
Detain					15	7	22
General Labouring	1	4	9	6	25	25	70
Gutting	1	2	1		23	10	37
Lifting	3	5	4	1	34	8	55
Loading Out		1	2	2	23	5	33
Packing		6	9	1	37	16	69
Runner			2	1	13	4	20
Shepherding		1	1	3	11	5	21
Trimming		1	16	6	28	3	54
Y-Cut		1		1	15	6	23
Grand Total	**6**	**26**	**73**	**31**	**384**	**187**	**707**

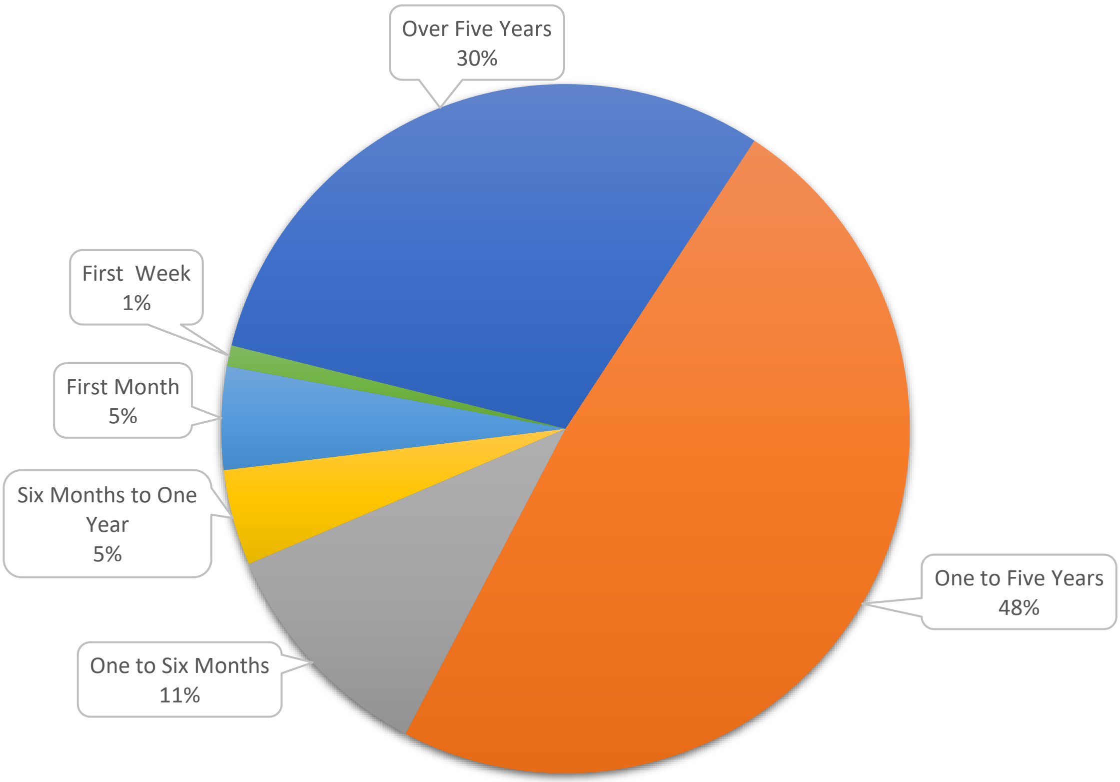
Note. Top Musculoskeletal injury frequency across experience levels. High frequency; Medium.

Moreover, comparing the number of staff across different experience categories is crucial. This comparison provides a comprehensive understanding of the workforce composition and allows for more accurate assessments of injury rates and risks. By considering the distribution of experience levels within the workforce, organisations can tailor their safety measures and training programs to address the specific needs of different employee groups.

Considering these factors helps enhance workplace safety, reduce injuries, and promote a healthy and productive work environment. It also enables organisations to allocate resources effectively, implement targeted training initiatives, and ensure the necessary support is provided to employees at all levels of experience.

Figure 4.46

Smithfield Five-Season Musculoskeletal Injuries Occurrence by Years of Experience



An interesting observation can be made when comparing the injured tasks with different experience levels. There is a consistent increase in injuries during the first six months, likely influenced by the initial learning curve and adjustment period for new employees. Following this period, the injury rates stabilise, potentially due to the completion of the first season and increased familiarity with the tasks.

However, a significant spike in injury occurrence rates is observed over the next five years among employees (48%) with more experience. This could be attributed to various factors, including complacency, repetitive strain, or accumulated wear and tear on the body. It is worth noting that the injury rates subsequently decreased to 30% among the most experienced employees, potentially indicating a heightened awareness of safety measures and improved skill in task execution.

Upon examining the body location of musculoskeletal injuries, as depicted in Table 4.73 and Figure 4.47, it becomes evident that certain areas, specifically the upper limbs (from hand to shoulder) and the spine, are particularly vulnerable to injuries.

Table 4.73

Smithfield Musculoskeletal Injuries by Body Location

Body Location	Number of injuries
Abdomen	7
Ankle	37
Arm	52
Back	159
Back - Cervical	40
Back - Lumbar	54
Back - Sacrum	4
Back - Thoracic	7
Buttocks	1
Chest	9
Elbow	73
Fingers	49
Foot	15
Forearm	9
Groin	7
Hand	87
Hip	16
Knee	56
Lower Limb	8
Multiple Locations	47
Ribs	4
Shoulder	206
Thigh	4
Thumb	43
Toe	2
Upper Leg	1
Upper Limb	1
Wrist	211
Grand Total	**1209**

Note. Top Musculoskeletal injuries by body location. High frequency; Medium.

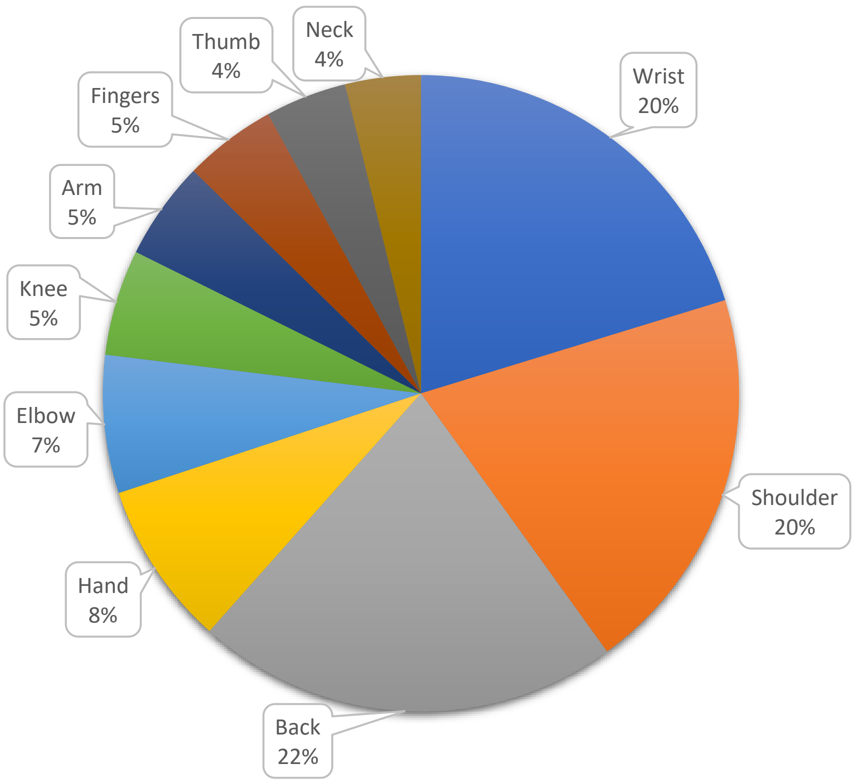
It is crucial to prioritise protecting these specific areas to mitigate the risk of musculoskeletal injuries effectively. This can be achieved through various means, including implementing ergonomic devices and optimising workstation design to alleviate strain on these body locations.

By employing ergonomic principles and ensuring correct equipment and workstation setup, organisations can reduce the likelihood of injuries and promote a safer work environment. Training and education on correct body mechanics and lifting techniques can also prevent injury in these vulnerable areas.

Considering the vulnerability of the upper limbs and spine, organisations should focus on implementing proactive measures that address the specific risk factors associated with these body locations. This targeted approach will help minimise the incidence of musculoskeletal injuries and safeguard the well-being of employees.

Figure 4.47

Smithfield Top 10 MS Injury Locations



Additionally, organising work schedules and rotations can help limit or minimise the workload in these susceptible areas. It is essential to carefully select employees for roles that may pose a risk if they have any pre-existing musculoskeletal conditions. Implementing targeted work-hardening programs that aim to enhance their physical abilities can be beneficial for at-risk individuals. These programs may include pre-season, off-season, and in-season initiatives. Furthermore, implementing targeted stretching protocols can contribute to injury prevention. In high-risk areas, it is advisable to consider additional staffing when injury tallies increase. Allowing for a seasonal lead-in time for physically demanding tasks and considering the same approach for overtime work and extended hours when necessary, can also be beneficial in reducing the risk of musculoskeletal injuries.

4.10 Focus Group

A focus group discussion was held to identify successful interventions, during which the findings from the literature review and significant trends identified during the secondary data analysis were disseminated. A focus group collects data from individuals who share similar experiences or opinions on a specific issue or topic of interest. (Marczyk, DeMatteo, & Festinger, 2010). The focus group discussion was conducted on the 7th of May 2021 through Microsoft Teams and was facilitated by the researcher. The researcher conducted the focus group discussion(s) to better understand the participant's perceptions, thus actively participating in the research process. (Saunders, Lewis, & Thornhill, 2019).

The AGL Health and Safety Managers, Health and Safety Advisors, and Injury management personnel were invited to discuss the findings and potential variations observed between the processing plants. The researcher utilised the Microsoft Teams video recording function to document the focus group discussion. Subsequently, the researcher transcribed the recorded information for further analysis. Please refer to Appendix K for the transcribed Focus Group discussion. This appendix provides readers with a valuable opportunity to thoroughly understand the topic by exploring the various discussion points. The aim was to address research questions five and six:

- Research question five - Which MSD prevention interventions have been effective for addressing MSD at AGL?
- Research question six - What barriers to MSD prevention exist at AGL?

This resource is vital in enhancing comprehension of the overall injury landscape within the plants by identifying successful interventions and potential barriers to MSD prevention at AGL. Additionally, it assists in identifying areas where effective injury prevention measures can be implemented.

An unexpected outcome arose when the same group of individuals continued to engage in discussions in the following weeks, prompted by the implementation of injury prevention strategies. As the official AGL Musculoskeletal Injury Prevention Manager, the researcher would visit each plant twice per quarter to collaborate with plant leadership teams and employees. These visits aimed to introduce a range of initiatives to prevent musculoskeletal injuries. These initiatives included workshops on ergonomics, training for preventing musculoskeletal injuries, educational sessions, assessments of task-related risks, and the implementation of authorised measures for injury prevention. Many of these initiatives were directly derived from the data analysis and findings obtained through the focus group discussion and subsequent conversations.

Furthermore, the group's Health and Safety leadership teams have a regular weekly meeting. In these meetings, the feedback from the focus group discussion was elaborated upon. The primary source for transcription was the recorded video, which was further enhanced through subsequent conversations. The transcription of the focus group session and a summary of the discussion points can be located in Appendix K.

Table 4.74 summarises the outcomes of the focus group discussion. By identifying effective interventions and strategies for managing MSD, the focus group provides valuable insights and knowledge that the organisation can utilise. These findings can inform decision-making processes, help allocate resources effectively, and contribute to developing evidence-based guidelines and practices for managing and preventing musculoskeletal disorders.

Table 4.75 presents the focus group's identified challenges and barriers to MSD prevention. By identifying these challenges and barriers, the focus group findings provide valuable insights and knowledge that the organisation can use to overcome them. These findings can inform decision-making processes, help allocate resources effectively, and contribute to developing evidence-based guidelines and practices for managing and preventing musculoskeletal disorders.

Table 4.76 presents the action points that emerged during the focus group discussion. Acting upon these action points can provide valuable insights and knowledge that the organisation can utilise to enhance their efforts in preventing MSD injuries. By implementing these action points, the organisation can strengthen its approach to MSD prevention, leading to improved outcomes and a healthier work environment.

Table 4.74

Effective Interventions and Strategies for Managing MSD as Identified by the Focus Group

Proposed strategies or interventions	Required Actions
Discomfort Management	
Discomfort reporting - Increased reporting, early reporting of injuries at room level (x3).	Implement an early reporting initiative.
Discomfort management strategy: Once discomfort is identified, focus on prevention, easing people back into their job tasks by starting on lighter tasks.	Improved discomfort management strategy includes a return to work and job task transition.
Discomfort reporting: An important aspect is plant culture, which leads to easy interaction. Build trust in the medical centre to deal with injuries effectively.	Develop a Just Culture framework that is built on trust for injury reporting.
Employee Engagement and Education	
Educate Supervisors and employees on the benefits of easing workers into their roles (x2).	Develop an Enhancing Workplace Productivity and Employee Well-being through Effective Onboarding and Job Role Transition Strategies workshop.
Continued support for interventions that work. Manual handling skills training.	Implement ongoing manual handling skills training.
Stretching programs – active participation (awareness – more posters in rooms).	Implement an improved stretching initiative.
Improved and ongoing good quality training.	Improve employee training programs.
Leadership and Reporting	
Supervisor involvement leads to significant improvement (at Smithfield).	Increase supervisor engagement in injury management.
Health and Safety Managers must be fully aware of what is going on with injuries.	Improve existing injury reporting.

Frontline leaders have the most significant influence on change. e.g., plant culture safety walks.	Regular leadership safety walks.
Hands-on focus on new injuries, acting fast and working with the supervisors to find solutions.	Improved discomfort management strategy to include supervisor engagement
Treatment strategies	
Treatment of work/non-work injuries – use the same strategy regardless of where it happened – still impacts work and brings it back to plant culture of "we care" – if not, it becomes a barrier to recovery. Need this change in work culture (x2)	Include treatment of non-work injuries.
Chiropractor 1-day x week	Investigate the value of alternative treatment options for specific injury types.
Onboarding and employee selection	
Careful employee selection	Improve pre-employment medicals to include employee selection standards.
Ease people into their new roles. For example, start new starters on a Thursday, followed by a weekend of rest.	Enhance the onboarding process by formalising it to facilitate gradual increments in workload.
Evaluate high-risk employees – supported with work capacity testing, develop exit strategies with union support.	Develop work capacity testing protocols.
Identify persons at risk - make use of a top injured list. To allow for early intervention.	Develop an employee at-risk list.
More comprehensive pre-employment medicals with specific selection criteria.	Develop new pre-employment medical criteria.
Peer review all pre-employment medicals.	Peer review pre-employment medicals before employee placement
Maintenance and livestock supply	
Well-maintained plant and equipment.	Improve the Maintenance management system.
Ensure good livestock quality. Be more selective.	Improve Livestock selection criteria.

Table 4.75

Challenges and Barriers to MSD Prevention as Identified by the Focus Group

Challenges and Barriers to MSD Prevention	Required Actions
Impact of "Seniority" - direct passage into the new season regardless of their physical ability.	Develop a fit for work assessment.
Returning seasonal workers – poor physical condition.	Determine which employees from the seniority group are not suitable.
Correct placement of employees with increased injury risk.	Assigning employees who are at a heightened risk of injury to suitable positions.
Open discussion with employees about their current work/injury status and the longevity of their roles—seniority vs. not suitable?	Implement a five-year work/injury status suitability discussion.
Approving task competencies prematurely.	Ensure people are job-ready and not signed off too fast.
Lack of empathy for employees recovering from injuries. x2	Nurturing a culture of compassion and empathy.
Dwindling production resources and limited time for health and safety tasks.	Increased resourcing.
A shortage of available resources and limited training opportunities compound increased work hours for health and safety managers.	Increase resourcing and training opportunities.
Absenteeism causes staffing pressure on unfit employees.	Increase staffing to compensate for absenteeism.
Limited budgets for investment into Ergonomics.	Dedicating additional resources
Impact of extended hours.	Action plan to manage or consideration to limit extended hours.
Poor stock quality. x2	Improve Livestock selection criteria.

Table 4.76

Action Points and Suggestions from the Focus Group Discussion

Action Points and Suggestions
1. Use 5-year data to make comparisons and track changes.
2. Collect data on less suitable employees who were employed and got injured. ▪ *Determine the percentage of at-risk employees who were employed or wrongly placed despite medical team recommendations.* ▪ *Calculate the percentage of declined pre-employment medicals and the number of employees with restrictions employed across all plants.* ▪ *Analyse the percentage of persons with restrictions who get injured.* ▪ *Conduct a comparison of injury rates between knowingly employed at-risk individuals and those with no limitations or clear medical records.*
3. Adopt a proactive approach instead of being reactive.
4. Consider change management and ergonomics within the existing resources.
5. Emphasize the focus on constructing the plant, prioritising people rather than equipment and use.
6. Exercise diligent attention to increasing line speed/tally, considering the limitations of the plant.
7. Identify and stop practices that lead to similar negative results.
8. Align metrics and definitions to ensure safety policy and practice consistency.
9. Present suggestions to the business and challenge them to support change.
10. Develop a strategy to ensure good stock quality.
11. Investigate whether plants with stronger leadership focus have better safety performance records.
12. Collect and compare rejected pre-employment medical data. ▪ *Explore correlations between % of injuries and rejection rates across the business.* ▪ *Review selection criteria and set a threshold based on injury rates.* ▪ *Determine the rate and threshold (acceptance injury rate and then determine the threshold).*

Action Points and Suggestions
13. Report data-supported information to the Safety Leadership Team (SLT). ▪ *Plan a Health and Safety Group agenda for SLT with discussions and actions for change.* ▪ *Include actions required at both Corporate and Plant levels.* ▪ *Identify two groups - plant vs. corporate level changes/interventions to be determined.*
14. Evaluate the safety culture established by frontline leaders. ▪ *Determine changes in safety culture over the past few years.* ▪ *Examine data for safety walks, safety incident trends, and safety walk frequency.*
15. Investigate a possible link between extended work hours and injury rates.
16. Determine the number of employees employed against medical advice or approval. ▪ *Establish accountability for decisions made against medical advice.* ▪ *Develop guidelines for handling such situations.*

4.11 Applied Action Research

The primary objective of the recently established position of Musculoskeletal Injury Prevention Manager at AGL was to minimise and prevent occurrences of musculoskeletal injuries throughout the company. Having taken on the role of the Musculoskeletal Injury Prevention Manager, the researcher aimed to effectively meet their responsibilities by implementing all feasible interventions. Concurrently, the intention is to refine a systematic approach to leverage this knowledge to curtail the prevalence of MSDs in the meat processing industry.

While not initially planned to be included in this study, this aspect offers the researcher a chance to actively apply the conclusions drawn from the earlier research sections. The implementation process will incorporate the use of action research. The purpose of employing action research is to produce practical knowledge that can elevate individual and organisational practices while empowering participants to take decisive steps. Action research aims to produce functional knowledge and remedies that can be enacted to enhance musculoskeletal injury prevention outcomes.

Applying these outcomes requires a participatory and open research approach, where the involved employees play an active role as agents of change in the process (Shani & Coghlan, 2021).

Following this practical process also provides an opportunity to evaluate the effectiveness of selected interventions implemented since the beginning of this research project. A decrease in the overall occurrence of MSD injuries would prove the success of the recently introduced injury prevention measures. It would also validate this research's impact on enhancing strategies for handling MSD within the meat processing industry.

By implementing (in August 2021) the cloud-based Risk Manager Incidents Module, AGL has gained the ability to record incidents, near misses systematically, and hazards throughout the entire organisation (Impac, 2023). All injury-related data is now consolidated within this new database. In the capacity of the Musculoskeletal Injury Prevention Manager, the researcher can leverage this data to evaluate the impact of novel initiatives and pinpoint areas that warrant increased investment or resource allocation. This dataset will prove invaluable for making well-informed decisions and effectively refining strategies to mitigate musculoskeletal injuries.

Table 4.77 outlines some musculoskeletal injury prevention initiatives identified via secondary data analysis and the focus group study and subsequently implemented.

Table 4.77

Musculoskeletal Injury Prevention Initiatives that were Identified from Research Data and Actioned

Strategies or interventions	**Enactment**
Increased Discomfort reporting.	Various early injury reporting initiatives, including posters, induction workshops, and media display screens. Please refer to Figure 4.48 (designed by the researcher).
Similar treatment of work/non-work injuries.	Allowance has been made to treat non-work-related injuries at AGL medical clinics (when resourcing allows).
Stretching programs.	Implementation of an improved stretching initiative: Posters, induction workshops, in-room stretching breaks, and media display screens. New 5-minute mandatory dynamic stretching and dynamic warm-up protocol. Please refer to Figure 73 (developed by the researcher).
Educate supervisors in injury management.	Developed a workshop to train supervisors to recognise and effectively manage injured employees. Please refer to Appendix L (developed by the researcher).
Careful employee selection.	New pre-employment medicals that allow for work capacity testing. Please refer to Appendix M.
Evaluate hi-risk employees	Use a seasonal top injured list to allow for early intervention. Offer alternative work tasks and work hardening programs to employees.
Improved and ongoing good quality training.	New improved Standard Operation Procedure with more specific competency sign-off. Please refer to Appendix N.
Manual handling skills training.	Primed for the Gates workshop – Manual handling skill, work posture, wellness training, and induction program. Please refer to Appendix O (developed by the researcher).

Strategies or interventions	Enactment
Improved plant and equipment design.	Re-design of workstations to improve ergonomics and reduce injury risk. Please refer to Figure 74 (modifications proposed by the researcher).
Change management and ergonomics training within the existing resource budgets.	Delivery of a “Developing an Ergonomic Eye” workshop to Middle management and all supervisory staff. Please refer to Appendix P (developed by the researcher).
Ensure good livestock quality. Be more selective.	Livestock quality is monitored with feedback from stock agents.
More comprehensive pre-employment medicals with specific selection criteria.	Pre-employment medicals were reviewed with new criteria in place. Please refer to Appendix M (development overseen by the researcher).
Ease employees in their roles.	“New Starter” training commences on a Tuesday, with the first full workday commencing on Thursday, followed by a weekend’s rest. Training occurs on a “slow” chain to allow for a more manageable workload adjustment – the same procedure for returning seasonal employees in their first week.
Improving plant safety culture.	Weekly leadership safety walks with safety topics introduced.
Peer review, all pre-employment medicals.	Health and Safety managers review all at-risk pre-employment medicals.
Report data-supported information to the Safety Leadership Team (SLT)	Monthly SLT feedback meetings.
Managing Absenteeism.	10% surplus staffing to allow for absenteeism.

Figure 4.48

Early Injury Reporting Visual Aid

Table 4.77 presents various strategies and interventions designed to mitigate the risk of musculoskeletal injuries. These initiatives, discerningly identified through the research data analysis, have been implemented to create a robust framework for injury prevention. The subsequent actions detailed below showcase the commitment to fostering a safer and healthier workplace.

Several initiatives were introduced to foster early injury reporting, including posters, induction workshops, and media display screens. Similarly, a significant stride was taken toward equitable treatment of work and non-work-related injuries, allowing for treatment at AGL medical clinics contingent upon resource availability.

An invigorated stretching initiative was introduced to address the occurrence of sprains, strains, compromised balance, and diminished physical well-being. This initiative encompassed an array of strategies, such as posters, workshops, in-room stretching sessions, and the utilisation of media display screens.

An illustrative representation, depicted in Figure 4.49, showcases an innovative 5-minute mandatory dynamic stretching and warm-up protocol thoughtfully tailored to the demands inherent in the meat processing industry. This protocol, complete with a synchronised soundtrack, was meticulously crafted to address the specific tasks undertaken in this industry.

As a testament to its efficacy, the dynamic stretching and warm-up protocol has been seamlessly integrated, significantly contributing to the ongoing endeavours to prevent workplace injuries.

Creating a dedicated workshop (Appendix L) bolstered supervisor competence, empowering them to adeptly recognise and manage injured employees. Likewise, a discerning approach to employee selection was taken, introducing new pre-employment medical assessments (Appendix M) encompassing work capacity testing.

A seasonal list of top injured individuals was established to prioritise high-risk employees and enable proactive interventions. Furthermore, alternative work tasks and work hardening programs were offered to those identified as high-risk, fortifying injury prevention strategies.

Elevating training standards, an enhanced Standard Operating Procedure (Appendix N) with targeted competency sign-off was introduced, fostering a culture of continuous improvement. Concurrently, comprehensive training on manual handling skills, work posture, and wellness was initiated, encompassing an induction program.

Ergonomics became a focal point with redesigned workstations (an example can be seen in Figure 4.50) to optimise ergonomics and reduce injury risk. Middle management and supervisory staff received specialised training on change management and ergonomics, exemplified through the "Developing an Ergonomic Eye" workshop (Appendix O).

Ensuring livestock quality and conducting more exhaustive pre-employment medicals with specific selection criteria underscored a commitment to worker health and overall operational success. Employee integration was approached with care, offering gradual training initiation, reduced chain speeds, and carefully selected start-up dates to allow for rest periods and ease workload adjustments.

Cultivating a safety-focused environment, weekly leadership safety walks were implemented, facilitating open discussions on safety topics. Additionally, the introduction of peer review for at-risk pre-employment medicals ensured thorough assessments, further reinforcing the commitment to employee well-being.

Data-driven insights were channelled into monthly Safety Leadership Team feedback meetings, endorsing informed decision-making. Finally, a pragmatic approach to absenteeism management was adopted, with a 10% staffing surplus to account for fluctuations in workforce availability.

Figure 4.49

Mandatory 5-min in Room Dynamic Warm-up and Stretching Routine

Figure 4.50

Improved Ergonomics in the Offal Department – Heart Wash and Packing Station

4.12 Chapter Summary

This chapter presents a comprehensive overview of the research findings. Initially, the injury data was thoroughly analysed on a plant-by-plant basis, leading to the identification of prominent trends. Following this, a focus group discussion was conducted, utilising insights from the literature review and significant secondary data analysis trends. This served as a foundation to identify potential opportunities and challenges and develop strategies and interventions to mitigate MSD risks at AGL. Finally, the concluding section introduces the actions implemented to address and minimise MSD risks within AGL. The subsequent chapter will provide a detailed discussion of the study's outcomes.

Chapter 5 - Discussion

The preceding chapter provided an analysis of the research data. The injury data was thoroughly examined on a plant-by-plant basis, leading to the identification of prominent trends. Following this, a focus group discussion was conducted, incorporating insights from the literature review and significant trends from the secondary data analysis. This established a solid foundation for identifying potential opportunities and challenges. It also facilitated the development of strategies and interventions to reduce risks associated with MSDs. Several of these proposed strategies were implemented and subsequently reported on.

5.1 Chapter Overview

This chapter presents the research findings, explains how the research questions were addressed, and suggests ways to apply the research outcomes in practice. These findings portray the intricate and diverse nature of the meat processing industry, underscoring the importance of taking these variations into account when analysing the injury and drawing conclusions.

This research aims to review the existing literature on known MSD risk factors, barriers to preventing MSDs, and industry interventions for addressing MSDs in NZ meat processing.

1. to collect and analyse new injury data from the AGL database and find and compare injury trends, including risk factors and barriers to MSD prevention.
2. to use the findings from this research and develop a systematic approach/intervention programme to combat MSD risk factors at AGL.

The research hypothesis posits that notable MSD trends will be discerned within the AGL database, which will play a pivotal role in formulating a comprehensive MSD prevention program for AGL.

To complete the objectives of this study, the researchers aimed to address the following research questions:

1. Which MSD risk factors are prevalent in the NZ meat processing industry?
2. What industry interventions for addressing MSD in NZ meat processing are recommended?

3. What barriers to MSD prevention in NZ meat processing have been identified?
4. What MSD trends can be observed at AGL?
5. Which MSD prevention interventions have been effective in addressing MSD at AGL?
6. What barriers to MSD prevention do exist at AGL?
7. Which Factors Need to be Considered when Developing a Systematic MSD Prevention Program?

5.2 Review of Individual Research Aims, Study Findings and Implications

Presented below is a concise summary of the principal findings from the study that addressed each research question, along with the conclusions that can be inferred from these findings in conjunction with the existing literature.

5.2.1 Research question 1: Which MSD risk factors are prevalent in the NZ meat processing industry?

Research question one aimed to determine the prevalent MSD risk factors in the New Zealand meat processing industry. This objective was accomplished by conducting secondary data analysis and reviewing existing literature. While a significant portion of the earlier research originates from Northern European countries, the USA, and Australia, the industry's operational methods share similarities that apply to New Zealand. Moreover, the literature broadly agrees on the primary MSD risk factors (Tappin, Moore, Ashby, Bentley, & Trevelyan, 2006).

Table 5.1 provides a summary of all the MSD risk factors that were identified from the secondary research.

Table 5.1

Prevalent MSD risk factors in the New Zealand meat processing industry

Risk Factor	Resulting outcome
Lack of employee training and education	Low morale, unproductivity, increase in expenses, increased injury risk.
Cold environment	Reduced work capacity, impaired reach and mobility, increased workloads.
Warm or hot environments	Reduced work capacity, heat stress, and increased fatigue levels.
Poor tool/plant and equipment design	Increased work force and effort, poor and awkward work postures, reduced productivity, increased injury risk.
Noise risk	Stressor that reduces focus and human performance and increases injury risk.
Poor work organisation and scheduling	Reduced ability to control injury risk, lack of task rotation, lack of task variety, insufficient rest breaks.
Manual handling risk factors	High-frequency handling, handling heavy loads, poor lifting techniques, increased injury risk.
Awkward work posture	There is an increased injury risk resulting from working with hands above shoulder height, twisting the spine, bending down, low squatting and kneeling, bending, twisting the wrists, static postures, and poor posture.
Repetitive work	Increased injury risk.
Increased musculoskeletal loads/force	Increased injury risk.

Table 5.1 (continued)

Risk Factor	**Resulting outcome**
Lack of recovery (fatigue)	Increased injury risk.
Poor Injury Management	Extended recovery times, prolonged return to work times, lack of work hardening post-injury, increased re-injury risk.
Contextual risk factors	
Cultural influences Culture of high work pace, competitive and entrenched culture, machoistic culture, mono-causality belief, 'Blame the victim' culture.	Increased injury risk, lack of injury reporting
Political and human relations influences Seniority factors, level of workforce participation, adversarial relationship between management and workers, and hygiene compliance requirements.	An ageing workforce, poor physical condition, poor employee engagement, restrictive PPE
Economic factors Company mergers, plant closures, shortened production seasons, low national unemployment, export focus, and high exchange rates.	Increased work pressure.
Human resource issues Limited Labour resourcing, staff and skill retention issues, training factors, preparedness of recruits, ageing workforce, limited career pathways.	Increased workloads, extended work hours, increased injury risk.
Seasonality and environmental influences Off-season recruitment retention challenges, workload variability, weather impacts on workflow. Variance in livestock size, availability, and quality.	Understaffing, increased workloads, extended work hours, increased injury risk.

Table 5.1 *(continued)*

Risk Factor	Resulting outcome
Job demand factors Production pressures, work compression and scheduling, low control of work planning, variability in workflow, task complexity, and increased carcass weights.	Increased workloads, extended work hours, increased injury risk.
Payment and scheduling systems Work compression, bonus systems, piece-rate work.	Increased work speeds, workload, fatigue levels, and injury risk.
Change factors Industry resistant to change, competitive nature of industry, industry scepticism about MSD, low participation of workforce, pre-contemplative management.	Prolonged MSD injury reduction gains.

Note. Table 5.1 offers a comprehensive overview of the predominant risk factors associated with MSDs within the New Zealand meat processing sector, as identified through secondary research. The table presents a compilation of these risk factors and their corresponding projected outcomes regarding injury risk.

Table 5.1 shows numerous risk factors that require thorough consideration when strategising MSD prevention in New Zealand's meat processing sector. Notably, industry resistance to change and the inclination to attribute MSD occurrences to a single cause is prominent. Embracing multi-causality is vital, acknowledging events as intricate interplays of diverse factors, yielding a more precise and comprehensive understanding. This perspective finds support in local (Tappin, Bentley, & Vitalis, 2008) and international studies, which reveal that risk factors for WMSDs encompass physical, psychosocial, and organisational elements (Donovan, 2021). French literature on MSD highlights the importance of embracing a multi-factorial origin. In dynamic settings like meat processing, single-factor causation of MSD cases is highly uncommon. MSD does not conform to a cause-and-effect model driven by a singular factor; instead, it exists within a probabilistic framework where various factors interact, including occupational and external ones. Each factor contributes to the emergence of these conditions to varying degrees. Consequently, MSDs are complex ailments influenced by multiple factors, including occupational factors (Tappin, Moore, Ashby, Bentley, & Trevelyan, 2006).

OHS (1997) pinpointed work organisation and task scheduling as the foremost risk control factors in New Zealand. Within these, supervisory structures, task clarity, chain speeds, seasonal workload impact, monotony, shift work, and overtime needs were highlighted. These findings aligned with the risk factors identified during the secondary research.

During the research's focus group discussion, it was notable that the health and safety staff understood the contextual factors linked to MSD risks. This observation aligns with Tappin, Bentley, and Vitalis's earlier findings (2008), highlighting similar patterns. Health and safety staff surpassed managers and processing staff in mentioning contextual MSD risk factors, likely due to their heightened awareness of MSDs and their involvement in risk management and injury cases.

Health and safety staff also emphasised cultural influences and change factors more than managers and processing staff. This underscores their deeper comprehension of the nuanced nature of MSDs in meat processing. Managers and supervisors identified parallel factors related to human resources, job demands, and job design. Conversely, processing staff were more familiar with risk factors directly tied to their specific work aspects, like job demands and human resources (Tappin, Bentley, & Vitalis, 2008).

Another risk factor identified during the data analysis in this research was the increase in MSD in the more experienced employee category at Lorneville (more than >5 years – please refer to Table 4.37). The more experienced employees were also older. This finding highlights the MSD injury risk the seniority system poses for the industry. Most plants employ a seniority system, which offers assurance to workers and employers by determining aspects like post-seasonal shutdown return times, roles, and fixed pay levels. This system prioritises job security for those with the longest tenure, ensuring consistency throughout the year. However, this system can also introduce MSD risk factors while providing security. It hinders the adoption of alternative work arrangements to reduce MSD risks, potentially elevating the MSD risk due to limited training, infrequent rotation, and minimal transfers. It might even contribute to turnover as career advancement hinges on retirements or departures. Novices might lack training for higher-seniority tasks, while seniors might not rotate to lower-seniority tasks. Further, the seniority system might discourage shift or department transfers due to seniority loss. The earlier research also supports this finding (Tappin, Bentley, & Vitalis, 2008).

The focus group discussion identified various human resource challenges, one being recruitment due to various factors; a significant hurdle is the remote location of many processing plants, limiting the labour pool. Moreover, low unemployment rates, modest wages, skill shortages, limited career advancement, and attractive alternative job opportunities heighten MSD risks among the current workforce (Tappin, Bentley, & Vitalis, 2008). Attracting workers is further complicated by extended off-seasons, weekend shifts, night work demands, and reductions in migrant worker quotas, resulting in reduced staffing levels at meat processing plants. Consequently, employees face extended work hours and inadequate time for recovery, training, and skill development, leading to increased absenteeism. These conditions amplify the risk of MSDs among the workforce.

The red meat processing industry in New Zealand operates seasonally, tied to the presence of pasture-grazed livestock. This leads to an offseason in processing plants, spanning from weeks to months, guided by environmental influences on pasture and stock growth. Consequently, staff recruitment and training are closely linked to anticipated stock quantities. The focus group discussions also highlighted another MSD risk: subpar stock quality and variations in livestock size. This impact can be addressed through enhanced work organisation and scheduling. An upstream intervention could involve influencing the condition of the animals sent by suppliers to the plants to ease the workload (Toulouse, Vezina, Lapointe, & Geoffrion, 1991).

Job demand factors represent another critical MSD risk factor identified in secondary research that must be considered when devising strategies to manage MSDs in the meat processing industry. Other researchers have also recognised this risk factor. Elevated workloads stemming from heavier carcass weights and subsequent production growth, coupled with heightened productivity expectations, have collectively influenced workloads and other physical risk elements, intensifying the pressure to achieve production goals.

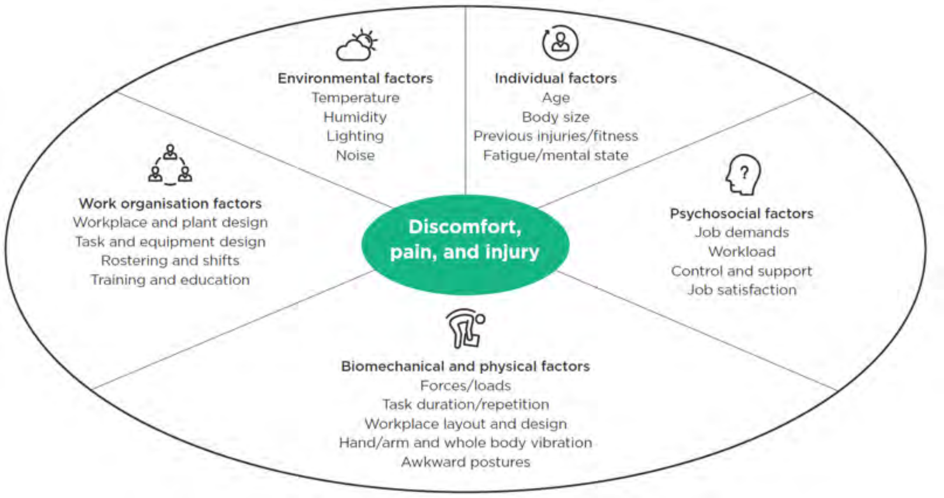
Notably, competition within the meat industry significantly drives innovation and productivity growth (Keogh, 2017). A shift has occurred from prioritising yield to emphasising heightened productivity. Consequently, numerous workstations have been automated, chain speeds have increased, and greater job specialisation has been introduced within confined workspaces. This transformation presents challenges for new employees, who must keep up with seasoned colleagues' pace while honing their skills and physical capabilities simultaneously (Tappin, Bentley, & Vitalis, 2008). To meet the broader range of processing needs, the increased skill requirement for meat workers is challenged by resourcing and timely training of employees to learn these new skills. A 2012 Institute for Work and Health study showed that the heightened risk of workplace injuries among new employees has persisted for the past decade. Workplaces must implement additional measures to ensure that new hires receive adequate training and supervision, fostering a safe work environment (Institute for Work and Health, 2012). After recovering from an MSD injury, employees face an elevated risk of subsequent injuries if the work pace exceeds their current recovery level. Regrettably, numerous meat processing plants lack sufficient measures to support a gradual return to work (Thrive at work, 2022).

Many meat processing plants employ payment incentives and scheduling systems to enhance productivity during peak demand and shorter production seasons. The piece rate system, where employees are paid per task completed instead of time taken, is standard. For instance, compensation might be based on cartons loaded into containers or animals slaughtered per shift (Employsure, 2023). Bonus-driven work rewards exceeding targets. Compressed schedules, as outlined by Duke Human Resources (2023), enable a traditional work week to be completed in fewer than five days. This, in turn, increases the MSD injury risk because of such practices. By embracing a new perspective and devising strategies to mitigate the effects of external factors like seasonality and human resource challenges, alongside internal factors such as cultural influences and payment systems, the meat industry can notably advance the implementation and success of MSD interventions within the sector (Tappin, Bentley, & Vitalis, 2008).

Key insights. Numerous prevalent MSD risk factors exist within the New Zealand meat processing sector. These encompass work-related factors and, to some extent, non-work elements like previous sports involvement, hobbies, or post-work activities that could intensify muscle fatigue and heighten MSD risks. These factors, whether in isolation or combination, can result in discomfort and pain. Worksafe (2023) presents these contributing risk factors graphically in Figure 5.1. Enhancing workstation ergonomics and the physical aspects of meat processing, such as knife sharpening and equipment maintenance, might be possible. However, the industry often faces challenges dealing with larger economic, political, social, and cultural factors beyond its direct control or influence.

Figure 5.1

Contributing Factors for Work-Related Musculoskeletal Disorders



Note. The image provides a succinct overview of all factors contributing to work-related musculoskeletal disorders.

Worksafe. (2023). Work-related musculoskeletal disorders and risk factors. Retrieved from Worksafe August 22, 2023: https://www.worksafe.govt.nz/topic-and-industry/work-related-health/musculoskeletal-disorders/quick-guide-work-related-musculoskeletal-disorders-and-risk-factors/

The impact of these factors on individuals varies according to their unique attributes and circumstances. Workers frequently face a combination of work-related risk factors simultaneously, and heightened exposure escalates the potential for harm (Worksafe, 2023). Recognising contextual factors' sway on workplace dynamics is the crucial initial step towards tackling these concerns. By embracing novel perspectives and formulating strategies to alleviate the impact of external elements like seasonality and challenges related to human resources, alongside internal factors such as cultural influences and payment systems, the meat industry can notably make strides in enhancing the acceptance and effectiveness of interventions for MSDs within the sector (Tappin, Bentley, & Vitalis, 2008).

5.2.2 Research question 2: What industry interventions for addressing MSD in NZ meat processing are recommended?

Research question two aimed to identify which industry interventions are recommended to address MSD in the New Zealand meat processing industry. This objective was accomplished by conducting primary and secondary data analysis and reviewing existing literature.

Recognising the significance of addressing these concerns, WorkSafe and the Meat Industry Association (MIA) have extended their support for industry research within New Zealand. This support is notably directed towards identifying interventions to alleviate MSDs within the meat processing sector efficiently. The subsequent interventions represent some of those already put into practice in New Zealand:

Incident Reporting and Investigation for Mitigating MSDs. Establishing a robust incident reporting and investigation system is imperative to address the challenge of MSDs within the meat processing industry. This system revolves around precise data collection, focusing on the prevalence of MSDs, contributing tasks, and risk factors. A comprehensive incident reporting and investigation framework reduces MSDs (Goode et al., 2016). The physically demanding nature of meat processing heightens the concern of MSDs, necessitating timely hazard communication and recognition.

Early Identification of Hazards. Incident reporting empowers workers to report hazards, aiding in promptly identifying hazards early. This system enables employers to detect MSD-related patterns and trends (Carrillo-Castrillo et al., 2019). For instance, frequent discomfort at a workstation indicates a need for ergonomic enhancements.

Investigations for Root Cause Analysis. Thorough investigations following incidents delve into the underlying causes of MSDs. This process encompasses assessing circumstances, practices, and environmental factors (Carrillo-Castrillo et al., 2019). By addressing root causes, organisations can enact meaningful changes.

Implementing Corrective Actions. Root cause identification forms the basis for targeted corrective actions, preventing recurrence (Goode et al., 2016). Implementing interventions directly addressing underlying issues, such as mechanical assistance for heavy lifting, enhances workplace safety.

Tailored Training Programs. Incident data analysis pinpoints areas needing training. Customised programs can educate workers on lifting techniques, ergonomics, and posture, reducing MSD risks (Goode et al., 2016).

Continuous Monitoring and Evaluation. Incident reporting and investigation systems facilitate ongoing monitoring. Organisations track trends, assess intervention effectiveness, and adapt strategies, fostering continuous improvement (Meat Industry Health and Safety Forum, 2013).

Implementing an incident reporting and investigation system is integral to combating MSDs in the meat processing industry. It ensures early hazard recognition, addresses root causes, guides corrective and preventive actions, tailors training, and promotes ongoing enhancement. Such a system establishes a safer work environment, safeguarding worker health and well-being.

Reducing MSD Injury Risk with the use of Ergonomic Assessments. Ergonomic assessments are a pivotal strategy in preventing MSDs within meat processing plants. By analysing the work environment, tools, and equipment, these assessments target ergonomic issues contributing to MSDs (Johnson, 2018).

Expert Involvement. Ergonomic assessments are conducted by experienced specialists in ergonomics, human factors, and occupational health and safety. They employ methods like observation, interviews, and measurements to collect data on ergonomic factors.

Workstation Evaluation. The assessments evaluate workstations for good design and adjustability, considering individual worker needs. This includes analysing the arrangement of tools, equipment, surfaces, work stands and chairs.

Task Analysis. Detailed task analysis identifies risk factors such as repetitive movements, awkward postures, and excessive force. This information informs strategies to reduce the potential for MSD development.

Equipment Examination. Ergonomic experts scrutinise tools and equipment to identify design flaws and recommend modifications that enhance usability and reduce physical strain.

Recommendations and Implementation. Findings from assessments guide recommendations for improving equipment, processes, and workstations. This can involve modifying existing tools, suggesting new ergonomic technologies, and optimising work processes (Hoe, Urquhart, Kelsall, & Zamri, 2018).

Comprehensive ergonomic assessments provide actionable insights into MSD risk factors. Addressing these factors minimises MSD occurrences, promotes worker well-being, and establishes a safer work environment in meat processing plants.

Reducing MSD Risk by Ensuring Job Rotation and Task Variety. Examining successful interventions in comparable industries or countries and tailoring those best practices to New Zealand's meat processing context holds promise for mitigating MSDs. Job rotation and task variety strategies in meat processing offer the potential to lessen muscle and joint strain, emphasising worker well-being and safety.

Benefits of Job Rotation. Job rotation involves shifting workers between tasks, providing relief from prolonged exposure to a single task (Tappin et al., 2007). Tasks like deboning or packaging can strain specific muscle groups and joints; rotation minimises repetitive strain, easing muscle fatigue and preventing overuse injuries.

Task Variety's Role. Continual task repetition strains targeted muscle groups, fostering MSD development (Barr et al., 2004). Task variety diversifies movements and muscle engagement, lowering the risk of MSDs like tendinitis and carpal tunnel syndrome.

Careful Implementation. Effective job rotation and task variety demand careful planning. Employers should assess task risks, design rotation schedules, and ensure adequate training for each task (Van Eerd et al., 2022).

Worker Involvement. Worker engagement with open communication channels and feedback mechanisms is pivotal. Regular evaluations and worker input refine rotation and task assignments for optimised results, worker engagement, and enhanced well-being (WorkSafe, 2023).

When thoughtfully executed, job rotation and task variety strategies can reduce strain, increase worker involvement, and foster long-term success in the meat processing industry, fostering a safer and more productive work environment.

Enhancing Worker Safety in Meat Processing through Manual Handling Training. Thorough manual handling training is vital due to the hazards tied to tasks with heavy loads. Training programs that educate workers and management about correct techniques, posture, lifting, and movement are essential to mitigate MSD risks.

Reducing Injury Risks. Incorporating correct lifting techniques taught in manual handling training minimises muscular and joint strains, mitigating the risk of MSDs and injuries (Provention, 2019).

Handling Heavy Loads. Manual handling training addresses the safe handling of heavy loads, imparting techniques for secure gripping and control. Workers learn their weight limits and when to seek assistance (Health and Safety Executive, 2019).

Effective Use of Lifting Aids. Training covers using lifting aids and trolleys, empowering workers to manage tasks more safely and efficiently, and reducing injury risks.

Maintaining Posture and Breaks. Training emphasises maintaining neutral spine alignment and taking regular breaks. Correct breaks enhance musculoskeletal health, reduce fatigue, and prevent overexertion.

Essential Elements for Successful Manual Handling Training. Effective manual handling training is pivotal in reducing musculoskeletal injuries in workplaces. To ensure organisations reap the rewards of injury reduction, four essential elements must be integrated into the training process. These elements encompass knowledge acquisition, appropriate learning methodologies, real-life application, and consistent practice (Provention, 2019).

Right Knowledge (Understanding): Manual handling training provides participants with accurate knowledge of safe body usage during manual tasks. This includes understanding techniques like balanced bending, breathing during heavy exertion, controlled pushing/pulling, and correct grip. Clear language is crucial to effectively conveying this information, allowing participants to relate it to their daily activities.

Right Learning Process (Learning by Doing and Comparing): Merely imparting knowledge cannot effectively alter movement habits. The presentation of knowledge is key. It is vital to enable participants to sense the difference between safe and unsafe movement habits. This experiential approach aids comprehension, helping participants internalise safe practices. Active engagement and comparison deepen understanding of correct techniques (Box 2 in Figure 5.2).

Figure 5.2

Four Essential Elements Needed for Manual Handling Training to Succeed

Note. The image illustrates the four crucial elements necessary for the success of manual handling training, adapted from Provention (Provention, 2019).

Real-Life Application: Translating learned principles into real-life scenarios is integral for successful training. Techniques acquired must be seamlessly applicable in various activities, both at and outside the workplace. Linking work-related tasks (e.g., hock *cutter operation) with everyday activities (e.g., using secateurs* to prune thick branches) reinforces the consistency and universality of safe movement practices.

Practice (Embedding New Habits with Practice): Knowledge is insufficient to establish lasting habits. Regular practice is indispensable for turning correct techniques into habits. Organisations must establish processes that encourage ongoing practice among their workforce. This step ensures that newly acquired safety habits replace unsafe ones, resulting in sustained positive change.

In conclusion, the effectiveness of manual handling training in workplaces depends on the seamless integration of these four crucial elements. Without these elements, manual handling training investment may yield limited returns on investment (Provention, 2019). Comprehensive manual handling training equips meat processing workers with skills to ensure safety, prevent injuries, and foster a healthier work environment. Employers can benefit from reduced injuries, increased productivity, and improved workplace safety.

Minimising MSD Risks in Meat Processing with Engineering Controls.

Investigating adjustments to workstations, tools, and equipment to enhance task ease and worker comfort is essential. Prevention through design (PTD) begins with engineering solutions to eliminate risks. Automation and mechanisation of specific tasks can also help reduce repetitive motions and heavy lifting (OSHA, 2023). Implementing engineering controls is a pivotal strategy in minimising MSD risks by altering the work environment and tasks, thus reducing physical strain on workers' bodies.

Workstation Optimizations. In meat processing, ergonomically designed workstations can enhance safety. Height-adjustable surfaces, adjustable seating, suitable lighting, and tool placement reduce strain. Adaptability ensures correct and minimises MSD risk.

Mechanical Aids and Equipment. Mechanical aids like conveyor belts, hoists, and forklifts alleviate physical burdens by lifting and moving heavy loads, curbing MSD potential.

Automation and Robotics. Integrating automation and robotics relieves workers from physically demanding and repetitive tasks, diminishing MSD risks. Automated systems decrease repetitive motions and awkward postures. Figure 5.3 shows an automated robotics system used at AGL to reduce the risk of MSD and improve efficiencies.

Figure 5.3

Use of an Automating Robotics System to Reduce MSDs and Improve Efficiency

Note. Primal Cutters: Elevating Manufacturing Excellence. Alliance Group invests $12.5 million to upgrade the Lorneville plant, incorporating X-ray analysis for every carcass and advanced forequarter-cutting technology (Alliance Group Limited, 2021).

Pneumatic Tools and Anti-Fatigue Mats. Using pneumatic tools for forceful tasks reduces strain. Anti-fatigue mats provide cushioning, reduce fatigue, and alleviate discomfort from prolonged standing.

Force Reduction and Vibration Control. Engineering controls minimise the force required for tasks, employing ergonomic enhancements and assistive technologies. Addressing vibration and noise risks further safeguards musculoskeletal health.

Adopting a holistic approach is essential for ensuring worker safety in the meat processing industry. While engineering controls play a crucial role, a comprehensive strategy integrating administrative controls, personal protective equipment, and innovative technologies like

PEDs is the key to creating a robust and effective safety framework. By addressing risks from multiple angles, we can safeguard the well-being of workers and establish a safer and more secure work environment.

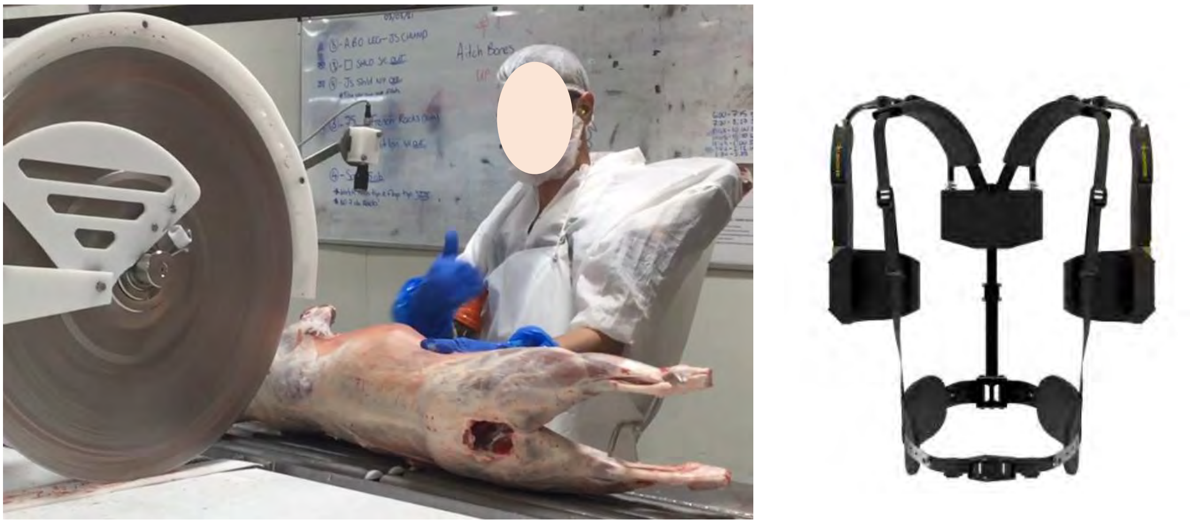
Personal Ergonomic Devices (PED). Exoskeletons provide valuable assistance to employees who have been injured and are looking to return to work. They aid in the recovery process and make it safer for them to reintegrate into physically demanding job environments, such as meat processing (Sarcos, 2023). However, there are certain challenges associated with using exoskeletons in the meat processing industry. These challenges include ensuring compliance with food safety regulations, managing costs, ensuring compatibility with various tasks, maintaining hygiene standards, addressing storage concerns, overcoming limitations to single-user usability, and gaining acceptance from workers.

The effectiveness of exoskeletons hinges on multiple factors, including their design, correct usage, and seamless integration into existing work procedures. In Figure 5.4, there is an image depicting an employee from AGL testing out a PED in a food processing area.

To summarise, incorporating PEDs like exoskeletons in the meat processing sector can enhance worker well-being and workplace safety and reduce MSD occurrences. As exoskeleton technology advances and becomes more tailored to specific tasks and user requirements, it could significantly improve the safety and efficiency of meat processing. However, to maximise the benefits of this technology, it is crucial to take a comprehensive approach that combines exoskeleton usage with other ergonomic tactics, worker training, and ongoing evaluation (Pienaar, Rapp, & Mills, 2022).

Figure 5.4

AGL Employee trialling the Levitate Airframe Wearable Exoskeleton during Food Processing Tasks

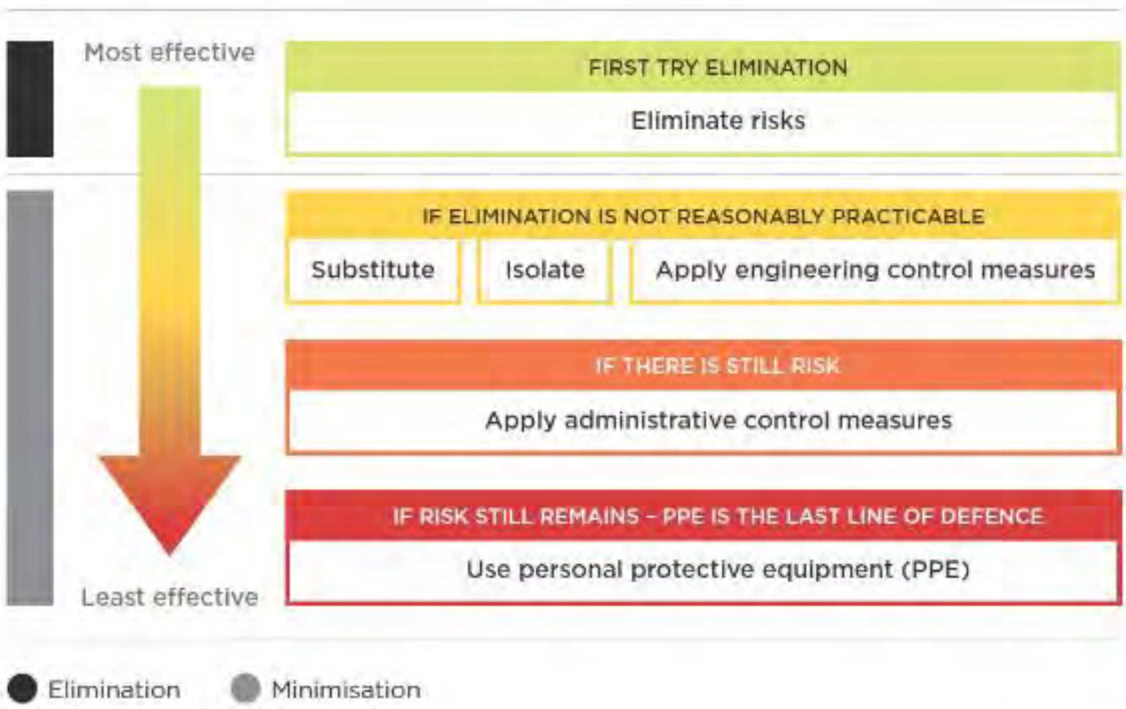


Note. The employee approves of the suit, which significantly simplifies the task of lifting carcasses. To adhere to food compliance regulations, the suit was protected by a reusable smock.

Personal Protective Equipment. Personal Protective Equipment (PPE) pertains to gear, attire, or accessories crafted to safeguard individuals from workplace hazards. Although PPE is vital for ensuring workers' safety and wellness, it should be viewed as a secondary control measure, not the primary solution for tackling MSDs. For instance, in the meat processing sector, outfitting an employee in full mesh can eliminate lacerations but might also lead to increased muscular fatigue due to added weight and reduced tactile sensation, necessitating a firmer grip. In accordance with the Health and Safety at Work Act 2015 (HSWA), organisations are obligated to reasonably ensure the health and safety of their workers and other affected individuals. The hierarchy of controls, illustrated in Figure 5.5, aids organisations in determining the optimal control measures. Prioritising controls higher up the hierarchy is recommended over-relying on administrative measures such as policies, procedures, or PPE. Following this hierarchy, the most effective strategy involves eliminating or substituting the hazard with a safer option. Engineering controls, administrative measures, and work practices are primary measures that address the source of the hazard. Conversely, PPE is a final layer of defence when other control methods are impractical or inadequate (NIOSH, 2023).

Figure 5.5

Hierarchy of Controls to Determine the Most Effective Control Measure



Note. The hierarchy of controls is a well-known structure for handling workplace hazards and arranging control measures based on their effectiveness in reducing or removing risks. This hierarchy advocates for hazard elimination or substitution as the most potent strategy. Image by Worksafe https://www.worksafe.govt.nz/assets/Uploads/image-hierarchy-of-control-measures.jpg

In conclusion, it is crucial to acknowledge that PPE protects workers from workplace hazards. However, it should be viewed as a secondary control measure when addressing MSDs. Primary measures like engineering controls, administrative controls, and work practice controls offer a more thorough and effective approach to preventing MSDs by directly addressing their root causes.

Stretching Programs. Stretching programs effectively mitigate the risk of MSDs in the meat processing industry. These injuries stem from repetitive tasks, awkward postures, and excessive force exertion on muscles, tendons, ligaments, and soft tissues. Pre- and post-work stretching programs provide multiple advantages, including enhanced flexibility, reduced muscle tension, and improved joint range of motion, thus preventing MSDs (King et al., 2020). For instance, dynamic stretching before work readies muscles for tasks, while post-work static stretching relaxes muscles, counteracting strain. Addressing poor posture with targeted stretches further decreases MSD risk. In summary, stretching programs augment flexibility, reduce MSD risk, and offer valuable warm-up and cool-down routines for enhanced workplace performance (Alger-Norton, 2023).

Worker Engagement and Participation. Engaging workers in recognising and managing MSD hazards is essential. Joint committees or worker-led initiatives enable employees to contribute insights on workplace design, interventions, and practices, resulting in effective and sustainable solutions (WorkSafe, 2019). Worker involvement taps into their first-hand knowledge of tasks and ergonomic challenges, fostering accurate hazard understanding. Collaboration generates practical control measures, enhancing adoption and safety culture. This engagement cultivates a positive safety ethos and customises solutions for workforce needs (Van Eerd et al., 2022).

Key insights. To discover practical solutions for managing MSDs within the New Zealand meat processing sector, it is vital to tailor interventions according to individual processing facilities' distinct requirements and needs. Regularly monitoring, assessing, and consistently enhancing these interventions is imperative to guarantee their efficacy in diminishing MSDs and enhancing the welfare of industry workers.

5.2.3. Research question 3: What barriers to MSD prevention in NZ meat processing have been identified?

In New Zealand's meat processing industry, the prevention of MSDs has become a concern. Addressing this issue requires challenging established industry norms and attitudes that may inhibit advancement. MSDs can result in significant consequences, such as decreased productivity, increased healthcare costs, and reduced workers' quality of life. Furthermore, the neglect of MSD prevention can lead to high employee turnover and recruitment challenges, further damaging the industry's financial health (Bevan, Gunning, & Thomas, 2012).

To overcome these barriers, industry stakeholders must understand the broader economic and social implications of MSDs. Recognising the advantages of preventive measures, there is an opportunity to allocate additional resources toward initiatives explicitly aimed at overcoming these obstacles. Collaborations with researchers, healthcare professionals, and other stakeholders can aid in devising evidence-based strategies for the industry's unique challenges. As highlighted by Yazdani and Wells (2018), integrating MSD prevention measures into management systems is pivotal, and organisations should be aware of the challenges they might face in this integration process.

Lack of Ergonomic Design. The New Zealand meat industry faces ergonomic concerns regarding the tools and equipment utilised throughout the meat processing stages. Using non-ergonomically designed equipment can result in ergonomic hazards like awkward postures, repetitive movements, and excessive force. For instance, poorly designed knives may lead to repetitive strain injuries. Similarly, inappropriately designed workstations can cause back, neck, and shoulder strains. This significantly elevates the risk of work-related MSDs. Addressing this necessitates investments in ergonomically designed tools and adequate ergonomic training for workers (Meat Industry Health and Safety Forum, 2020).

Limited Worker Participation. In the meat industry, workers often remain excluded from shaping MSD prevention programs despite their first-hand experience. This exclusion can reduce program success due to diminished worker buy-in and engagement. Workers might perceive the program as impractical or irrelevant when they feel disconnected. Conversely, active worker participation increases engagement, program success, and effective hazard identification. Such involvement is paramount for establishing safer workplaces and can significantly mitigate MSD risks (WorkSafe, 2023; Farr, Laird, Lamm, & Bensemann, 2019).

Inadequate Work Organization. Work organisation is instrumental in preventing MSDs in the NZ meat processing sector. Risks like repetitive motions, awkward postures, and forceful movements intensify with poor work organisation. For example, high-speed processing lines can cause fatigue and injury due to their demanding pace. Limited breaks further contribute to muscle overuse and subsequent MSDs. The absence of job rotation and ergonomic practices in some facilities exacerbates the situation, emphasising the importance of addressing these organisational challenges. For optimal MSD prevention, the industry should focus on ergonomic design, job rotation, and scheduled breaks (Canadian Centre for Occupational Health and Safety, 2019; Padula, Comper, Sparer, & Dennerlein, 2017).

Time Pressures. Workers in the meat processing industry often face intense production targets, compelling them to prioritise speed, which can overshadow safety considerations. This rush can lead to workers adopting unsafe postures, exerting excessive force, and not taking adequate breaks, all contributing to MSD risk (Tappin, et al., 2007). An environment emphasising speed might also deter workers from reporting injuries. To mitigate these risks, employers should emphasise safety over production, offer regular training on safe practices, and implement measures such as job rotations and breaks.

Limited Training and Supervision. In the meat processing sector, a key contributor to the heightened risk of MSDs is insufficient training. Many newcomers to the industry often lack adequate training on safe work practices. This deficiency means they might not execute tasks safely, use equipment correctly, or recognise early MSD symptoms like pain, leading them to delay seeking medical help (Huziej, 2022). Furthermore, the absence or inadequate training of supervisors exacerbates the problem, as they play a pivotal role in guiding workers. To address this, employers should prioritise comprehensive training for workers on topics such as correct lifting techniques and MSD symptom recognition. Refresher courses are also vital. Equally important is training supervisors to identify unsafe practices and ensure they are on-site to oversee workers and institute immediate corrective actions (Yanar, Lay, &

Smith, 2019). To safeguard workers and boost productivity, the industry must ensure that workers and supervisors are well-trained in safety measures.

Limited Training and Education for MSD Prevention. Despite the high risk of MSDs in the meat processing sector, training and education on MSD prevention are often inadequate. Training should encompass a variety of preventive measures. Education on MSD prevention should include topics such as correct lifting techniques, ergonomic workstation design, stretching and warm-up exercises, and the significance of taking breaks and rotating tasks. Additionally, workers need to be educated on recognising the symptoms of MSDs, like pain and stiffness in the impacted regions (EU-OSHA, 2012). Ensuring comprehensive training and education on MSD prevention is critical to foster a safe work environment.

Inadequate Equipment. The use of outdated or improperly maintained equipment in the meat processing industry amplifies the risk of MSDs (Meat Industry Health and Safety Forum, 2013). Employers can also adopt measures like providing ergonomic equipment and rotating jobs. Tasks like lifting and cutting, when combined with subpar equipment like blunt knives or poorly designed workstations, increase the strain on workers' bodies. Moreover, outdated machinery might pose additional hazards like excessive vibration or noise. Addressing these issues requires regular equipment maintenance, investment in ergonomic workstations, and continuous training on equipment use.

Workplace Culture as a Barrier to Preventing MSDs. Workplace culture significantly influences the prevention of MSDs; a positive culture promotes safe work habits, employee well-being, and injury prevention. Conversely, a culture that overlooks employee safety can push workers to overextend physically, increasing MSD risks. A sentiment that acknowledges the physically demanding nature of meat processing work and the inevitability of injuries acts as a barrier to reporting injuries (Yazdani & Wells, 2018). Key issues in the industry include a prevalent "macho" culture discouraging injury reports, the prioritisation of rapid production over ergonomics, and inadequate communication between employees and management (Redivo & Olivier, 2021). Addressing these cultural barriers is vital for MSD prevention. Effective strategies include fostering a safety-focused culture, offering ergonomic training, enhancing communication, and implementing policies centred on employee health.

Language and Cultural Barriers. Language and cultural barriers present significant challenges in the New Zealand meat processing industry, especially in preventing MSDs. A clear understanding of safety protocols is essential, but language barriers can impede comprehension of guidelines, leading to risks in ergonomic practices, equipment usage, and safe lifting techniques. These barriers also impact the effectiveness of training programs, causing gaps in technical knowledge and compliance with safety standards (Arcury, Estrada, & Quandt, 2010). Communication challenges due to language differences can also compromise safety, risk management, and even product quality standards. Culturally diverse workforces bring varied norms and expectations; without good understanding and sensitivity, this can result in misunderstandings and a negative work environment (Farnaaz, 2020). Addressing language and cultural barriers is pivotal for safety, quality control, and efficient operations in the industry.

Limited Access to Healthcare. In the meat processing industry, limited access to healthcare hinders MSD injury prevention. Challenges like affordability, lack of health insurance, and unfamiliarity with the healthcare system, especially among immigrant or culturally diverse workers, prevent timely medical care for MSDs (Suphanchaimat, Kantamaturapoj, Putthasri, & Prakongsai, 2015). Delayed medical attention can exacerbate conditions, leading to more severe, chronic issues, potential long-term disability, and hindering job performance. Such barriers to healthcare result in postponed or insufficient care for MSD injuries, emphasising the need for improved access and understanding of the healthcare system.

High Production Demands. New Zealand's meat processing industry is fast-paced and physically demanding, encompassing activities like slaughtering, butchering, and packaging (IBISWorld, 2023). Workers often face rigorous production targets due to high market demand, leading them to work rapidly under tight deadlines (Heathrose Research, 2013). This urgency to meet production goals can overshadow the importance of worker safety, potentially neglecting essential safety protocols, workplace ergonomics, and hazard prevention, thereby increasing the risk of MSDs among employees.

Limited Resources. Financial restraints impact many meat processing companies, especially smaller ones. Due to limited financial resources, these businesses frequently face challenges in investing in ergonomic assessments, controls, and training. Tight budgets can prevent these businesses from conducting comprehensive assessments, upgrading equipment, or implementing training programs. The high costs of specialised equipment or consultations can be daunting for them, often resulting in the use of outdated equipment, which increases the risk of MSDs among workers (Yazdani & Wells, 2018).

Resistance to Change. Resistance to change in the meat processing industry can hinder MSD prevention efforts. Both workers and managers may resist altering work practices or adopting new controls due to concerns about costs, productivity, or workflow disruptions (Yazdani & Wells, 2018). Overcoming this resistance is vital for effective MSD prevention. By emphasising continuous improvement and worker well-being, organisations can foster safer work environments, benefiting both employees and the business (Stoewen, 2016).

Inadequate Reporting and Tracking of MSD incidents. In the meat processing industry, the absence of thorough reporting and tracking of MSD incidents obscures the true extent and seriousness of these injuries, making it hard to pinpoint problem areas and assess prevention measures (J. Spiers, personal communication, 19 May 2023). Inadequate data collection impedes targeted solutions and hampers resource allocation. A robust reporting system is vital for capturing detailed data, understanding MSD trends, and implementing tailored prevention strategies (Van Eerd et al., 2022). By promoting a culture of timely incident reporting, organisations can ensure better treatment responses, reduced injury severity, and informed decision-making for effective preventive measures (WorkSafe, 2023).

Key insights. To successfully address barriers to MSD injury prevention, a comprehensive approach is necessary, involving worker involvement, ergonomics, work organisation, training, and oversight is essential. Collaborative efforts between employers and employees can pinpoint risks and introduce measures like ergonomic tools, task rotation, and timely injury reporting. Prioritising worker safety over production goals and offering suitable training and supervision ensures safer job execution.

5.2.4. Research question 4: What MSD trends can be Observed at AGL?

Research question four seeks to discern MSD injury trends at AGL through a statistical examination of the AGL database. This database contains data from the past five years on MSD occurrences across seven different meat processing plants. Data was extracted and collected in MS Excel format, allowing the use of the program’s statistical tools. Bradwell et al. (2022) describe the use of data harmonisation to standardise varied datasets from these plants, ensuring their effective comparison and analysis. In cases of missing or incomplete data, values were cross-referenced with incident reports from all plants. The use of plant-specific ratios and department and injury task percentage rates allowed for a more comparable range of data points. However, this would not account for the differences in Plant size, “chain” length (or size) or species variations that were present. Table 5.2 summarises the predominant musculoskeletal injury trends throughout all AGL business divisions, including plants and inter-plant departments. It details the tasks causing the injuries, the affected body locations, and the experience level of the injured employees.

In the Corporate sector, the Livestock team was at the highest risk, with the "Drafting" task being the primary cause of injuries. The most injured body parts were the knees (14%) and backs (11%). Notably, 84% of these injuries occurred in employees with over five years of experience. Additionally, a concerning 2.6:1 lead/lag ratio indicates that for every 2.6 Discomfort/First Aid injuries reported, we can anticipate one significant (LTI or MTI) injury. This ratio implies that injuries within this group tend to be more severe.

Dannevirke stands out as AGL’s safest plant, boasting an impressive lead/lag ratio of 185:1. Injuries from packing in Further Processing 1 (FP1) make up 11% of the MSDs on-site, a percentage that appears just above the plant average (9.2%) for the packing task. The reporting rate for discomfort is commendable at 71%, with back injuries predominating among the more experienced (older) employees. This trend presents an opportunity to reassess work postures and perhaps introduce work-hardening programs to protect and strengthen the employees' backs against injury.

Table 5.2

Leading Musculoskeletal Injury Trends Across all AGL Business Divisions, Plants, Departments, Injury Causing Tasks, Injured Body Location and Employee Experience

Leading Musculoskeletal Injury Trends (5 season data)						
AGL Sector	**Top ranked Injury Departments**	**Top ranked Injury Causing Tasks**	**Top ranked Injury Type**	**Top ranked Injured Body Location**	**Injury ranking by Level of Experience**	**Lead/Lag Injury Ratio**
Corporate (n=32)	*Livestock (41%)* *People and Safety (19%)* *Finance (16%)*	*Drafter (31%)* *Clerical (22%)* *Supervising (16%)*	*Sprain/Strain (59%)* *Discomfort (28%)* *Aches/pain specific (9%)*	*Knee (14%)* *Back (11%)* *Neck (9%)* *Shoulder (9%)*	*>5 yrs (84%)* *1-5 yrs (16%)*	**2.6:1**
Dannevirke (n=744)	*Further Processing 1 (38%)* *S/Bd Labourers (30%)* *S/Bd Chain 1 (16%)* *Load out (8%)* *Pelts (2%)*	*Packing (11%)* *Carton Handling (7%)* *Viscera trays (6%)* *Gutting tasks (5.6%)* *Y cut (5%)*	*Discomfort (71%)* *Aches/pain specific (28%)*	*Back (21%)* *Wrist (20%)* *Shoulder (18%)*	*>5 yrs (40%)* *1-5 yrs (26%)* *First mth (18%)* *1-6 mths (13%)*	**185:1**
Levin (n=403)	*Further Processing 1 (25%)* *Beef Boning (21.5%)* *S/Bd Chain 1 (20.5%)* *Load out (8.4%)* *Beef Slaughter (5.7%)*	*Packing (12%)* *Trimming (8%)* *Bulk Packing (7%)* *Carton Handling (5.7%)* *Boning (5.7%)*	*Discomfort (71%)* *Aches/pain specific (18%)* *Sprain/Strain (6%)* *Aches/pain gradual (5%)*	*Back (33%)* *Shoulder (17.4%)* *Wrist (16%)*	*1-5 yrs (45.7%)* *>5 yrs (27%)* *6 mths-1yr (17%)* *First mth (3.9%)*	**39:1**

Table 5.2 *(continued)*

AGL Sector	Top ranked Injury Departments	Top ranked Injury Causing Tasks	Top ranked Injury Type	Top ranked Injured Body Location	Injury ranking by Level of Experience	Lead/Lag Injury Ratio
Lorneville (n=3234)	*Further Processing1 (24.4%)* *S/Bd Labourers (13.5%)* *Further Processing 2 (10.3%)* *Further Processing 4 (8.4%)* *S/Bd Chain 1 (7.1%)*	*Boning (11%)* *Packing (9%)* *Carton Handling (4%)* *Trimming (3.7%)* *General Labouring (3.7%)*	*Discomfort (51.4%)* *Aches/pain specific (21%)* *Sprain/Strain (17.4%)* *Aches/pain gradual (7%)* OOS (2.5%)	*Wrist (17.7%)* *Back (15.8%)* *Shoulder (15.5%)* *Hand (10%)* *Elbow (6%)*	*>5 yrs (45.4%)* *1-5 yrs (27.6%)* *1-6 mths (14%)* *First mth (13%)*	**22.4:1**
Mataura (n=1202)	*Beef Boning (43.2%)* *Beef Slaughter (39.1%)* *Freezers (3.6%)*	*Packing (13.3%)* *Trimming (11.8%)* *Boning (8.9%)* *Beef Slaughter B-grade (7.4%)* *Cleaning (6.8%)*	*Sprain/Strain (58%)* *Discomfort (36.8%)* *Aches/pain specific (4%)*	*Back (24.9%)* *Shoulder (19.2%)* *Wrist (12.1%)* *Elbow (8%)*	*>5 yrs (46.8%)* *1-5 yrs (33.4%)* *1-6 mths (14%)* *First mth (5.5%)*	**18.4:1**
Nelson (n=623)	*Further Processing1 (38%)* *S/Bd Labourers (24.9%* *S/Bd Chain 1 (16.7%)* *Stock Yards (6.7%)* *Pelts (3.7%)*	*Packing (8.3%)* *Boning (7.1%)* *Shepherding (6.1%)* *Offal (5.5%)* *Cleaning (5%)*	*Discomfort (73%)* *Aches/pain specific (21.8%)* *Sprain/Strain (3.4%)*	*Back (22.6%)* *Shoulder (17%)* *Wrist (12.8%)* *Elbow (4.2%)*	*>5 yrs (44.5%)* *1-5 yrs (27 %)* *1-6 mths (13%)* *First mth (8.8%)*	**22.7:1**

Table 5.2 *(continued)*

AGL Sector	Top ranked Injury Departments	Top ranked Injury Causing Tasks	Top ranked Injury Type	Top ranked Injured Body Location	Injury ranking by Level of Experience	Lead/Lag Injury Ratio
Pukeuri (n=3180)	*Further Processing 5 (15%)* *S/Bd Labourers (23.9%* *S/Bd Chain 1 (8.3%)* *Beef Boning (8%)* *Beef Slaughter (7.7%)*	*Boning (10.7%)* *Carton Handling (6%)* *Packing (5.1%)* *General Labouring (4.6%)* *Kidney Enucleator (4.3%)*	*Discomfort (89.3%)* *Sprain/Strain (8.1%)* *Aches/pain specific (1.8%)*	*Shoulder (20.5%)* *Back (16.6%)* *Wrist (15.5%)* *Hand (6.6%)* *Elbow (5.9%)*	*1-5 yrs (41.4 %)* *>5 yrs (27.5%)* *First mth (15.2%)* *1-6 mths (13.2%)*	**23.3:1**
Smithfield (n=1209)	*Further Processing 1 (18.4%)* *S/Bd Chain 1 (17.9%)* *S/Bd Labourers (10%* *Fancy Meats (8.9%)* *Freezers (6.5%)*	*Boning (11.4%)* *Packing (5.7%)* *General Labouring (5.7%)* *Trimming (4.5%)* *Meat Inspecting (3.4%)*	*Discomfort (49.6%)* *Sprain/Strain (23.7%)* *Aches/pain specific (20.3%)* *Aches/pain gradual (6.3%)*	*Back (18.5%)* *Wrist (17.6%)* *Shoulder (17%)* *Hand (7.2%)* *Elbow (6%)*	*1-5 yrs (48.4 %)* *>5 yrs (30.4%)* *1-6 mths (10.8%)* *First mth (5.8%)*	**30:1**

Note. The table summarises the leading musculoskeletal injury trends for each category. Highlights from each sector will be addressed in the subsequent text.

Levin ranks second with a lead/lag ratio of 39:1. The Further Processing 1 (FP1) and Beef Boning departments account for the highest percentages of reported incidents, at 25% and 21.5%, respectively. The top five tasks causing injuries also originate from these departments. The 71% discomfort reporting rate is noteworthy, especially with a significant 33% of injuries related to the back. Most of these injuries occur among employees with 1-5 years of experience (45.7%). This pattern provides an opportunity to revisit workstation design and work postures and improve manual handling skills, such as correct lifting techniques. The nature of processing beef, which involves handling larger and heavier products, also contributes to the types of injuries reported.

The Lorneville data reveals a notably higher conversion rate of musculoskeletal injuries from discomforts and first aid treatments to LTIs and MTIs compared to other plants. A discomfort reporting rate of 51.4% also correlates with an elevated Aches/Pain-gradual score (7%), which can escalate to Occupational Overuse injuries, which is evident at 2.5%. This escalation might be due to late identification, delayed treatment, or the likelihood that employees only report discomfort when it becomes a severe injury. Boning (11%), packing (9%), and trimming tasks (3.7%) across the Further Processing departments (FP1, FP2, and FP4) account for a significant share of the site's injuries. Notably, most of these injuries occur within the most seasoned employee group (45.4%). According to G. Vincent (personal communication, October 19, 2022), the mean age of this group is over 50. The observed patterns, combined with an ageing workforce, could be attributed to differences in the layout and design of the "longer" processing lines. Larger teams and confined workspaces might also lead to more repetitive work being conducted. These trends underscore the importance of correct work postures, well-designed workstations, frequent task rotation, and targeted work hardening programs to focus on the most vulnerable areas.

Mataura's recordable injury ratio at 18.4:1 of all the processing plants poses the greatest recordable injury risk. This might be because it is the sole plant dedicated exclusively to beef processing, handling larger animals, and longer processing hours. Such conditions could also account for the plant having the highest sprains and strains at 58% of all plants. The wide range in carcass sizes, from Heifer, Cow, Steer, Prime Steer, to Bull, and workstation ergonomics that may not be optimal could also be contributing factors (as per D. Glover's personal communication on August 21, 2023). Mataura has the lowest discomfort reporting rate at 36.8% relative to other processing plants. Prompt reporting of discomforts can enhance treatment results, expedite recovery, and reduce the likelihood of the injury becoming an LTI or MTI.

Nelson presents intriguing injury data, with the Stock Yards accounting for 6.7% of recorded injuries and Shepherding making up 6.1% of injury-inducing tasks. Notably, 44.5% of these injuries occur among the most experienced employees. This suggests possible differences in the layout of Nelson's stockyards or in the manner tasks are carried out compared to other plants. Focused safety assessments in this area could help identify the underlying factors contributing to these injuries.

Pukeuri, which processes both bovine and ovine, has a recordable injury ratio of 23.3:1. Employees with 1-5 years of experience are the most frequently injured, representing 41.4%. Most injury categories and types align with averages seen in other mid-range plants, and the plant maintains solid discomfort reporting. However, the Kidney Enucleator task, which accounts for 4.3% of injuries and ranks in the top five, merits closer examination when compared with other plants.

Smithfield is a multi-species processing plant that processes bovine (bobby calves), cervine, and ovine species. It has a recordable injury rate of 30.1:1. Employees with 1-5 years of experience are the most prone to injuries, making up 48.4% of the injury cases. While most types and categories of injuries at Smithfield are consistent with averages from other mid-sized plants, there are specific concerns to note. The Fancy Meats department accounts for 8.9% of the plant's MSD injuries, warranting a more in-depth comparison with other plants. There is also an unusual trend of meat inspectors making up 3.4% of the injuries; this could be linked to their workstations' design. The primary areas of injury are the back (18.5%), wrists (17.6%), and shoulders (17%). Targeted injury prevention training would benefit these areas.

Table 5.3 compares each plant's contribution to overall musculoskeletal injuries over a five-season period. This data is valuable for identifying outliers and discrepancies. Specifically, it helps pinpoint areas that may require attention, such as treatment protocols, work organisation, and any differences in plant and equipment.

Table 5.3

Plant Contribution to Total Musculoskeletal Injury across the Five Season Period

Musculoskeletal Injury Leanings (5 season data)							
Plant	**Count of Workforce ***	**Percentage of Plant Workforce**	**Rank in Workforce**	**Count of MSK Injuries**	**Percentage of MSK Injury**	**Rank in MSK Injuries**	**Lead/Lag MSK Injury Ratio (Rank)****
Dannevirke	251	5.2%	6	744	7%	5	**185:1 (7)**
Levin	426	8.8%	5	403	3.8%	7	39.1:1 (6)
Lorneville	1810	37.4%	1	3234	30.5%	1	22.4:1 (2)
Mataura	558	11.5%	4	1202	11.3%	4	**18.4:1 (1)**
Nelson	198	4.1%	7	623	5.9%	6	22.7:1 (3)
Pukeuri	947	19.6%	2	3180	30%	2	23.3:1 (4)
Smithfield	645	13.3%	3	1209	11.4%	3	30.1:1 (5)

Note. * Workforce numbers on 3 April 2021 (number varies continually).

** A higher ratio corresponds to a lower frequency of recordable musculoskeletal injuries (LTI/MTI); thus, a higher ratio is desirable.

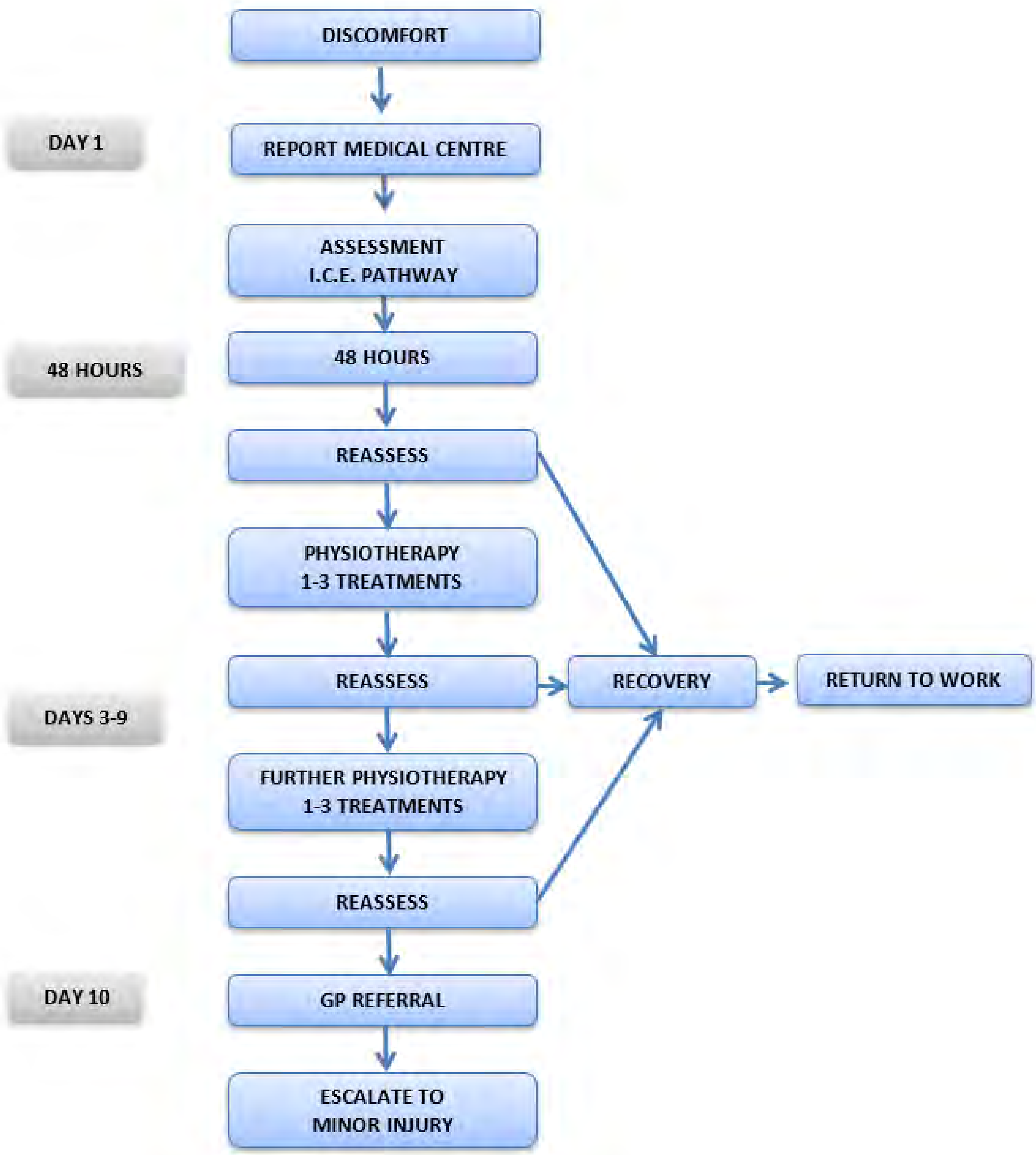
The data from the five-season period reveals that Pukeuri has the highest proportion (30.5%) of Musculoskeletal (MSK) injuries per person of all the AGL processing plants. Lorneville follows, though its significance is always accentuated due to its large employee count and its substantial contribution to MTI/LTI incidents. Interestingly, Mataura, which is solely a beef processing plant with intensive workloads (processing larger animals for extended hours), sits midline in terms of MSK injuries. Yet, it has the highest recordable injury ratio (18.4:1). This may be because Mataura is the only plant solely focused on beef processing, which involves handling larger animals and requires more processing hours. This could also account for the highest occurrence (58%) of sprains and strains among all the plants.

On a positive note, Dannevirke and Levin showcase the best recordable injury ratios, aligning with their high discomfort reporting levels at 71%. The observed trends underscore increased discomfort reporting, leading to a decline in musculoskeletal injuries. This suggests that preventive measures at these plants are effective. It might also reflect the efficient use of treatment pathways for injured employees at these sites. For a detailed overview of the AGL discomfort pathway, refer to Figure 5.6.

Key insights. The fourth research question aimed to identify MSD injury trends at AGL by statistically examining the AGL database. This database holds five years' worth of data on MSD incidents from seven distinct meat processing plants. Percentages and ratios were employed to effectively compare and analyse the data between these plants. This analysis highlighted a few departments and tasks from each processing plant that are major contributors to musculoskeletal injuries. However, it is worth noting that the full breadth of the data presented in Appendices E-P serves as a foundational point for injury prevention.

Figure 5.6

AGL Discomfort Pathway



Note. The flowchart outlines the procedure for addressing discomfort (injury) to facilitate a swift recovery. The effectiveness of this process hinges on the prompt reporting of injuries.

By examining detailed comparisons within high-risk departments and tasks, either individually or collectively, we can formulate injury prevention strategies. Allocating resources and funding to areas with high injury occurrences can pave the way for better returns on investment. This data promotes collaborative efforts between employers and employees to identify risks. Subsequently, this can lead to the introduction of measures such as ergonomic tools, workstation improvements, enhanced task rotation schedules, and increased staff during high-demand periods. Furthermore, it aids in identifying alternative or lighter-duty tasks for positions with a high injury risk. Prioritising worker safety safeguards our workforce and can boost productivity through enhanced training and supervisory oversight, ensuring tasks are executed more safely.

5.2.5. Research Question 5 - Which MSD Prevention Interventions have been Effective in Addressing MSD at AGL?

To ascertain the effectiveness of MSD prevention interventions at AGL, the researcher conducted a focus group discussion with Health and Safety managers, advisors, and injury management personnel to discuss variations between processing plants and known successful interventions. The focus group identified the following successful interventions.

Discomfort Reporting. Early reporting of MSD symptoms is crucial. Promptly identifying and addressing discomfort, especially at the room level, benefits workers and fosters a culture of trust and easy interaction. Early detection of MSDs, whether sprains, strains, tendinitis, or other conditions, allows for accurate diagnosis and timely treatment, preventing the disorder's progression.

When MSD symptoms are recognised early, healthcare professionals can offer guidance on activities or ergonomic adjustments to avert further harm. This minimises the risk of exacerbating the condition and promotes quicker recovery. Early intervention can encompass treatments like medication, physical therapy, occupational therapy, or chiropractic care, targeting the root cause before it worsens.

Personalised treatment plans crafted for an individual's needs can include pain management, strengthening exercises, stretching routines, and ergonomic adjustments aligned with their lifestyle and work demands. Such proactive treatments alleviate pain, reduce inflammation, restore mobility, and deter secondary complications from prolonged MSDs, ensuring rapid recovery and a speedy return to regular activities.

In essence, early reporting of MSDs paves the way for proactive, tailored treatments, resulting in better outcomes, minimised condition severity, and swift recoveries. Thus, it is imperative to promptly relay any MSD symptoms or concerns to healthcare professionals for optimal management.

Stretching Programs. Encouraging active participation in stretching can be enhanced through improved stretching initiatives, such as increasing awareness with more posters in rooms. Pre- and post-work stretching programs offer increased flexibility, decreased muscle tension, and enhanced joint range of motion, helping prevent MSDs (King et al., 2020). Specifically, dynamic stretching before work prepares muscles, while post-work static stretching helps relax them. In essence, these programs reduce the risk of MSDs and serve as effective warm-up and cool-down routines for better workplace performance (Alger-Norton, 2023).

Educational Initiatives. It is essential to educate supervisors and employees on early injury identification, good ergonomics, and the necessary steps to enhance well-being in the workplace. Shaw, Robertson, McLellan, and Pransky (2006) also identified this perspective.

Discomfort Management Strategy. Once discomfort is identified and the Discomfort pathway (Figure 5.6) is followed, the focus should shift to prevention. This includes easing people back into their job tasks, starting with lighter tasks. It also emphasises the importance of acting swiftly on new injuries and collaborating with supervisors to find solutions. Furthermore, improving the discomfort management strategy would involve supervisor engagement and a shift towards a prevention focus.

Health and Safety Management. Health and Safety Managers should be kept well-informed about injuries. This calls for an improvement in the existing injury reporting systems. Moreover, considering earlier and more physiotherapy treatment sessions or a chiropractor's involvement (when joints need alignment) one day a week can be explored as an alternative treatment option for specific injuries.

Work Culture and Injuries. A consistent strategy for treating work and non-work injuries is important. The approach should reinforce the plant's culture of care, showing employees that their well-being is prioritised regardless of where an injury occurs.

Employee Management. This encompasses careful employee selection enhanced by improving pre-employment medicals and standards. High-risk employees need to be evaluated with work capacity testing. Identifying persons at risk early on is vital, possibly by developing an 'employees at risk' list. Furthermore, new employees should be eased into their roles, suggesting starting new employees on a Thursday, followed by a weekend of rest. Another essential factor is managing absenteeism effectively and ensuring that workloads are adjusted accordingly when staffing numbers are low.

Training and Equipment. Continuous support for interventions, especially manual handling skills training, is essential. This is complemented by ensuring an ongoing quality training program for employees. Additionally, the maintenance of the plant and equipment is crucial, necessitating an improved maintenance management system.

Frontline Leadership. Leaders at the frontline are instrumental in bringing about change. Regular leadership safety walks, for instance, can establish a safety culture. It is also recommended that pre-employment medicals undergo a peer review before finalising employee placement.

Key insights. This summarised discussion about successful interventions at AGL aims to highlight the need for a multi-faceted approach in addressing workplace injuries and discomfort, strongly emphasising early reporting, employee education, management strategies, and fostering a culture of care and safety.

5.2.6. Research Question 6 - What Barriers to MSD Prevention Exist at AGL?

Research question six aimed to identify barriers to MSD prevention at AGL through a focus group discussion involving all essential Health and Safety managers, advisors, and injury management personnel. The session drew heavily on findings from research question three about barriers in NZ meat processing and results from research question four concerning MSD prevention strategies. These insights were combined to discern potential barriers to MSD prevention. The focus group identified several challenges and barriers to preventing MSDs in the workplace, each demanding specific actions for mitigation. A critical challenge was the impact of "Seniority," wherein employees were moved into a new season regardless of physical readiness, and a similar issue arose with returning seasonal workers in potentially poor physical condition. The actions suggested included implementing a fit-for-work assessment and determining the suitability of employees within the seniority group. The misplacement of employees with higher injury risk and premature approval of task competencies were also noted, with resolutions involving assigning at-risk employees to suitable positions and ensuring workers are sufficiently job-ready before approval, respectively. Addressing the adequate engagement of conversations about work/injury status, particularly in the context of seniority versus suitability, led to the proposal of a five-year work/injury status suitability discussion. A lack of empathy towards recovering employees was another concern, emphasising a need to nurture a culture of empathy and compassion. This aligns closely with one of AGL's core values: Care. Challenges like dwindling production resources and increased workload on health and safety managers due to resource shortages and limited training opportunities have also pointed towards increased resourcing and improved training provisions. Absenteeism-related problems impacting unfit employees required increased staffing to mitigate pressures. Furthermore, restricted budgets for ergonomic investments, the impact of extended working hours, and poor stock quality were met with solutions like allocating additional resources, implementing plans to manage or consider limiting extended hours, and enhancing livestock selection criteria, respectively. The underlying theme was a robust strategy incorporating preventive measures, appropriate resourcing, and empathy to safeguard worker well-being while maintaining production efficacy.

5.2.7. Research Question 7 - Which Factors Need to be Considered when Developing a Systematic MSD Prevention Program?

To address research question seven, which seeks to determine the essential factors for creating a systematic MSD prevention program, secondary data analysis and reviews will be combined with the findings from previous research questions. Developing a targeted Work-Related Musculoskeletal Disorders (WRMSDs) prevention program for the meat processing industry necessitates a holistic approach, encompassing assessment, intervention, training, and ongoing enhancement. It is vital to recognise the significant diversity within the meat processing sector. Even within individual companies, variations arise due to factors like plant and equipment design and workforce size, including cultural and psychosocial elements. These variations will affect the specifics of a WRMSD prevention program. While the steps proposed by the researcher are tailored to address the needs of AGL, many aspects can apply to other meat processing companies. Creating a WRMSD prevention plan begins by identifying appropriate safety metrics to monitor. These indicators provide crucial insights into which areas require emphasis to optimise results and enhance the company's safety performance (Vector soultions, 2020). As the company's CEO, Willie Wiese, succinctly expressed on November 9, 2022, it is about "fishing where the fish are."

Utilising Lead and Lag indicators aligns with worker expectations for safety and well-being. Employees anticipate that their employers will prioritise these aspects, highlighting the need for regulatory compliance in the contemporary workplace. This commitment is essential for instilling confidence among workers regarding their safety and fostering automatic safety behaviours within organisations that emphasise safety. Effective implementation of leading indicators can mitigate workplace injuries and illnesses, reduce incident-related costs, enhance productivity, optimise safety and health performance, and increase worker engagement. Organisations using these indicators for continuous improvement can outperform competitors, demonstrating social responsibility and valuing employees. This proactive approach also leads to cost savings and overall performance improvement. A comprehensive health and safety program that integrates both leading and lagging indicators enables organisations to identify and encourage safe behaviours, promote a proactive safety culture, involve all personnel in creating a safe working environment to identify hazards proactively, and spread best practices throughout the organisation (SAI360, 2020).

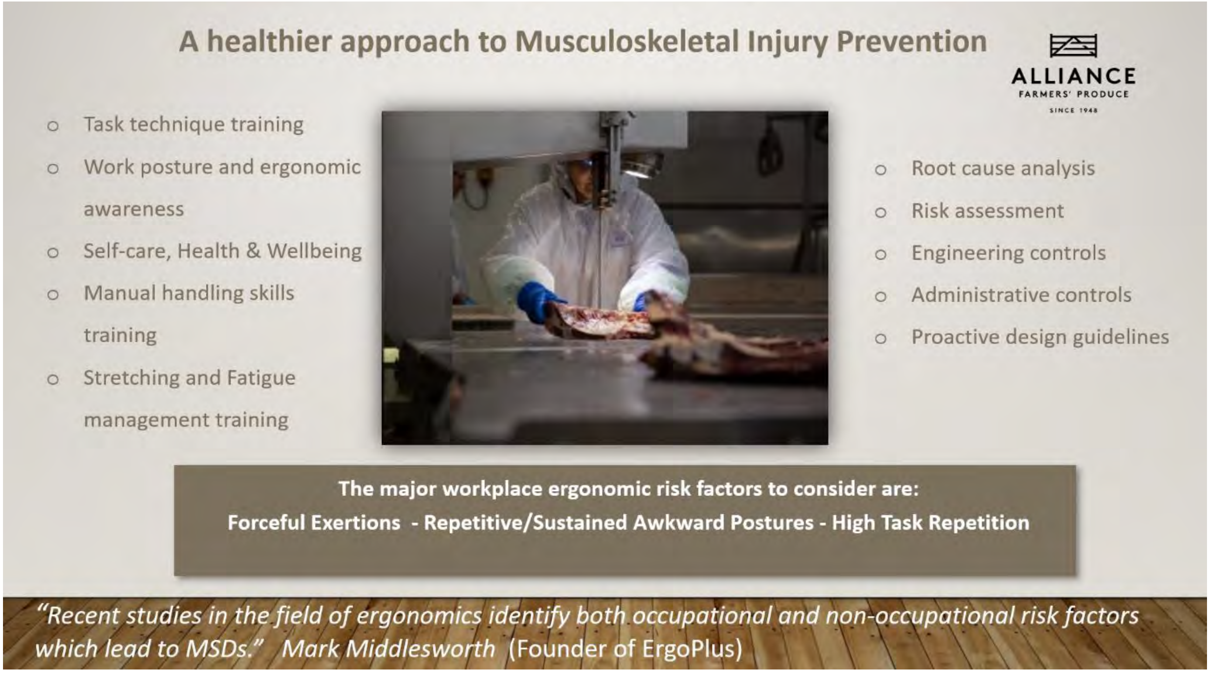
Key considerations in developing a systematic MSD prevention program. The subsequent sections outline the critical components to develop a thorough MSD prevention program. Initially, the process involves identifying the precise locations of injuries, their nature, and occurrence frequency. This crucial first step forms the foundation for an in-depth analysis of the comprehensive approach necessary to devise and enact a systematic strategy for MSD prevention. This strategy encompasses various aspects, ensuring that the program effectively addresses the complexities of injury prevention and managing MSDs.

Robust injury reporting **system.** The initial step in the process involves identifying the specific locations where injury incidents occur. It is crucial to gather accurate data on these incidents to understand their nature and frequency. This requires a well-established and efficient injury reporting system that captures and documents every incident, injury, or near miss. Once an incident is reported, it is imperative to conduct a comprehensive investigation to determine the underlying causes and identify measures that could have prevented the injury or reduced the associated risk. This thorough approach ensures that effective preventive strategies can be developed and implemented, aiming to enhance workplace safety and minimise the occurrence of future incidents.

Hazard Identification. A hazard in the workplace is any element or behaviour that might harm an employee. MSDs, however, do not have a singular cause. Boocock et al. (2009) noted the challenge of defining all WRMSDs under one term due to their complex, multifactorial nature. The crucial step is to accurately pinpoint all risk factors contributing to the onset of MSDs. Work-related risk factors contributing to hazards can be classified into five categories: biomechanical and physical factors related to the physical nature of tasks; work organisation factors, which concern how work is structured; environmental factors related to the working surroundings; individual factors which pertain to person-specific variables; and psychosocial factors, concerning emotional states and interpersonal relationships. Additionally, non-work factors, such as sporting activities or hobbies outside of work, may also pose risks by contributing to muscle fatigue (Worksafe, 2023). When pinpointing factors affecting WRMDs, it is crucial to consider contextual factors. These are external influences that shape situations, decisions, or outcomes. Health and safety cover aspects like environmental conditions, organisational culture, workplace policies, and socio-economic conditions. These factors can influence ergonomic designs, work methods, and employee behaviours, potentially heightening risks, particularly in meat processing. Awareness of and comprehension of these factors can bolster the effectiveness of strategies targeting MSD risk reduction in industries (Tappin, Bentley, & Vitalis, 2008). Conducting a root cause analysis is essential for WRMSDs. This procedure will entail careful consideration of all the risk factors that may impact the injury and an ergonomic evaluation to pinpoint tasks or specific areas with potential MSD risks. Figure 5.7 presents a more practical approach to preventing musculoskeletal injuries. This illustration is taken from an AGL injury prevention workshop designed by the researcher to boost employee engagement with the MSD injury prevention strategy.

Figure 5.7

A Healthier Approach to Musculoskeletal Injury Prevention



Note. The image is taken from the "Developing an Ergonomics Eye" workshop which was developed by the researcher (Appendix P). It summarises the MSD injury prevention strategy to mitigate musculoskeletal injury risk.

Employee Feedback. As the end user, the employee possesses valuable insights into the core issues. Employ methods like surveys, interviews, and suggestion boxes to collect employee feedback regarding MSD-related issues or symptoms they might be encountering.

Policy Development. Formulate a clear policy statement emphasising the organisation's commitment to preventing and managing MSDs. Define roles and responsibilities for the program's implementation and management.

Training and Education. Train employees about correct ergonomics, safety procedures, and the significance of prompt reporting. Supervisors and managers should be educated on identifying MSD symptoms and associated risk factors.

Ergonomic Interventions. Implement workstation modifications or adjustments to accommodate the user. For office workers, for instance, introduce enhancements such as adjustable chairs, ergonomic mouse/keyboards, or standing desks. For process workers, modify workstations, tools, or equipment to minimise strain, vibration, or repetitive motion. Implement job rotation or cross-training for employees to avert prolonged task repetition. Encourage short, frequent micro-pauses to allow muscles to recover.

Mitigating Barriers. Research question six explored barriers to MSD prevention at AGL using a focus group that relied on insights from known barriers in NZ meat processing and considered how this might impact MSD prevention strategies. The group identified numerous challenges to preventing MSDs in the workplace, each requiring specific mitigation strategies. For example, one major challenge was the "Seniority" issue, where employees were transitioned into a new season irrespective of their physical readiness. The heightened risk of injury associated with an ageing workforce can be ascribed to the natural progression of ageing in conjunction with the physical requirements of specific occupations. As per StatsNZ (2017), the labour force segment aged 65 and over has been increasing. While they made up only 1% of the workforce in 1991, they now account for 6% and are projected to constitute 9% by the late 2020s. Addressing this demographic shift is crucial, especially in the meat processing industry. Implementing a "fit for work" procedure is essential to prevent employees from being susceptible to MSDs. Thorough evaluation, careful job selection, and correct work placement to limit exposure to high-injury tasks are vital. Consideration for alternative job roles, specific tasks to condition employees or ergonomic interventions is necessary to adapt to this evolving work scenario.

Early Reporting and Treatment. Strong evidence exists that using a systems-based risk management approach in primary prevention can reduce the incidence of new WMSDs. Additionally, effective multidisciplinary, coordinated care within a systems approach at the secondary prevention level can reduce the duration and costs of WMSD-related disabilities (Donovan, 2021). Rehabilitation programs are reactive, aiming to return injured workers to normal duties after an injury. However, early recognition, triage, and management of WMSD symptoms in the meat processing industry can prevent symptoms from becoming recordable injuries. Utilising injury management programs proactively, at the intersection of primary and secondary prevention, presents an opportunity for the industry to mitigate WMSD risk. Establishing a system that allows for prompt reporting (Figure 4.48) of discomfort or symptoms is essential, ensuring that employees can do so without fearing repercussions.

Ensure that reported symptoms receive prompt medical assessment and treatment (Figure 5.6). Make necessary workplace adjustments or modifications for affected employees based on the recommendations of healthcare professionals.

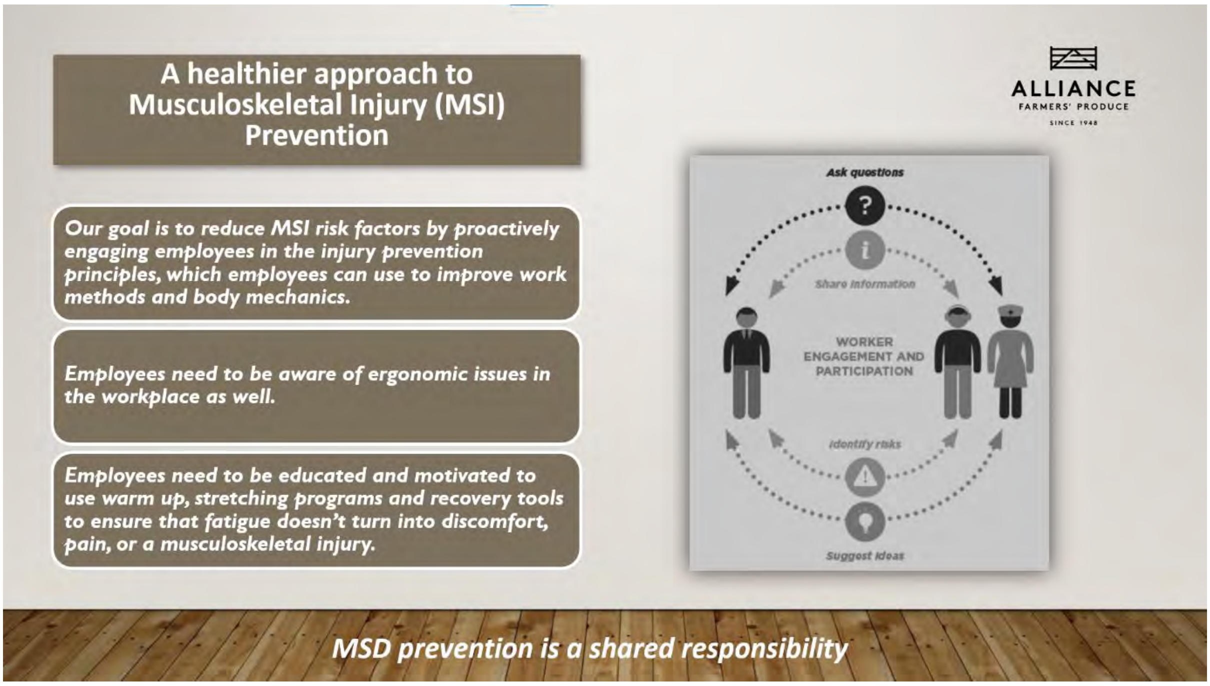
Monitoring and Evaluation. Consistently assess the impact of interventions using indicators like a decrease in MSD incidents, lowered task risk scores, employee feedback, and lower absentee rates. Refine the program in response to the feedback and data collected.

Communication. Communicate regularly with employees about the program, its goals, and any updates or changes. Share success stories or case studies to enhance morale and underscore the program's significance.

Engagement and Participation. Engage employees in the program's development and implementation, emphasizing that this is a collective responsibility. Establish a joint health and safety committee or an ergonomics committee, which includes both management and employees, to supervise and advocate for the program. At AGL, there are Musculoskeletal Steering committees. Figure 5.8 illustrates the process of ensuring good employee engagement and shared responsibility when embarking on a new ergonomics project.

Figure 5.8

Shared Responsibility a Part of Musculoskeletal Injury Prevention



Note. Content developed by the researcher as part of the musculoskeletal injury prevention initiative: Image taken from the 'Developing an Ergonomics Eye' workshop (Appendix P), which underscores the collective responsibility and the crucial role of worker engagement in preventing musculoskeletal injuries."

Documentation and Record Keeping. Maintain detailed records of ergonomic assessments (task analysis library is kept at AGL), training sessions, reported MSD cases, medical treatments, and intervention outcomes. Use this data to identify trends, problem areas, and the effectiveness of implemented interventions. This data will also be helpful to secure funding for future projects and to illustrate ROI to senior management teams.

Continuous Improvement. Keep abreast of the latest research and best practices in ergonomics and MSD prevention. Periodically reassess and refine the musculoskeletal injury prevention program to integrate emerging strategies and technologies.

By following these guidelines and ensuring regular updates based on feedback and emerging research, organisations can effectively manage and reduce the risk of work-related MSDs.

Emerging Technologies for the Prevention of Musculoskeletal Disorders. For the past thirty years, efforts have been made to adapt workplaces based on workers' capabilities, but work-related musculoskeletal disorders still prevail as a primary workplace concern. The current shift towards digitisation, automation, and computer intelligence in workplaces presents an opportunity to reduce ergonomic hazards by automating work processes and integrating new technologies. These advancements can substantially improve the prevention of MSDs by redesigning operational systems. Emerging technologies help reduce physical strain, enhance ergonomics, boost productivity, and provide improved training and guidance. In a recent report, the National Safety Council highlighted the value of emerging technologies in preventing MSDs. The report expands on resources (Figure 5.9) with insights covering computer vision, wearable sensors, exoskeletons, autonomous materials handling, and extended reality (XR). Key findings include the use of computer vision in large organisations for ergonomic risk analysis, wearable sensors as a financial alternative to engineering controls, and the adoption of passive exoskeletons in manual materials handling, which can reduce muscle activity by up to 40% (Reid, Maikala, DeBaylo, & Williams Ischer, 2023).

Figure 5.9

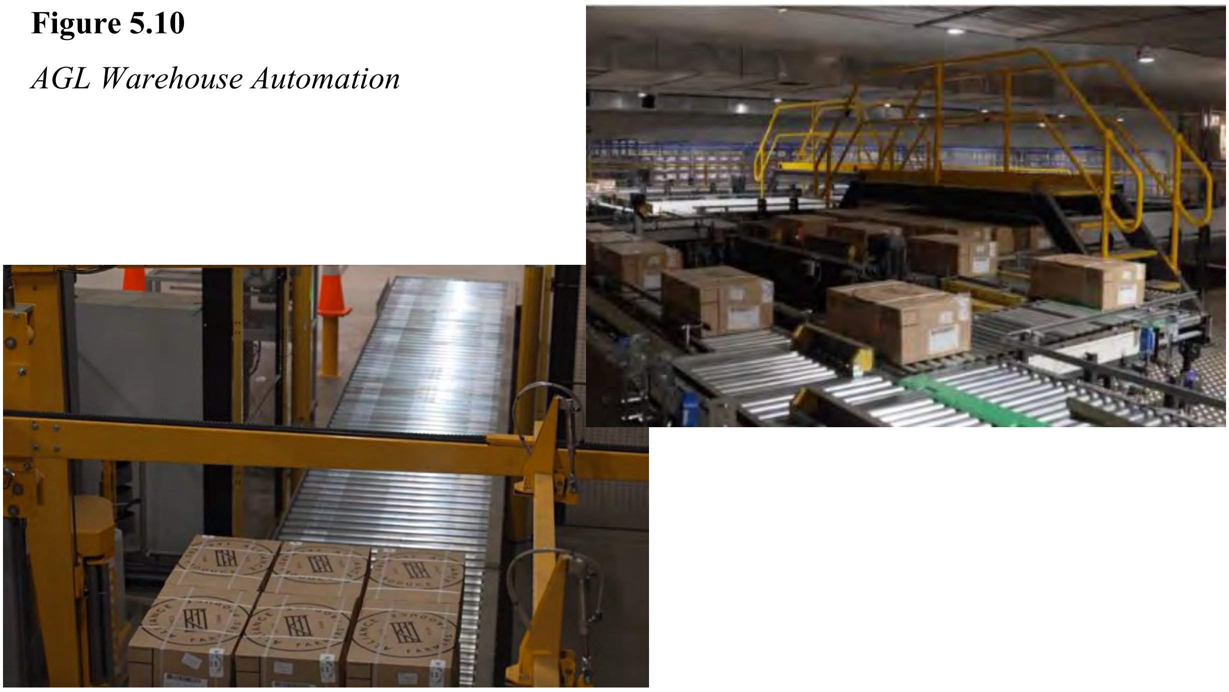
Emerging Technologies for the Prevention of Musculoskeletal Disorders

(Reid, Maikala, DeBaylo, & Williams Ischer, 2023)

Most of these new technologies have been adopted by AGL. Figures 5.10-5.13 highlight the use of emerging technologies at AGL to decrease MSDs within the company.

Figure 5.10

AGL Warehouse Automation

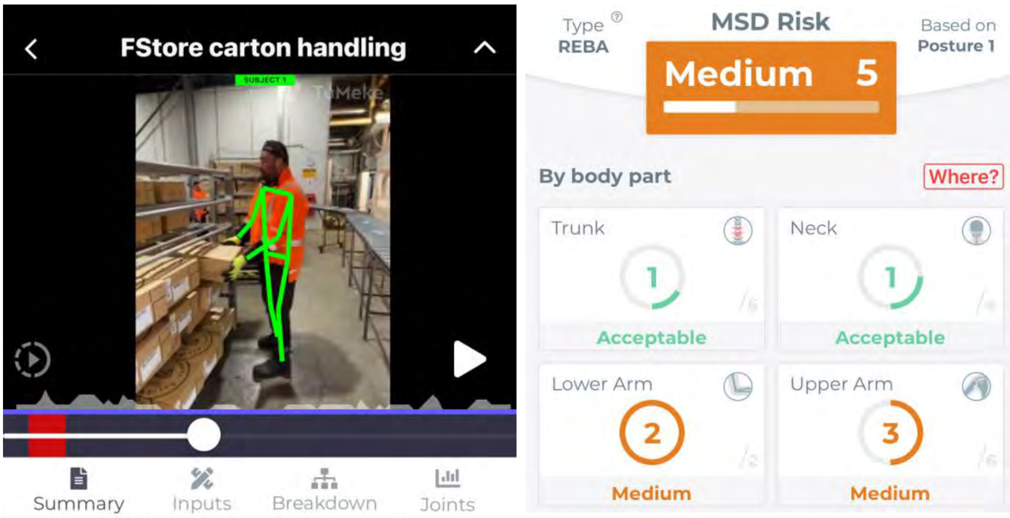


Note: At the AGL Lorneville plant near Invercargill, products are automatically moved and palletised throughout the warehouse without human intervention.

A $16 million automated storage and warehouse management system for frozen products has transformed the warehousing process at AGL's Lorneville plant. This system moves and palletises products automatically, eliminating the need for manual handling and reducing employee exposure to repetitive lifting and cold temperatures. This technological advancement has enhanced health and safety and increased efficiency, scale, and competitiveness. Previously, 66 workers manually handled over 3 million cartons, each weighing up to 27kg, posing a risk of musculoskeletal injuries (Alliance Group Limited, 2023).

Figure 5.11

Making use of Computer Vision to Reduce MSD's at AGL



Note: AGL has invested in TuMeke Ergonomics, which uses Computer vision joint tracking for ergonomic assessments and helps prevent MSD across its plants.

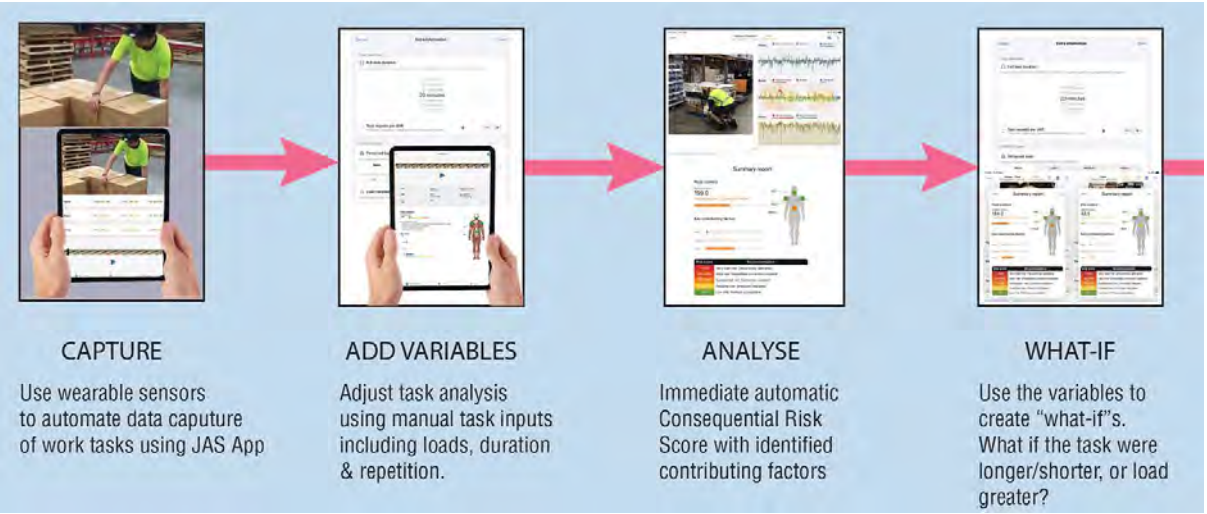
Implementing computer vision technology to minimise MSDs is crucial to a department-focused task risk analysis project at AGL. This analysis is pivotal in creating a comprehensive task risk library. Such a library will be instrumental in enhancing task rotation schedules and pinpointing tasks with a lower risk of joint-specific injuries. This approach will facilitate a more effective and graduated reintegration into the workplace for employees who are recuperating from injuries.

AGL has invested significantly in Joint Action Solutions, a company specialising in wearable sensor technology. This technology is specifically designed to empower Health and Safety teams by providing them with advanced tools for risk analysis. It enables these teams to investigate various intervention strategies effectively by creating "what if" scenarios. This process involves designing risk controls and comparing the outcomes after proposed interventions and injury-mitigating strategies have been implemented, particularly those aimed at reducing MSDs.

This innovative technology is now accessible across all AGL plants, enhancing their safety protocols. Notably, five of the seven AGL plants are equipped with their own sets of this technology, referred to as 'kits'. Additionally, these plants have team members who have received specialized training to utilize this equipment effectively. This strategic deployment of wearable sensor technology signifies AGL's commitment to enhancing workplace safety and proactively addressing health risks.

Figure 5.12

Making use of Wearable Sensor Technology to Mitigate Musculoskeletal Injury Risk at AGL

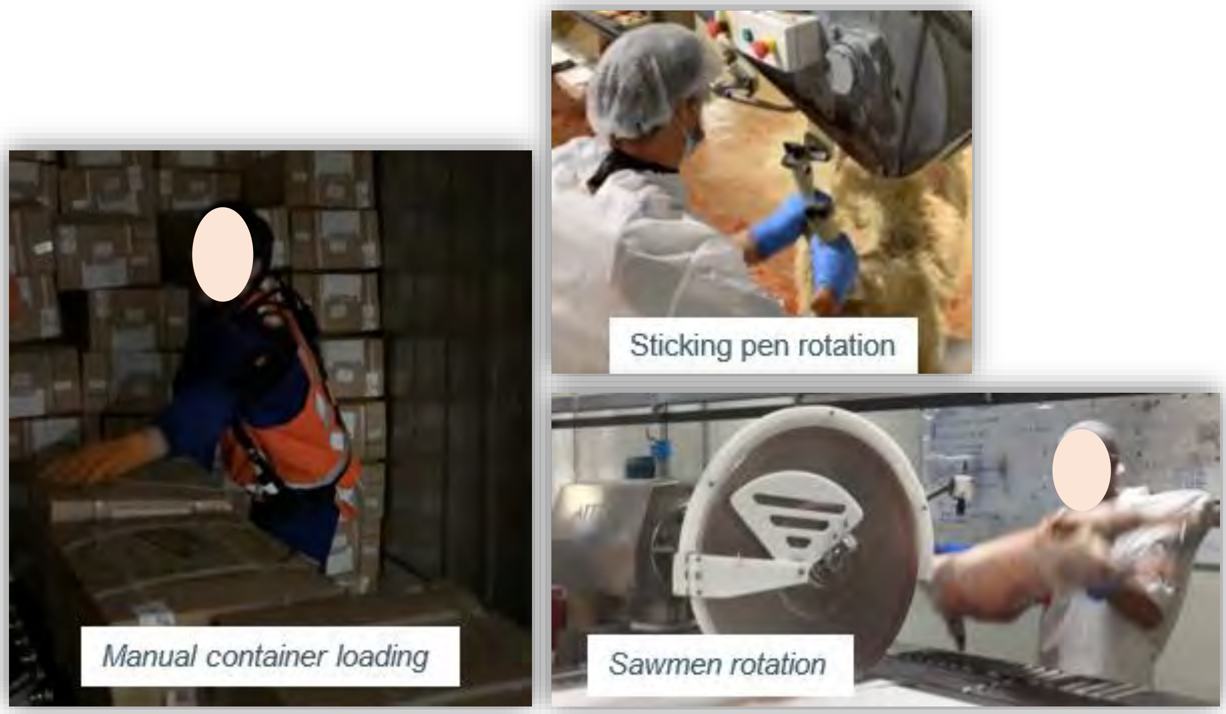


Note: AGL has invested in Joint Action Solutions, wearable sensor technology that enables Health and Safety teams to assess high-risk tasks and develop injury-mitigating strategies to reduce MSD across their plants.

In a collaborative research project spearheaded by AGL and Silverfern Farms, with support from AgResearch and funding from the MIA, the feasibility of exoskeletons, also known as personal ergonomic devices (PEDs), was investigated for reducing MSDs in the meat processing industry. The research aimed to evaluate the suitability of two PED models for meat processing lines, focusing on food safety risks, user acceptance, and ergonomic factors. The research was motivated by the need to address the repetitive strain and injuries caused by lifting heavy weights in the industry. Passive exoskeletons were considered, which assist workers in maintaining their arms and tools in overhead positions and provide constant shoulder support. While these have been utilised in various sectors, their application in food processing was uncharted. The findings did not reveal any immediate food safety risks, but a long-term assessment was advised for their use in food areas. The PEDs demonstrated potential as effective aids in reducing fatigue, mitigating musculoskeletal injuries, helping employees return to work post-injury, and supporting the ageing workforce by meeting the physical demands of work in the meat industry. However, the research concluded that careful task selection and consideration of the work environment were crucial for PED usage and that their functionality and design needed to be task-specific. Recommendations were made to the suppliers to refine the exoskeletons to better suit the meat processing environment.

Figure 5.13

Trialling the use of Exoskeletons to Reduce Musculoskeletal injury risk at AGL



In the realm of emerging technologies aimed at preventing MSDs, the researcher is exploring two cutting-edge solutions. Collaborative robots, or "Cobots," are being assessed for their ability to work alongside human employees. They offer a unique advantage as a rotational unit that can step in to maintain productivity during periods of employee absence or while recovering from injuries. Extended Reality (XR) also shows significant promise in the training sector. XR has the potential to provide immersive training experiences, allowing employees to be trained remotely before they transition to the actual work environment. This technology enhances learning outcomes and enables a seamless integration of workers into their roles while minimising the risk of injury.

5.3 A Conceptual Framework for Preventing WRMSD in the Meat Processing Industry

Research question seven, which aimed to identify all the factors that need to be considered when developing a systematic MSD prevention program, made use of existing literature to identify MSD risk factors, secondary data analysis of the AGL injury database to identify where injury clusters exist and a focus group discussion to gain more insight regarding barriers and successful past interventions. Developing a targeted WRMSD prevention program for the meat processing industry requires a holistic approach involving multiple elements at different stages. This includes robust incident reporting, early intervention after discomfort reporting (Figure 5.6), ongoing data analysis, identifying injury clusters, risk assessment, following the hierarchy of control (Figure 5.5) to mitigate or eliminate known MSD risk factors, using workplace ergonomics to improve work postures and reduce workload, quality training, and continuous enhancement.

Establish a system for prompt discomfort reporting (Figure 4.48) to allow employees to report without fear of repercussions. Ensure that reported symptoms receive immediate medical assessment and treatment (Figure 5.6) and make necessary workplace adjustments (e.g. alternative work offered) based on healthcare professionals' recommendations.

Pro-active responses to early MSD injury reporting involve creating a supportive environment for symptom reporting, regular training on recognising MSD symptoms, frequent ergonomic assessments, and ergonomic interventions such as redesigning workstations and providing appropriate tools. Encouraging regular breaks to reduce strain is also essential.

Reactive responses occur after an MSD injury is reported. This includes tracking injury clusters to identify patterns, investigating root causes, and implementing targeted interventions. Key reactive measures include providing medical treatment, revising safety protocols, and making necessary workplace changes. Continuous monitoring and communication with employees about these changes ensure effectiveness.

Tracking injury clusters is crucial for identifying trends and high-risk areas and guiding the development of prevention strategies. This includes adjusting workloads, modifying equipment, and altering work practices to reduce or eliminate injury risks. Tracking also helps measure the effectiveness of interventions and allows for adjustments.

Effective prevention strategies combine both proactive and reactive measures. Proactive strategies include ensuring employee suitability and work readiness (Fit for Work), providing ergonomic training, managing fatigue, conducting workplace assessments, implementing early intervention programs, establishing a centralised knife tutor advisory group focused on best practice quality training, and maintaining an ongoing knife sharpness testing program. Reactive strategies involve analysing injury data, investigating incidents, and revising safety protocols. These approaches create a safer work environment, reduce MSD risks, and ensure prompt responses to reported injuries.

This research, echoing findings in the poultry meat processing industry (Donovan, 2021), revealed that workplace safety climate and injury management practices can vary within a single organisation. This thesis identified that AGL's unique workplace microenvironments, influenced by personal characteristics (physical, behavioural, and psychological), processing times, species variation, seasonal fluctuations, and equipment, are linked to WRMSDs and recordable injuries. Organisations should assess these microenvironments to strategically target underperforming work zones. Further understanding of these zones and the role of supervision in injury prevention is needed.

The meat processing sector shows significant diversity due to factors like plant and equipment design, workforce size, and cultural and psychosocial elements, even within the same company. These variations affect the specifics of WRMSD prevention programs. Figure 5.14 offers a conceptual framework for preventing WRMSD at AGL. While tailored for AGL, many aspects apply to other meat processing companies. By following this framework, a complete model can be developed to meet each company's unique needs in preventing and mitigating WRMSD risk.

Figure 5.14

A conceptual framework for preventing WRMSD at AGL

Conceptual Framework for Preventing WRMSD at AGL

Step 1: Identify MSD Injury Risk Factors

- Consult with stakeholders
- Incorporate identified MSD risk factors and barriers into the prevention plan

Step 2: Analyse MSD Injury Data to Identify Injury Clusters (Reactive Response)

- Track injury reporting and respond to early discomfort reporting with best practice injury management (discomfort pathway)
- Engage with stakeholders to ensure data is accurate

Step 3: Identify Root Causes and Assess Risk

- Engage with stakeholders
- Make use of participatory ergonomics
- Mitigate immediate MSD risk (reactive response to reduce severity)

Step 4: Develop MSD Injury Prevention Strategies

- Engage with stakeholders
- Make use of participatory ergonomics (during design stages)
- Ensure selected injury prevention strategies have been evaluated and deemed viable for implementation

Step 5: Implement MSD Injury Prevention Strategies (Proactive Response)

- Engage with stakeholders (funding and resources allocated)
- Make use of participatory ergonomics (during implementation)
- Factor in “fit for work” elements and employee wellbeing
- Evaluate effectiveness – implement across AGL (industry)

5.4 Limitations

The study faced limitations due to inconsistent injury categorisation and a lack of detailed descriptions for injuries and tasks across different meat processing plants. This issue was further complicated by the dispersal of similar injuries, like back injuries, across various categories, which required consolidation for analytical clarity. Upon visiting the plants, the researcher identified significant disparities in plant design, equipment, operational scale (from 270 to 2000 employees), and processing lines (ranging from single to six chains), which affected production speeds and cutting types. Variability was also noted in the species processed (Ovine, Bovine, Cervine), livestock size (e.g., lambs vs. mutton), and seasonal processing durations (six to 11 months), influencing the plants' start-up and termination dates. These differences highlighted the complexity of the meat processing sector, emphasising the need for nuanced data analysis and recommendations to manage MSDs effectively. Consequently, the study adopted an individualised approach to analysing plants, focusing on specific variations within plants rather than across them to avoid comparing fundamentally different operations. Data harmonisation techniques were employed to standardise disparate datasets for analysis, supplemented by cross-referencing missing data with incident reports and using plant-specific ratios. However, these methods could not fully adjust for variations in plant size, chain length, or species processed, underscoring the challenge of accurately comparing and analysing data across diverse meat processing environments.

5.4 Chapter Summary

The chapter presented the research findings, detailed how the research questions were addressed, and proposed methods for applying these results in real-world settings. The discoveries highlighted the complex and varied characteristics of the meat processing industry, emphasising the necessity to consider these nuances when examining injuries and forming conclusions. In addressing the intricate challenges presented by MSD in the New Zealand meat processing industry, this research undertook a multifaceted approach. Each research question served as a building block towards understanding the broader landscape of MSD in the industry, particularly at AGL.

For the first research question, secondary data analysis and reviews emerged as essential tools in identifying prevalent MSD risk factors in the New Zealand meat processing industry. The depth and breadth of the information collected provided a comprehensive view of the prevailing risks.

Regarding the second question, secondary data analysis and reviews illuminated potential interventions that might be effective in the meat processing industry. If implemented in clinical practices, these interventions could significantly curtail MSD-related challenges.

Secondary data and literature reviews explored barriers to MSD prevention in the meat processing industry. The focus group discussions further enriched this exploration by shedding light on specific areas of concern.

Delving into the trends at AGL, a comprehensive statistical analysis of the AGL database was executed. This analysis, enhanced by Data Harmonization, revealed intricate patterns of MSD occurrence across different processing plants over an eight-year span. Such trends provided an invaluable foundation for the subsequent research questions.

The fifth research question intertwined with the fourth, with the identified trends serving as a precursor to understanding the effectiveness of various MSD prevention interventions at AGL. The focus group discussions with Health and Safety personnel were particularly instrumental in delineating the differences in intervention efficacy across processing plants.

Focus group discussions were conducted to understand AGL's unique barriers, capitalising on the insights of Health and Safety managers and advisors. The synthesis of findings from the third and fourth research questions enabled a more nuanced understanding of AGL-specific challenges.

Finally, the seventh research question encapsulated the essence of the entire study. Developing a systematic MSD prevention program would necessitate the integration of findings from all preceding research questions. Secondary data, reviews, focus group outcomes, and trend analyses collectively inform the critical factors that need consideration in this program. A conceptual framework for preventing WRMSD at AGL has been developed and can be adapted into an industry-specific model. While tailored for AGL, many aspects apply to other meat processing companies. This framework can be used to develop a customised model to meet each company's unique needs in preventing and mitigating WRMSD risks.

In summary, this research's multidimensional approach has fostered a profound understanding of MSD in the New Zealand meat processing industry, especially at AGL. The insights garnered will significantly influence future intervention strategies and policy formulations in the industry.

The next chapter will encapsulate the essence of the thesis, revisiting its pivotal points from each chapter and highlighting key findings. The section will further acknowledge the research limitations, setting the stage for actionable recommendations for future work in the field.

Chapter 6 - Conclusions

As this journey of scholarly exploration draws to a close, this final chapter seeks to encapsulate and reflect upon the critical insights and significant findings that have emerged throughout this research. It aims to summarise the key themes, patterns, and implications analysed in the previous chapter.

In the Discussion chapter, the researcher explored the research findings, dissecting the research questions to reveal the complexities and intricacies of the subject matter. This section served as a meeting point for theoretical perspectives and empirical evidence, resulting in a comprehensive and insightful interpretation.

The focus shifts from exploration to synthesis in the conclusion chapter. The researcher's goal is to articulate the overarching conclusions derived from the research, emphasising the study's contributions to the broader field of knowledge. This chapter will revisit the research objectives and questions, offering clear and concise answers grounded in the evidence and earlier discussions.

Finally, the Conclusion chapter summarises the practical implications of this research, providing recommendations for policy, practice, and further academic inquiry. In this section, the researcher evaluates the study's real-world impact, effectively linking academic research with its possible applications. Essentially, this chapter is the culmination of the dissertation, concluding the research narrative while paving the way for new ideas, discussions, and investigations within the field.

6.1 Thesis Review

The primary aim of this study is to identify and evaluate interventions and risk factors associated with MSDs at AGL, to understand the barriers hindering effective MSD prevention, and to utilise these findings to develop a systematic process aimed at reducing the incidence of MSDs in the meat processing industry. This thesis review revisits considerations for preventing musculoskeletal disorders in the meat processing industry, synthesising core themes from the introduction and chapters to reflect on the depth and significance of the findings.

Chapter One established the purpose of this study by reviewing existing literature, analysing new injury data, and comparing trends with effective MSD interventions. The aim was to use these insights to develop an intervention program to address MSD risk factors at AGL. The chapter also emphasised the research's value for stakeholders, supporting creating a systematic MSD prevention program that benefits AGL and the broader New Zealand meat processing industry. By addressing the high costs of MSDs, this program could result in substantial savings for ACC, increased profitability for organisations, and improved well-being for affected individuals. The research outcomes are also expected to shape a comprehensive process for mitigating MSD incidence through risk identification, barrier assessment, and intervention prioritisation. Beyond risk reduction, the program could also enhance productivity and product quality while alleviating workers' pain and improving quality of life. Lastly, this research aims to advance current knowledge by introducing innovative strategies and refining interventions to support workers' health in and outside the workplace.

Chapter Two comprehensively reviews the literature on managing and preventing MSDs in New Zealand's meat processing industry. The review focused on identifying factors contributing to MSD development, evaluating past and present interventions, and understanding barriers to implementing prevention programs. The chapter established a solid foundation for formulating effective prevention strategies by systematically analysing industry-specific risks and interventions. The only gap in the literature was that a conceptual framework was needed for developing an industry-specific model for preventing MSDs in the NZ meat processing sector. This understanding was critical for shaping the proposed MSD prevention program and addressing potential implementation challenges.

Chapter Three describes the research methodologies used, highlighting the integration of quantitative and qualitative approaches. This mixed-methods strategy was well-suited for the study and proved effective in providing a comprehensive understanding of factors influencing MSD prevention in New Zealand's meat industry, particularly at AGL. The applied action research methodology facilitated ongoing improvements in MSD prevention outcomes by enabling continuous learning and refinement throughout the research process.

Chapter Four provides an in-depth analysis of the research outcomes, beginning with a detailed examination of injury data at the individual plant level to identify key trends. These findings and insights from the literature review informed a focus group discussion that identified opportunities, challenges, and strategies to reduce MSD risks at AGL. By analysing patterns in MSD injury data, the chapter pinpointed high-risk activities, helping prioritize tasks for the development of an MSD prevention plan. Including key stakeholders in the focus group facilitated a deeper understanding of the effectiveness of past interventions across different processing plants. The chapter concludes with actions to mitigate and reduce MSD risks within the AGL framework.

Chapter Five presented the research findings, addressed the research questions, and proposed practical applications. It highlighted the complexity of the meat processing industry and the importance of these nuances in analysing injuries. The insights contributed to developing a conceptual framework for WRMSD prevention at AGL, with potential for broader industry use. The chapter also reflects on the study's limitations and acknowledges the challenges encountered.

This research adopted a multifaceted approach to tackling the complex challenges posed by MSDs in New Zealand's meat processing industry. Each research question was a foundation for understanding the broader scope of MSDs within the industry, focusing on AGL.

6.2 Key Findings

This research project has led to important discoveries that helped the researcher better understand the complexity of MSD in the meat processing industry. Through careful analysis and thorough investigation, the researcher has identified new insights. These insights build on existing knowledge and encourage us to think differently about the topic. This summary emphasises the key findings that emerged from addressing the research questions, spotlighting the new insights and their capacity to propel the field forward. In doing so, it refines the core aspects of the research and establishes a basis for additional studies and dialogues in this domain.

The research hypothesis posited that a thorough review of relevant literature, coupled with a detailed study at AGL, would successfully identify risk factors for MSDs, along with effective interventions for their prevention and management. The findings of this study align with the hypothesis, as it has indeed identified not only the key risk factors associated with

MSDs at AGL and comparable sites but also highlighted successful interventions that can be implemented. Moreover, the study has provided valuable insights into the facilitators and barriers affecting the implementation of these interventions at AGL. Consequently, the hypothesis is not rejected, as the study has met its objective of uncovering crucial elements contributing to MSD risk mitigation and shaping the formulation of an MSD prevention program for AGL.

6.2.1 Research Question One – Which MSD Risk Factors are Prevalent in the NZ Meat Processing Industry?

Addressing research question one revealed that the New Zealand meat processing sector is confronted with numerous prevalent MSD risk factors (please refer to Table 81 for a comprehensive list). These include work-related factors like workstation ergonomics and equipment maintenance and non-work factors like previous sports involvement or hobbies that can increase muscle fatigue and MSD risks. Worksafe (2023) visually presents these risk factors in Figure 74, indicating that individual and combined factors can lead to discomfort and pain for workers. The industry faces challenges in addressing broader economic, political, social, and cultural factors that influence MSD risks but are beyond its direct control.

The impact of these risk factors varies among individuals, with workers often exposed to multiple work-related risks that increase the potential for harm. Recognising the influence of contextual factors on workplace dynamics is a critical first step in addressing these issues. By adopting new perspectives and strategies to mitigate the impact of external factors (like seasonality and human resource challenges) and internal factors (such as cultural influences and payment systems), the meat processing industry can significantly improve the acceptance and effectiveness of MSD interventions.

6.2.2 Research Question Two - What Industry Interventions for Addressing MSD in NZ Meat Processing are Recommended?

Research question two focused on identifying recommended interventions to address MSDs in the New Zealand meat processing industry (see Table 6.1).

Table 6.1

Industry Interventions for Addressing MSD in NZ Meat Processing

Intervention	Description
Reporting and Investigation	Implementing a robust reporting and investigation system to collect precise data on MSD prevalence, contributing tasks, and risk factors.
Ergonomic Assessments	Conducting ergonomic assessments to identify and address workplace ergonomic issues, reducing MSD occurrences and enhancing worker well-being.
Job Rotation and Task Variety	Job rotation and task variety should be introduced to reduce muscle and joint strain, improve worker safety, and reduce MSD risk.
Manual Handling Training	Providing comprehensive training on proper techniques, posture, lifting, and movement to minimise MSD risks and prevent injuries.
Engineering Controls	Implementing engineering solutions like workstation adjustments, automation, and mechanisation to reduce physical strain and MSD risks.
Personal Ergonomic Devices (PEDs)	Using devices like exoskeletons assists injured workers in safely returning to physically demanding tasks.
Personal Protective Equipment (PPE)	While PPE is essential, it should be a secondary control, with primary measures addressing root MSD causes.
Stretching Programs	Introducing pre- and post-work stretching programs to improve flexibility and joint range of motion, reducing the risk of MSDs.
Worker Engagement and Participation	Applying a participatory ergonomics approach by involving workers in MSD hazard identification and management for sustainable solutions.

The key finding from research question two is the importance of tailoring interventions to individual processing facilities' specific needs and challenges, with regular monitoring and enhancement to ensure their effectiveness in reducing MSDs and improving worker welfare.

6.2.3 Research Question Three - What Barriers to MSD Prevention in NZ Meat Processing have been Identified?

Research question three identified key barriers to MSD prevention in New Zealand's meat processing industry, as shown in Table 6.2:

Table 6.2

Barriers to MSD Prevention in NZ Meat Processing

Barrier	Description
Industry Norms and Attitudes	Established norms and attitudes can hinder MSD prevention efforts, leading to decreased productivity, increased healthcare costs, high employee turnover, and recruitment challenges.
Lack of Ergonomic Design	Non-ergonomic tools and equipment increase the risk of MSDs due to awkward postures and repetitive movements. Investment in ergonomic designs and training is necessary.
Limited Worker Participation	Exclusion of workers from shaping MSD prevention programs reduces engagement and buy-in, impacting program success.
Inadequate Work Organization	Poor work organisation, including high-speed lines and limited breaks, contributes to repetitive motions and awkward postures, increasing MSD risk.
Time Pressures	Intense production targets push workers to prioritise speed over safety, leading to unsafe postures, excessive force, and insufficient breaks.
Limited Training and Supervision	Inadequate training on safe practices and MSD recognition increases risks, highlighting the need for comprehensive training and supervision.
Workplace Culture	A culture that overlooks safety, including a 'macho' mindset and focus on speed, elevates MSD risks. Addressing cultural barriers is essential.

Barrier	Description
Language and Cultural Barriers	Language and cultural differences impede understanding of safety protocols, affecting training program effectiveness.
Limited Access to Healthcare	Affordability and lack of insurance can delay medical care for MSDs, underscoring the need for better healthcare access.
High Production Demands	The industry's physically demanding nature, combined with high market demand, often overshadows worker safety and ergonomics.
Limited Resources	Financial constraints, especially for smaller businesses, limit investments in ergonomic assessments and training programs.
Resistance to Change	Concerns about costs, productivity, and workflow disruptions lead to resistance to adopting new MSD prevention measures.
Inadequate Reporting and Tracking of MSD Incidents	Lack of thorough reporting and tracking makes assessing prevention effectiveness and implementing targeted solutions challenging.

To address these barriers successfully, a comprehensive approach involving worker involvement, ergonomic improvements, effective work organisation, adequate training, and a supportive workplace culture is essential. Collaborative efforts between employers and employees to identify risks and implement preventive measures will significantly improve worker safety and productivity.

6.2.4 Research Question Four - What MSD Trends Can be Observed at AGL?

The fourth research question used the AGL database to analyse trends in MSD injuries at AGL by statistically reviewing data from the past five years across seven meat processing plants. The data was standardised through data harmonisation techniques as described by Bradwell et al. (2022), allowing for effective comparison and analysis despite challenges like missing data, which was mitigated by cross-referencing incident reports.

Despite efforts to make the data comparable across plants, plant size, chain length, and species differences were not accounted for. Key findings include:

The Corporate sector's Livestock team faced the highest injury risk, particularly from the "Drafting" task, with knees and backs being the most injured body parts. A significant 84% of injuries occurred in employees with over five years of experience, and a lead/lag ratio of 2.6:1 suggests a high severity of injuries.

Dannevirke emerged as AGL's safest plant, with a lead/lag ratio of 185:1. The "packing" task in the Further Processing department contributed to 11% of the plant's MSD injuries, slightly above the plant average. A high reporting rate of 71% for discomfort among experienced employees indicates a need for reassessment of work postures and the potential introduction of work hardening programs to prevent back injuries.

Levin, ranking second with a 39:1 lead/lag ratio, reports the highest incident rates in their Further Processing and Beef Boning departments, accounting for 25% and 21.5% of incidents, respectively. Notable is the 71% discomfort reporting rate, with 33% of injuries involving the back, predominantly among employees with 1-5 years of experience. This suggests a need to revisit workstation design and improve manual handling skills.

Lorneville shows a high conversion rate of discomforts to more severe injuries, with a 51.4% discomfort reporting rate and a notable 7% Aches/Pain-gradual score. Most injuries occur among the most experienced workers, indicating potential issues with workstation layout and repetitive work in confined spaces.

With an 18.4:1 injury ratio, Mataura faces the highest risk due to exclusive beef processing. It reports the highest rate of sprains and strains at 58% and a low discomfort reporting rate of 36.8%, pointing to the need for prompt reporting and optimal workstation ergonomics.

Nelson's data reveals that Stock Yards and Shepherding tasks lead to a significant portion of injuries, mainly among experienced employees, suggesting a need for targeted safety assessments.

Pukeuri has a 23.3:1 injury ratio, with employees having 1-5 years of experience most at risk. The Kidney Enucleator task requires further analysis.

Smithfield, processing multiple species, shows a 30.1:1 injury rate, with a significant number of injuries among employees with 1-5 years of experience. The Fancy Meats department and meat inspectors' roles highlight specific areas for targeted injury prevention training, especially concerning back, wrist, and shoulder injuries.

Over a five-season period, Pukeuri had the highest rate of musculoskeletal injuries per person (30.5%) among all AGL processing plants, followed by Lorneville, which is notable for its large workforce and significant contribution to more severe injury incidents (MTI/LTI). Mataura, despite being a beef-exclusive plant with heavy workloads, ranks midline for MSK injuries but has the highest injury ratio (18.4:1), likely due to the demands of processing larger animals for longer periods, leading to a 58% rate of sprains and strains, the highest among the plants.

Conversely, Dannevirke and Levin exhibit the best injury ratios, correlating with high discomfort reporting rates of 71%. This correlation suggests that increased reporting leads to decreased severity of musculoskeletal injuries, indicating effective preventive measures and efficient treatment for injuries at these plants.

Tables 82 and 83 summarise the main trends in musculoskeletal injuries across all AGL business divisions, covering both individual plants and inter-plant departments. They specify the tasks leading to injuries, the body parts affected, and the experience levels of the injured employees.

6.2.5 Research Question Five - Which MSD Prevention Interventions have been Effective in Addressing MSD at AGL?

To assess the effectiveness of MSD prevention interventions at AGL, the researcher conducted focus group discussions with health and safety managers, advisors, and injury management personnel. Key MSD prevention interventions identified during these discussions are summarised in Table 6.3.

Table 6.3

Effective MSD Prevention Interventions at AGL

Intervention	Description
Discomfort Reporting	Early reporting of MSD symptoms enables timely diagnosis and treatment, preventing disorder progression. It promotes trust and encourages prompt intervention to address root causes early.
Stretching Programs	Programs before and after work enhance flexibility, reduce muscle tension, and prevent MSDs. They serve as preparation and recovery routines for employees.
Educational Initiatives	Education for supervisors and employees on recognising early injury signs, applying good ergonomics, and promoting workplace well-being.
Discomfort Management Strategy	Prevention-focused strategies for post-discomfort reporting include easing employees back into work with lighter tasks and rapid action on new injuries.
Health and Safety Management	Enhancements in injury reporting systems and additional treatments, such as increased physiotherapy or chiropractic care, are recommended.
Work Culture and Injuries	Managing work and non-work injuries with a consistent approach fosters a culture of care and prioritizes employee well-being.
Employee Management	It involves careful employee selection, pre-employment medicals, early identification of at-risk employees, absenteeism management, and workload adjustments.
Training and Equipment	Support for manual handling training and equipment maintenance is essential for injury prevention.
Frontline Leadership	Leaders establish a safety culture through actions like safety walks and reviewing pre-employment medicals.

The key insights highlight the need for a comprehensive approach to preventing workplace injuries and discomfort, stressing the importance of early reporting, education, proactive management strategies, and fostering a culture of care and safety.

6.2.6 Research Question Six - What Barriers to MSD Prevention Exist at AGL?

Research question six investigated barriers to preventing MSDs at AGL, drawing on insights from previous research and a focus group discussion with health and safety managers, advisors, and injury management personnel. The group identified (Table 6.4) several key challenges to MSD prevention:

Table 6.4

Barriers to MSD Prevention at AGL

Category	Barrier	Suggested Actions
Seniority vs. Physical Readiness	Employees frequently begin a new season or return to work without undergoing a physical readiness assessment, leading to potential issues.	Implement fit-for-work assessments and determine suitability for seniority group members.
Misplacement and Competency Approval	There is a risk of placing employees with higher injury risks in unsuitable positions and prematurely approving their task competencies.	Assign at-risk employees to appropriate positions and ensure job readiness before competency approval.
Work/Injury Status Discussions	Discuss an employee's work suitability and injury status, particularly concerning seniority and role suitability.	Propose a five-year review of work/injury status and role suitability.
Empathy for Recovering Employees	There is a need to cultivate a culture of empathy and compassion towards employees recovering from injuries.	Reflecting on this as one of AGL's core values.

Category	Barrier	Suggested Actions
Resource Limitations	Challenges include dwindling production resources, increased workloads on Health and Safety managers, limited training opportunities, and increased staffing to address absenteeism.	Reevaluate resource allocation and consider strategic staffing and training investments.

Lastly, restricted budgets for ergonomic improvements, the impact of extended working hours, and poor stock quality were identified, with solutions including additional resourcing, managing or limiting extended hours, and enhancing livestock selection criteria. The findings underscore the necessity of a comprehensive strategy that includes preventive measures, appropriate resourcing, and fostering empathy to ensure the well-being of workers while maintaining production efficiency.

6.2.7 Research Question Seven - Which Factors Need to be Considered when Developing a Systematic MSD Prevention Program?

Research question seven identifies key elements for establishing a systematic prevention program for Work-Related Musculoskeletal Disorders (WRMSDs) in the meat processing industry. This entails a comprehensive approach that includes assessment, intervention, training, and continuous improvement. Recognising the industry's diversity and variations among companies, such as differences in plant design, workforce size, and cultural factors, is crucial for tailoring the prevention program to specific needs.

A crucial step in creating an effective WRMSD prevention plan is selecting appropriate safety metrics for monitoring. These metrics are essential for identifying focus areas to enhance safety performance and optimise results. AGL CEO, Willie Wiese emphasised the importance of focusing efforts where they are most needed, using the metaphor "fishing where the fish are" to highlight the strategy of targeting specific areas for improvement.

Incorporating lead and lag indicators is vital for meeting employee expectations for safety and well-being, ensuring regulatory compliance, and building confidence in workplace safety. This approach fosters a safety culture, encouraging automatic safety behaviours within the organisation. Leading indicators can help prevent workplace injuries and illnesses, reduce costs associated with incidents, improve productivity, enhance safety performance, and increase worker engagement. Organisations that adopt these proactive measures can achieve competitive advantages, demonstrate social responsibility, realise cost savings, and improve overall performance. A comprehensive health and safety program that integrates these indicators supports the promotion of safe behaviours, a proactive safety culture, involvement of all personnel in safety efforts, proactive hazard identification, and dissemination of best practices across the organisation.

Table 6.5 highlights the key factors for developing an effective MSD management and injury prevention program:

Table 6.5

Key Factors for Developing an Effective MSD Management and Injury Prevention Program at AGL

Key Factor	Description
Robust Injury Reporting System	Establish an efficient system to record incidents accurately, understand their nature and frequency, and conduct thorough investigations to identify preventive measures.
Hazard Identification	Recognise workplace elements or behaviours that could cause harm, considering the complex nature of MSDs and assessing risk factors such as biomechanical, physical, organisational, environmental, individual, and psychosocial elements.

Key Factor	Description
Root Cause Analysis and Ergonomic Evaluation	Conduct detailed analyses to identify all risk factors and evaluate tasks or areas for potential risks to prevent musculoskeletal injuries.
Employee Feedback	Gather employee insights through surveys, interviews, and suggestion boxes to identify MSD-related issues or symptoms.
Policy Development	Create clear policies that reflect the organisation's commitment to preventing and managing MSDs, including defining roles and responsibilities.
Training and Education	Provide education on correct ergonomics, safety procedures, and the importance of prompt reporting, as well as training supervisors and managers on identifying MSD symptoms and risk factors.
Ergonomic Interventions	Implement workstation modifications, job rotation, and micro-pauses to minimise strain, vibration, or repetitive motion.
Mitigating Barriers	Identify challenges to MSD prevention, such as demographic shifts, and implement strategies like 'fit for work' procedures to address these challenges.
Early Reporting and Treatment	Establish a system for prompt symptom reporting without fear of repercussions, ensuring quick medical assessment and treatment.

Key Factor	Description
Monitoring and Evaluation	Regularly assess the impact of interventions and refine the program based on feedback and data collected.
Communication	Communicate program goals and updates to employees and share success stories highlighting the program's importance.
Engagement and Participation	Involve employees in the program's development and implementation, emphasising collective responsibility and establishing oversight committees.
Documentation and Record Keeping	Maintain detailed records of assessments, training, reported cases, treatments, and intervention outcomes to identify trends and measure effectiveness.
Continuous Improvement	Stay updated with the latest research and best practices in ergonomics and MSD prevention, periodically reassessing and refining the program.

By adhering to these guidelines and continually updating the program based on new research and feedback, organisations can effectively manage and reduce the risk of work-related MSDs.

6.3 Recommendations

Managing MSDs in the meat processing industry is a complex challenge, highlighted by the physically demanding nature of the work and the high rate of related injuries. With ongoing technological advancements and shifts in workforce demographics, there is an urgent need for innovative, evidence-based strategies to reduce these risks. This research project has pinpointed several key areas to help decrease and better manage MSD incidents and enhance employee well-being and productivity. By closely analysing these aspects, the following recommendations for future research aim to guide industry stakeholders toward creating safer and more sustainable meat processing environments.

6.3.1 Fit for work. During this research, it became evident that AGL faces challenges with an ageing workforce, many of whom suffer from poor physical health and are prone to injuries. According to StatsNZ (2017), the proportion of the labour force aged 65 and over has increased significantly, from 1% in 1991 to 6%, and is expected to reach 9% by the late 2020s. This demographic shift, particularly pronounced in the meat processing industry, necessitates the implementation of comprehensive "fit for work" protocols. These protocols should aim to minimise the risk of MSDs through thorough evaluations, careful job selection, and appropriate placement, especially for tasks with a high injury risk. Adapting to this changing workforce also requires considering alternative roles or specific tasks that condition employees, alongside ergonomic improvements.

Being fit for work involves many factors, such as ensuring employees are physically, mentally, and emotionally equipped to perform their duties without risk. This multifaceted concept includes physical fitness for safely executing job tasks, mental and emotional well-being for clear decision-making and stress management, and the necessary skills and competencies for job execution. A protocol to assess an employee’s fit for work status needs to be developed.

6.3.2 Demographic analysis of musculoskeletal injuries for targeted prevention strategies in meat processing plants. To enhance the effectiveness of MSD prevention strategies in the meat processing industry, it is recommended to conduct a comprehensive analysis of musculoskeletal injuries, disaggregated by gender, ethnicity, and age across all processing plants. Such an analysis will provide valuable insights into the specific vulnerabilities and risk factors associated with different demographic groups, enabling the development of targeted interventions. By addressing the unique needs of diverse populations, the industry can implement more inclusive and effective measures, ultimately reducing the incidence of MSD and promoting a healthier workforce.

6.3.3 Work injury status and work task suitability discussions. Future research in New Zealand's meat industry should focus on strategies to reduce MSDs by thoroughly examining work injury statuses and assessing the suitability of job roles for injured and employees recovering from injury. Engaging with injured employees to deepen their understanding of workplace injury nuances is crucial for effective prevention. Additionally, ensuring that tasks and environments accommodate all employees, especially those recovering from injuries or facing specific physical challenges, is vital.

6.3.4 Collaborative robots. In the context of emerging technologies aimed at preventing MSDs within New Zealand's meat industry, there is a pressing need to further explore the benefits of integrating collaborative robots, or "Cobots." These Cobots are designed to collaborate with human workers, offering a unique advantage as a rotational support system. They hold the potential to maintain productivity levels during periods of employee absence or while workers are recovering from injuries. This strategy helps preserve operational efficiency and promotes employee well-being by lessening the physical strain on workers. Therefore, it presents a promising avenue for future research on improving workplace safety and productivity.

6.3.5 Exoskeletons. As exoskeleton technology becomes more accessible and cost-effective, future research in the New Zealand meat industry should focus on integrating these personal ergonomic devices to mitigate MSDs, enhance worker safety, and boost productivity. These devices help maintain correct, minimise fatigue, and prevent overexertion injuries, particularly in tasks involving heavy lifting, repetitive motions, and awkward positions. Customisable and adjustable exoskeletons offer personalised support, contributing to a healthier workforce and improved efficiency. Effective training and worker acceptance are critical to their successful adoption. Moreover, exoskeletons can aid in rehabilitating injured employees, ensuring their safe return to work. Addressing cost, task compatibility, and worker acceptance challenges is vital. A comprehensive approach that combines exoskeletons with other ergonomic interventions and ongoing assessment is crucial for maximising the benefits of this technology in making the meat processing industry safer and more productive.

6.4 Conclusion

This research highlights the critical path to reducing musculoskeletal disorders in the New Zealand meat industry, emphasising the challenges and the benefits of proactive prevention strategies. The findings have contributed significantly to mitigating MSD risks at AGL. The original contribution is a conceptual framework for preventing WRMSDs at AGL (Figure 5.14), which can serve as a model for reducing MSD risks in the meat processing industry and similar sectors.

At the commencement of this research, the company's TRIFR rate was 18.9 injuries per million person-hours worked across AGL's seven meat processing plants, and currently (January 2024) sits at 14.9. Figure 6.1 shows the AGL TRIFR and recordable injury trend with future targets.

Figure 6.1

AGL TRIFR and Recordable injury trend and future targets

This study has identified key drivers of success that have not only reduced the incidence of MSDs at AGL but also enhanced overall worker well-being and productivity (please refer to Appendix Q). The Southland Business Chamber recognised this contribution when AGL was awarded the Primary Services Sector award (Figure 6.2), for promoting a positive workplace well-being culture and delivering outstanding services.

Figure 6.2

AGL Receives Recognition Promoting a Positive Workplace Wellbeing Culture

Note. AGL Musculoskeletal Injury Prevention Manager Hennie Pienaar (left) and Lorneville Plant Manager Shashank Pande (far right) proudly accept a business excellence award for fostering a culture of workplace wellbeing and exceptional service delivery.

The positive outcomes of this research, ranging from improved workplace safety to enhanced operational efficiency, underscore the symbiotic relationship between worker health and industry viability. By embedding these findings into the fabric of the meat processing industry, this project contributes significantly to a sustainable model of occupational health, one that other sectors might well consider emulating (Figure 5.14).

In the broader context, this research underlines the indispensable value of investing in worker health as a cornerstone of industry success, propelling the New Zealand meat industry towards a future where work-related musculoskeletal disorders are no longer seen as an inevitable cost of doing business but as a challenge that can be effectively managed and mitigated through informed strategic actions.

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Appendices

Appendix A - Letter of Support

This appendix serves as a letter of support for the PhD candidate, endorsing their research project and granting permission and access to the database necessary for the purpose of this study. The database comprises secondary data that encompasses the occurrence rates, locations, and nature of MSDs over the past five years. It covers seven meat processing plants and the corresponding corporate entities, which exhibit varying MSD rates.

ALLIANCE

26 March 2021

Doctoral Research Committee
Te Whare Wānanga o Awanuiārangi
Private Bag 1006
Rongo-o-Awa, Domain Road
Whakatāne

To whom it may concern

Letter of support for doctoral candidate
Thesis titled: Managing musculoskeletal injuries in the meat processing industry

I write on behalf of Alliance Group in support of **Hennie Pienaar** to make use of an existing Alliance Group database to support the research he is planning to undertake, with regards to managing musculoskeletal injuries in the meat processing industry. The database contains secondary data of the occurrence rates, location and nature of musculoskeletal injuries over the past five years (and longer if required). The findings of the research will be of great value to Alliance Group (and the meat processing industry) and will aid the company in finding new insights and strategies for managing and preventing musculoskeletal injuries in this industry.

Yours sincerely

Shane Fletcher

Group Health and Safety Manager

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Appendix B - Data Extraction, Cleaning and Coding Process

This appendix explains the dataset's characteristics, including its date range and the database and report from which it was extracted. It further details the methodology used to distinguish MSD incidents from other injury occurrences within the dataset. Additionally, it encompasses the implemented data coding and data cleaning processes.

Data Extraction

To determine the factors that can aid in managing MSD in the meat processing industry, a database of Alliance Group (AGL) injuries was analysed to identify emerging patterns or tendencies. Additionally, the musculoskeletal injury data underwent coding and cleaning procedures to ensure usability.

Information on 16,380 injury incidents that occurred from 1 October 2016 to 11 August 2021 was extracted from the company's Curo database in the form of an ACDNTNE3 report.

Data Cleaning

A systematic process was implemented to identify MSD injuries, which involved selectively removing certain data fields as follows:

- ✓ Removed employee names/identification numbers.
- ✓ Removed all near-miss reporting.
- ✓ Removed all burn injuries.
- ✓ Removed all busing/crushing injuries.
- ✓ Removed all bone scratch injuries.
- ✓ Removed all dislocation injuries.
- ✓ Removed all foreign body injuries.
- ✓ Removed all fracture injuries.
- ✓ Removed all industrial deafness and head injuries.
- ✓ Removed all inhalation and infectious, skin disease-type injuries.
- ✓ Removed all laceration & puncture wound injuries.
- ✓ Removed all respiratory injuries.
- ✓ Removed all mental health-related injuries.
- ✓ Removed all non-work compensation injuries.
- ✓ Removed all unclear or incomplete injury entries.
- ✓ Removed all superficial type injuries.
- ✓ Removed all open wound-type injuries.

Entries that were ambiguous regarding the injury's nature or did not qualify as MSDs were removed.

Aches & pain specific were seen as a First Aid Injury

Aches & pain gradual were seen as a Discomfort Injury

As an example, the Lorneville plant data had 6,837 recorded incidents before cleaning, but after the process, only 3,912 entries could be identified as MSD injuries.

Data coding

To simplify the data analysis process, the raw data was coded while being used in the Excel spreadsheets, as illustrated in the tables below:

Injuries by category	
Category name	**Category abbreviation**
Discomfort	DCO
First Aid – aches and pain gradual	ACG
First Aid – aches and pain specific	ACS
First Aid – sprains and strains	SPR
First Aid – multiple	MUL
Lost Time Injury	LTI
Medical Treatment Injury	MTI

Injury sub-category codes	
Injury Description	**Injury Code**
Aches/pain – gradual	ACG
Aches/pain – specific	ACS
Discomfort	DCO
Multiple	MUL
Musculoskeletal Disease	MUS
Nerves/Spinal Cord	NSP
Occupational Overuse Syndrome	OOS
Sprain/Strain	SPR
Body Description	**Body Area code**
Abdomen	ABD
Ankle	ANK
Arm	ARM
Back	BAC
Back – Lumbar	BAL

Back - Sacrum	BAS
Back – Thoracic	BAT
Back – Cervical	BAV
Buttocks	BUT
Chest	CHE
Elbow	ELB
Fingers	FIN
Foot	FOO
Forearm	FOR
Groin	GRO
Hand	HAN
Hip	HIP
Knee	KNE
Lower Limb	LBA
Multiple Locations	MUL
Neck	NEC
Ribs	RIB
Shoulder	SHO
Thigh	THI
Thumb	THU
Toe	TOE
Trunk	TRU
Upper Leg	UPL
Upper limb	UPP
Wrist	WRI

Task Description	**Task Code**
Amenities	AME
Anal Bung Application	ANA
Arriving on Plant	ARR
Bagging	BAG
Belly Flank	BEL
Beef Slaughter C Grade	BFC
Boning - Fleece Shoulder	BFS
Boning - Aitch Boning	BHL
Bin Man	BIN
Blast Loader	BLA
Blood	BLD
Boning - Leg Loins	BLL
Blood man	BLM
Blower man	BLO
Boilerman	BMN
Bobby Calf Boning	BOB
Boning	BON
Boxes/Pallets	BOX
Break necks	BRE
Broomie	BRO
Brisket Punching	BRP

Brisket Roller	BRR
Brushing	BRU
Boning - Trim Shoulder	BSH
Boning - Trim Shanks	BSK
Boning - Tunnel Leg	BTL
Boning - Trim Loin	BTR
Boning - Tunnel Shoulder	BTS
Building	BUD
Buffing	BUF
Bump Cutter	BUM
Bunger	BUN
Butcher	BUT
Box Boy	BXB
Carcass Relocating / off floor	CAC
Carpenter	CAP
Cartons	CAR
Casings	CAS
Carton Tunnel	CAT
Challenge Cook Operator	CCO
Cod area	CDA
Cod	CDD
Chamber hand	CHB
Chillers	CHI
Checking	CHK
Clerical	CLE
Cleaning	CLN
Clean Overheads	CLO
Clear Shoulder	CLR
Cock Removal	COC
Cooling Floor Grader	COF
Computer Entry	COM
Cod Removal	COR
Crutching	CRT
Carton Scanning	CSN
Cutting	CUT
Dagger	DAG
De-gambrel	DEG
Detain	DET
Dicing	DIC
Digester Loading	DIG
Dining Room	DIN
Driving	DRV
Electrical Work	ELW
Engineering	ENG
Engine Room Operator	ENO
Feeder	FEE
Fitters Mate	FIM

Fitting	FIT
Flay Brisket	FLB
Forklift Driver	FLD
Flap Press	FLP
Fleshing	FLS
Flay	FLY
Forequarter Hang-up	FOQ
Forequarter Trim & Wash Control	FQT
Flay Shoulder	FSH
First Aid	FST
Gambrel	GAM
General Maintenance	GEM
General Labouring	GEN
Gland Removal	GLN
Graders	GRA
Green Runners	GRR
Green Skins Selection	GRS
Gut Trays	GTT
Gutting	GUT
Hang up Fore/Hind Leg	HAG
Halal Slaughtering	HAL
Hanging	HAN
Head Removal	HED
Hide General	HE
Hi-Lo Operator	HIL
Hallways	HLL
Hockey Stick	HOC
Hocks	HOL
Horsing Up	HSS
Jack Hammer	JAC
Kidney Pulling	KDP
Kidney Fat Removal	KFR
Kidney Enucleator	KID
Kidney Remover	KIR
Labelling	LAB
Laboratory Operator	LAO
Laundry	LAU
Lazy Suzy	LAZ
L Bar Sealer	LBS
Leading Hand	LEA
Leakers	LEC
Legging	LEG
Leaving the Plant	LEV
Lifting	LFT
Lifting Down	LIF
Lift Operation	LIT
Loading Drums	LOA
Locker Room	LOC

Driving Locomotive	LOD
Loading Out	LOO
Marking	MAR
Main Saw	MAS
Mechanical	MEC
Mincing Machine	MIN
Miscellaneous	MIS
Maintenance	MNT
Netting	NET
Offal	OFF
Open and Locate	OPL
Opening Up	OPN
Operator	OPR
Open and Strip	OPS
Packing B/Pack	PAB
Packing	PAC
Painting	PAI
Palletizing	PAL
Paint Table	PAT
Packing Vacuumed	PAV
Packing Wrapped	PAW
Pelt Challenges	PCC
Pelt House Operator	PEH
Pelting	PEL
Pens	PEN
Petfood	PET
Pizzle	PIZ
Pluck	PLC
Plumbing	PLU
Points	POI
Pressers	PRE
Pre-op Clean Up	PRO
Pre-Trim	PRT
Pre-Wash Trim	PRW
Pallet Store Worker	PSW
Pull Back	PUB
Pull Down	PUD
Pullers	PUL
Quality Control	QUA
Racks	RAC
Ramps	RAM
Ringing	RIN
Railing In/Out	RIO
Rip Down	RIP
Rodder	RUD
Runner	RUN
Rover	RUV
Saw Dusting	SAD

Salting	SAL
Sawyer	SAW
Scales Operations	SCA
Services	SER
Setting Out	SET
Salting Hides	SHD
Shepherding	SHE
Sheetmetal	SHM
Shank Saw	SHN
Showering	SHO
Shoulder Puller	SHP
Shrink Wrap Operator	SHR
Shunting	SHU
Skin Belt	SKB
Skids	SKD
Skins	SKI
Skinning	SKN
Skirt Removal	SKR
Skirting	SKT
Spray Machines	SMA
Soup Stock Worker	SOU
Spleen Removal	SPL
Spreader	SPR
Stairways	STA
Stomachs	STC
Sterilising	STE
Staking	STG
Strapping	STI
Sticking	STK
Stripping	STP
Stringing	STR
Stunning	STU
Supervising	SUP
Steam Vac Operator	SVO
Tail Removal	TAI
Tallyman	TAL
Tanking	TAN
Tail Remover	TAR
Tallow	TAW
Tubs	TBS
Technician	TEC
Testicles	TES
Ticketing	TIC
Ticket Operator	TIK
Tunnel Boning	TNB
Tongue Drop	TON
Trimming	TRG
Tripe Operator	TRI

Trolley Operator	TRO
Trim Pickle	TRP
Tubing	TUB
Turning	TUR
Tutor	TUT
Tying	TYG
Various Driver	VAD
Vacuum Pump Operator	VAP
Vacuum Machine	VCM
Venison Boning	VEB
Venison Labouring	VEL
Vena Cava	VEN
Venison Slaughter	VES
Viscera Trays	VIT
Wash	WAH
Watchman	WAT
White Card Butcher	WCB
Weasand Clip	WEA
Weighing	WEI
Wizard Knife	WIZ
Wool Pulling	WPL
Wool Pressing	WPR
Wrapping	WRA
Wet Wheel	WWH
Yard	YAR
Y-Cut	YCT

For example, the Lorneville plant data had 6,837 recorded incidents before cleaning, but after the process, only 3,912 entries could be identified as MSD injuries. The data was classified by departments, including all incidents, and then filtered to only include MSDs. For instance, the rendering department had 68 incidents during the timeframe, out of which only 22 injuries were categorized as MSDs.

Rendering: 01/10/2016-11/08/2021

All injuries: 68

Aches/pain – gradual	**1**
Aches/pain – specific	**8**
Bruising/Crushing	5
Burns	13
Discomfort	**8**

Foreign Body	8
Head Injury	1
Infectious/Parasitic Disease	1
Inhalation	3
Laceration - Dressing Only	7
Multiple	1
Open Wound	1
Other	3
Poisoning or Toxic Effects	1
Skin Disease	2
Sprain/Strain	**5**
Superficial	1

MSD only = 22

Appendix C – Ethics Approval, Information Sheet and Consent Form

This appendix contains the ethics approval letter from the Ethics Research Committee, an information sheet, and a consent form. It also describes the consent process used before the Focus Group discussion. Participants received the information sheet and consent form electronically and had sufficient time to review them. They were informed that they could exit the recorded meeting at any time if they chose not to participate. After obtaining consent, the researcher recorded the focus group discussion using the MS Teams video recording function. All participants stayed engaged until the session ended.

TE WHARE WĀNANGA O
AWANUIĀRANGI

EC2021.17

10/06/2021 Student ID: 2183297

Hendrik Jacobus Pienaar
309 Chelmsford Street
Waverley
Invercargill
9810

Tēnā koe Hennie

Tēnā koe i roto i ngā tini āhuatanga o te wā.

Ethics Research Committee Application Outcome: Approved

The Ethics Research Committee met on Tuesday 08th June and I am pleased to inform you that your ethics application has been approved. The committee commends you on your hard work to this point and wish you well with your research.

Please contact your Supervisor Paul.Kayes@wananga.ac.nz as soon as possible on receipt of this letter so that they can answer any questions that you may have regarding your research, now that your ethics application has been approved.

Please ensure that you keep a copy of this letter on file and use the Ethics Research Committee document reference number: EC2021.17 in any correspondence relating to your research, with participants, or other parties; so that they know you have been given approval to undertake your research. If you have any queries relating to your ethics application, please contact us on our free phone number 0508926264; or e-mail to ethics@wananga.ac.nz.

Nāku noa nā
Kahukura Epiha
Ethics Research Committee Administrator

Ethics committee document reference number: EC2021.17

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INFORMATION SHEET

Participants Rights

All consenting participants have the right to:

- Decline to participate;
- Decline to answer any particular question.
- Withdraw from the study at any stage during the discussion.
- Mute and/or block the capture of your video/audio recording.
- Ask any questions about the study at any time during participation.
- Provide information on the understanding that your name will not be used unless you give permission to the researcher.
- To be given access to a summary of the project findings when it is concluded.

Support processes

Should you feel distressed as a result of any of the FG discussions, you will have access to AGL's OCP counsellor if or when required.

Project Contacts

All participants are invited to contact the researcher and/or supervisor if you have any questions about the project.

Ethics Committee Approval Statement

This project has been reviewed and approved by Te Whare Wānanga o Awanuiārangi Ethics Committee, **EC2021.17.** If you have any concerns about the conduct of this research, please contact the Ethics Committee administrator as named below.

Contact Details for **Ethics Committee Secretary**:

Kahukura.epiha@wananga.ac.nz

Postal address:
Private Bag 1006
Whakatāne

Courier address:
Cnr of Domain Rd and Francis St
Whakatāne

TE WHARE WĀNANGA O
AWANUIĀRANGI

Name and Address of School
School of Indigenous Graduate Studies
Rongo-o-Awa
Domain Rd
Whakatāne

Managing Musculoskeletal Disorders in the Meat Processing Industry

CONSENT FORM

THIS CONSENT FORM WILL BE HELD FOR A PERIOD OF FIVE (5) YEARS

I have read the Information Sheet and have had the details of study explained to me. My questions have been answered to my satisfaction, and I understand that I may ask further questions at any time.

I agree/do not agree to the Focus Group discussion **being audio taped.** *(only include if applicable)*

I agree/do not agree to the Focus Group discussion **being video-taped.** *(only include if applicable)*

I agree to participate in this study under conditions set out in the Information Sheet, but may withdraw my consent at any given time.

Signature:______________________________ **Date:** ____________

Full name – printed: ______________________________________

Appendix D - Dannevirke Plant Data Tables

This appendix is a comprehensive account of the analysed data, as the table header indicates. It allows readers to understand the various tasks performed within the plant and the associated musculoskeletal injury risks. By examining the detailed information presented in this appendix, readers can obtain valuable insights into the tasks' scope. This provides a valuable resource for enhancing comprehension of the overall injury landscape within the plant and aids in identifying areas where injury prevention measures can be implemented effectively.

Table D18

Dannevirke Musculoskeletal Injury Causing Tasks and Employee Experience

Task Description	Over Five Years	One to Five Years	Six Months to One Year	One to Six Months	First Month	First Week	Grand Total
Amenities				1			1
Anus Cut	2						2
Arriving on Plant	2						2
Bagging	1				1		2
Band Saw		2					2
Boning	19	4	2	2		3	30
Boning - Aitch Boning	2	2	1	2			7
Boning - Fleece Shoulder	1						1
Boning - Tunnel Leg	3	1		1			5
Boxes/Pallets	1						1
Brisket Chopper	1	1					2

Broomie	8	2	2	6	1	2	21
Butcher		1					1
Carton Scanning				1			1
Cartons	10	9	4	10	6	9	48
Casings		2			1	1	4
Chillers	5	3		2	2		12
Chine Saw Operator	1						1
Clean Overheads						1	1
Cleaning	7	7	2			1	17
Cock Removal	1						1
Computer Entry	1						1
De-gambrel	1	1		1			3
Detain	6	2	1				9
Engineering	2						2
Fitting		1					1
Flap Press				1			1
Flay		1					1
Flay Shoulder	1						1
Floor Scrubbing Operator	1						1
Floors		1					1
Forklift Driver		2		2			4
Gambrel	4	5		1	1		11
General Labouring						1	1
Gland Removal	1					1	2
Graders	6	3				1	10
Gut Trays		1					1
Gutting	17	12		5	2	6	42
Halal Slaughtering	8	4		3			15
Hang up Fore/Hind Leg	5	6	1		1	1	14

Head Removal			1			1	2
Hide Pullers		1					1
Hind Hock Removal				1			1
Hind Leg Hock Cut	1						1
Hind Leg Trim		1					1
Hocks				1			1
Kidney Enucleator		1		1	2	2	6
Kidney Fat Removal	6	3			1	3	13
Kidney Pulling				1			1
Labelling	2	1					3
Lamb Caps	2	1					3
Leading Hand	7						7
Leakers		3		2			5
Leaving the Plant	3	4		1	1		9
Lifting	2	1		1	1	1	6
Loading Out	1		1	2	7		11
Maintenance		1					1
Miscellaneous					1		1
Netting		1					1
Offal		5	1	5	1	4	16
Open and locate		1	1				2
Operator		1					1
Packing	38	20	1	9	6	6	80
Packing B/Pack	7	4	1	2	2		16
Packing Vacuumed product	8	8		1		2	19
Packing Wrapped	2	2	1	1			6
Pelting	1				1	1	3
Pizzel	2		1	1		1	5
Pluck		1			1		2

Pre-op Clean Up	6	1					7
Pre-Trim	1	4	1	1		1	8
Quality Control	1	2	1				4
Racks	4					2	6
Railing In/Out	1	1					2
Ringing	3	1					4
Rip Down	14	5		2	1	2	24
Sawyer	16	4	1	1	1		23
Scales Operations		1					1
Shoulder Puller	1						1
Skin Belt		2	2		1	1	6
Skinning	1						1
Skins				1	1	3	5
Stairways	2			1			3
Sticking		1					1
Strapping	2	1	1				4
Stringing				1			1
Supervising	6	4	1				11
Tail Removal	3	1					4
Tail Remover	1						1
Ticket Operator	1						1
Trimming	1	2		1		2	6
Tripe Operator	1	4	1	2	2	5	15
Trolley Operator					1		1
Vacuum Machine	1						1
Viscera Table						1	1
Viscera Trays	6	6	3	12	10	7	44
Yard	7	4	1	2	2		16
Y-Cut	23	7		4	1	2	37

Grand Total	**301**	**184**	**33**	**95**	**59**	**74**	**746**

Appendix E - Levin Plant Data Tables

This appendix is a comprehensive account of the analysed data, as the table header indicates. It allows readers to understand the various tasks performed within the plant and the associated musculoskeletal injury risks. By examining the detailed information presented in this appendix, readers can obtain valuable insights into the tasks' scope. This provides a valuable resource for enhancing comprehension of the overall injury landscape within the plant and aids in identifying areas where injury prevention measures can be implemented effectively. The alphabetical list highlights the top seven injury causing tasks.

Table E28

Levin Musculoskeletal Injuries by Task and Experience

Task Description	Over Five Years	One to Five Years	Six Months to One Year	One to Six Months	First Month	First Week	Grand Total
Air knife	1			1			2
Amenities		2		1	1		4
Animal	2	3	1	2			8
Anus Cut	1			1			2
Band Saw	3	2		2			7
Barrows		1					1
Boning	10	7	1	2			20
Carcase conveyors		1					1
Carcase handling	7	11	2	4	1		25
Carton blasts		1					1
Carton handling	4	10	1	13	1		29
Carton palletising area		2		1			3

Task Description	Over Five Years	One to Five Years	Six Months to One Year	One to Six Months	First Month	First Week	Grand Total
Chemicals		2		1			3
Chillers	1	1		3			5
Chine bone machine	1	1					2
Clean Up (Wash downs)	2	1	2		1		6
Cleaning between shifts		1	2				3
Containers	2						2
Conveyor belts/rollers		3					3
Flaying	1						1
Floors	5	8	1	3			17
Forklifts		5					5
Gates		1	1				2
Grading - cooling floor	1						1
Gutting	2	4		1			7
Head removal - mechanical	2						2
Head removal - scalper	1						1
Hide pulling	1	2		2			5
Kidney enucleator/removal/popping	1	1	1			1	4
Knife work	11	6				1	18
Knocking box	1						1
Laboratory - general		1		1			2
Legging	1						1
Loin boner		2	1	1			4
Maintenance work Shops	1						1
Offal recovery	2	5		1	2		10
Office	1						1
Packing	14	44	6	14		1	79
Pallet stores	2						2

Task Description	Over Five Years	One to Five Years	Six Months to One Year	One to Six Months	First Month	First Week	Grand Total
Pallets - storage of	1						1
Paunches				1			1
Pelting		1			1		2
Petfood tubbing - bulk		1					1
Pre-trim	2	2					4
Product Handling	1	1	1				3
Pushing up carcases		5		1	1		7
Quartering rail		1		1			2
Ramp				1			1
Rear leg hang-up					1	1	2
Rise and fall stands	1						1
Saws		2	1				3
Scales		1					1
Shoulder puller				1			1
Skin transfers	1						1
Skin washers	1						1
Skirt machine		1					1
Smoko-room			1				1
Stacking		1		1	1		3
Stairways		2		2			4
Stands	1						1
Steps				1			1
Stockyards		1		1			2
Stunning - auto	2	1					3
Tail removal	2						2
Trimming	11	15	2	1	1		30
Triton operator		2					2
Vacuum machines	2	7					9
Walkway	2	1					3
Weighing				1			1
Wrapping machines		1		1			2
Y -cutting	2	4					6
Grand Total	**111**	**188**	**25**	**71**	**11**	**5**	**411**

Appendix F - Lorneville Plant Data Tables

This appendix is a comprehensive account of the analysed data, as indicated by the table header. It offers readers an opportunity to gain a thorough understanding of the various injury types and tasks performed within the plant and the associated injury risks that are present. By examining the detailed information presented in this appendix, readers can obtain valuable insights into the scope of the incidents. This provides a valuable resource for enhancing comprehension of the overall injury landscape within the plant and aids in identifying areas where injury prevention measures can be implemented effectively.

Table F32

Lorneville Plant Five Season Incidents by Injury Type

	Season					
Injury Type	**16/17**	**17/18**	**18/19**	**19/20**	**20/21**	**Total**
Discomfort	331	437	245	295	357	1665
Aches/pain - specific	153	67	188	151	138	697
Bruising/Crushing	132	116	119	153	160	680
Sprain/Strain	71	70	157	105	158	561
Laceration - Dressing Only	72	43	78	55	15	263
Laceration - Steri Strips	57	59	58	53	30	257
Aches/pain - gradual	55		52	62	69	238
Foreign Body	48	38	16	21	29	152
Superficial	14	9	4	18	49	94
Occupational Overuse Syndrome	17	11	15	16	23	82
Burns	8	15	9	12	19	63
Bone Scratch	20	16	7	4	9	56
Open Wound	6	7	3	15	22	53
Burns - Scald	12	9	11	6	11	49
Skin Disease	9	15	8	5	4	41
Burns - Chemical	13	6	3	6	5	33
Infection	8	9	7	4	4	32
Other	7	5	7	5	4	28
Puncture Wound	5	2	1	2	14	24
Head Injury	4	9	4	3	2	22
Laceration - Referral - GP/Hosp	2	2	6	4	7	21

Inhalation	3	3	1	5	2	14
Multiple	1	2	3	1	3	10
Infectious/Parasitic Disease	2	2	5		2	11
Laceration - Sutures	1		3	1	1	6
Industrial Deafness		2			3	5
Fracture or Spine	1		1		1	3
Poisoning or Toxic Effects				3		3
Dislocation		1			1	2
Near Miss				1	1	2
Musculoskeletal Disease		1				1
Burns - Electrical	1					1
Other Fracture				1		1
Nerves/Spinal Cord		1				1
Damage to Artificial Aid	1					1
Internal (Trunk)			1			1
Grand Total	**1053**	**958**	**1012**	**1007**	**1143**	**5173**

Table F33

Lorneville Five Season Incidents by Department

			Season			
Department Name	**16/17**	**17/18**	**18/19**	**19/20**	**20/21**	**Total**
Further Processing 1	166	152	280	251	310	1159
S/Bd Labourers	181	154	165	137	116	753
Further Processing 2	85	104	68	112	123	492
S/Bd Chain 1	75	56	75	90	99	395
Further Processing 4	106	113	53	49	58	379
Fellmongery	47	55	34	33	35	204
S/Bd Chain 4	44	38	37	31	38	188
S/L Fancy Meats	43	34	38	21	28	164
Palletised Stores	40	23	32	23	39	157
S/Bd Chain 2	33	35	21	34	24	147
S/Bd Chain 3	23	19	21	25	35	123
Venison Boning	19	18	17	18	35	107
Amenities	24	14	9	22	17	86
Further Processing 5	13	8	6	23	34	84
Rendering	6	10	21	18	24	79
S/L Yards	9	14	15	20	14	72

Venison Slaughter	3	12	22	15	17	69
Casings	26	15	15	6	5	67
Yard Gang	18	14	9	13	9	63
S/L Tripe	16	10	7	9	15	57
Cooling Floor	11	7	8	16	10	52
Fitters	8	5	12	9	7	41
Soup Stock	5	3	10	7	8	33
Further Processing 3	15	9	4			28
Maintenance Admin	8	5	3	7	3	26
Gutshed	3	2	2	3	5	15
Plumbers		6	4	1	4	15
Electricians	4	4	2	1	4	15
S/Bd Chain 5	1	2	7	3		13
Beef Slaughter-084					12	12
Painters		2	3	2	3	10
Main Store	3	2		2	3	10
Pool Labour	6	2		1		9
Plant Administration	4		1	1	2	8
Engine Room	1	2	1		2	6
Beef Boning Room					6	6
Freezers	1	1	3		1	6
Quality Control		4		1		5
Safety	2	2				4
S/Bd Chain 6		1	2	1		4
Carpenters	2				1	3
Medical Centre			1	1	1	3
Farm	2		1			3
Pelts			1	1		2
Security			1	1		2
Graders			1			1
Laundry			1			1
Makarewa Transport		1				1
S/L Skids & Gambels			1			1
Corporate Secretarial					1	1
Garage	1					1
Beef Slaughter					1	1
Laboratory		1				1
Makarewa Pallet Store	1					1
Grand Total	**1055**	**959**	**1014**	**1008**	**1149**	**5185**

Note. Top injury departments are highlighted in the same colour.

Table F37

Lorneville Plant Five Season Injury tasks

			Season			
Task Description	**16/17**	**17/18**	**18/19**	**19/20**	**20/21**	**Total**
Packing	81	84	74	72	91	402
Boning	70	70	62	50	72	324
Cleaning	57	41	42	45	44	229
Cartons	45	37	38	32	48	200
General Labouring	28	27	22	26	88	191
Trimming	43	31	35	26	25	160
Gutting	38	25	19	41	36	159
Bagging	21	19	30	29	29	128
Racks	22	27	20	29	28	126
Pelting	23	22	21	30	20	116
Gut Trays	20	23	19	26	23	111
Sawyer	29	15	14	20	24	102
Y-Cut	16	22	20	19	23	100
Skirting	18	20	30	16	15	99
Wrapping	18	10	28	15	25	96
Butcher	11	25	24	10	7	77
Scales Operations	9	10	14	18	18	69
Detain	21	16	9	13	10	69
Sticking	11	9	19	19	7	65
Chillers	17	15	13	13	5	63
Flay	6	9	14	14	17	60
Pre-op Clean Up	10	7	9	16	14	56
Tripe Operator	18	11	5	7	13	54
Broomie	13	10	11	10	10	54
Pallet Store Worker	12	6	8	6	19	51
Pre-Trim	8	8	11	10	12	49
Operator	3	7	15	9	15	49
Cod	14	7	12	4	9	46
Paint Table	9	14	10	7	6	46
Loading Out	8	8	13	5	9	43
Forequarter Trim & Wash	6	9	3	14	11	43
Lifting	5	4	12	13	9	43
Locker Room	9	5	6	6	16	42
Supervising	8	9	3	10	12	42
Hang up Fore/Hind Leg	7	7	11	8	8	41

Boning - Aitch Boning	6	5	6	4	17	38
Stairways	8	4	6	3	15	36
Offal	8	8	7	5	8	36
Boning - Tunnel Leg	2	10	6	10	4	32
Fitting	6	4	9	6	6	31
Maintenance	6	7	4	8	4	29
Yard	3	6	6	10	4	29
Tutor	10	7	4	3	4	28
Shepherding	5	3	7	7	6	28
Pluck	4	6	2	7	7	26
Vacuum Machine	1	8	11	3	2	25
Skins	2	5	9	6	3	25
Stringing	11	2	3	3	5	24
Soup Stock Worker	4	2	4	5	8	23
Skids	5	2	7	4	5	23
Forklift driver	5	5	5	4	4	23
Petfood	6	5	2	2	8	23
Halal Slaughtering	3	2	2	8	7	22
Graders	4	5	7	1	4	21
Leakers	5	2	2	6	6	21
Cod Removal	4	3	1	8	3	19
Bobby Calf Boning		1	7	10	1	19
Opening Up	1	3	3	3	9	19
Amenities	4		3	7	5	19
Bunger	3	6	5	3	1	18
Wool Pulling	8	1	2	1	5	17
Carcass Relocating / off the floor	4	3	4	2	3	16
Tunnel Boning	4	4		6	2	16
Hanging	4	2	4	2	3	15
Electrical Work	5	4	1	2	3	15
Boning - Leg Loins	4	1	3	6	1	15
Gland Removal	5	3	5		2	15
Boxes/Pallets	3	3	2	6		14
Ticketing	6	2	2	2	2	14
Plumbing		6	4	1	3	14
Railing In/Out	3	2	3	1	4	13
Boning - Trim Loin	2	1	4	2	4	13
Pizzel	1	5	2	1	4	13
Dining Room	4			3	6	13
Weighing			4	6	2	12

Bump Cutter	2	2	6		2	12
Salting	2	5	1	4		12
Legging		1	1	2	8	12
Packing B/Pack	2	4	3	2	1	12
Tail Removal	4	5	1	2		12
Main Saw				3	9	12
Flap Press	3	3	3		2	11
Fleshing	2	4		2	3	11
Kidney Remover	3	3	1	3	1	11
Blood		4	4	1	1	10
Shank Saw		2	1	4	3	10
Venison Slaughter	2		4	2	2	10
Casings	4	3	2		1	10
Clerical	3	3		1	3	10
Barrows	2	4	2	1		9
Strapping	2		4	1	2	9
Runner	4	2	1		2	9
Painting		2	1	2	4	9
Quality Control	2	5		1	1	9
Horsing Up	3	2	2	1		8
Fitters Mate			4	1	3	8
Skirt Removal	4	2		2		8
Labelling	2	1	3	1	1	8
Flay Brisket		2	2	1	3	8
Arriving on Plant	2	4			2	8
Showering	4	2	2			8
Miscellaneous	3	1	1	2	1	8
Staking	1	1		4	2	8
Ramps	1	2	1	4		8
Wash		1	1	3	3	8
Services	2	2	2	1	1	8
Setting Out			5	2	1	8
Saw Dusting	1		2	3	2	8
Leaving the Plant	3	1		2	1	7
Rodder	1		2	2	2	7
Steam Vac Operator		1	4	2		7
Pens	1		1	3	2	7
Flay Shoulder	5			1	1	7
Clean Overheads		1	5		1	7
Dagger	1		1	3	2	7
Gambrel	2		4		1	7

Wet Wheel		1	1	2	3	7
Knife Sharpening	3	1	2		1	7
Leading Hand			3		4	7
Kidney Pulling	3			3		6
Engineering	4	1		1		6
Stunning	1	2	1		2	6
Cutting			2	4		6
Venison Boning	2				4	6
Cock Removal	2		2	1	1	6
Mechanical	1	1	3		1	6
Packing Vacuumed		2	2	2		6
Venison Labouring		3	1	1		5
Kidney Fat Removal	1	2		1	1	5
Viscera Trays	3		1	1		5
Kidney Enucleator	3			2		5
Green Skins Selection	3	2				5
Driving	1	1	1		2	5
Pull Back		2	1	2		5
Palletising	1	1	2	1		5
Checking		1	2	2		5
Green Runners		1			4	5
Driver Various	1	1	3			5
General Maintenance	1	1		2		4
Pullers	1		2	1		4
Chamber hand	1	1	2			4
Stripping	1		1	1	1	4
Anal Bung Application			1	1	2	4
Band Saw	1		1	1	1	4
Vena Cava	1	1	1	1		4
Tail Remover	2		2			4
Pelt House Operator	1			2	1	4
Tallow			1	2	1	4
Carpenter	2			1	1	4
Ringing				3	1	4
Boning - Tunnel Shoulder		3		1		4
Open and locate	1	1		2		4
Dicing				1	3	4
Hockey Stick	1	2	1			4
Stowing	2	1	1			4
Rover	2	1			1	4
Medical			1	1	1	3

Netting		1	1	1		3
Head Removal			3			3
Boning - Fleece Shoulder			2		1	3
Boning - Trim Shoulder		1	2			3
Trolley Operator	1	1		1		3
Challenge Cook Operator	2		1			3
Spreader	1		1		1	3
Packing Wrapped		1		1	1	3
Belly Flank	1				2	3
Lift Operation	1	1			1	3
Hocks		1			2	3
Rip Down	2	1				3
Salting Hides	2				1	3
Tallyman			1	2		3
Mincing Machine					3	3
Cod Area		2			1	3
Laundry				2		2
Carton Scanning			1		1	2
Tubing		1		1		2
Boilerman		1			1	2
Driving Locomotive	1		1			2
Cooling Floor Grader			1	1		2
Blood man			1		1	2
Neck Boning				2		2
Vacuum Pump Operator			1		1	2
Box Boy		1			1	2
Laboratory Operator		1		1		2
Shoulder Puller				1	1	2
Pelt Challenges			1	1		2
De-gambrel		1		1		2
Chine Saw Operator	1			1		2
Skin Belt		1			1	2
Feeder	2					2
Skinning					2	2
Points				2		2
Stomachs	1	1				2
Hide General			1		1	2
Wool Driers		1	1			2
Welding	1				1	2
Loading Drums	1		1			2
Paint Mixing	1				1	2

Tongue Drop	1					1
Pre-Wash Trim	1					1
Turning					1	1
Hide Pullers				1		1
White Card Butcher	1					1
Beef Slaughter C Grade					1	1
First Aid	1					1
Buffing				1		1
Open and Strip			1			1
Chemical Mixer		1				1
Weasand Clip			1			1
Digester Loading			1			1
Ticket Operator		1				1
Spare Cut		1				1
Trim Pickle			1			1
Spleen Removal	1					1
Blast Loader				1		1
Spray Machines					1	1
Tying		1				1
Chemical Shed				1		1
Pressers		1				1
Boning - Trim Shanks				1		1
Pull Down			1			1
Chemical Storeman				1		1
Brisket Punching	1					1
Break necks		1				1
Salt Mine	1					1
Hallways			1			1
Marking		1				1
Broom - Wash to Detain	1					1
Training	1					1
Save-all		1				1
Sheet metal	1					1
Wool Pressing		1				1
Blower man		1				1
Gall Processing			1			1
Clear Shoulder		1				1
Floors				1		1
Head and Tongue				1		1
Hammer Mill			1			1
Rumble Room					1	1

Ironing				1		1
Bin Man	1					1
Cutting up Pelts					1	1
Shrink Wrap Operator			1			1
Scraping			1			1
Shunting				1		1
Hi-Lo Operator				1		1
Watchman				1		1
Jack Hammer	1					1
Lifting Down		1				1
Lazy Suzy	1					1
Loader Driving		1				1
Tanking		1				1
Wide to Narrow					1	1
Testicles			1			1
Thumb Tool		1				1
Forequarter Hang-up	1					1
Chemicals				1		1
Carton Tunnel		1				1
Sterilising		1				1
Rescue Squad Training	1					1
L Bar Sealer			1			1
Grand Total	**1055**	**959**	**1014**	**1008**	**1149**	**5185**

Note. Listed high to low according to total frequency by season.

Table F38

Lorneville Plant Musculoskeletal Injury Causing Tasks (>10 injuries) by Years of Experience

Task Description	First Week	First Month	One to Six Months	Six Months to One Year	One to Five Years	Over Five Years	Grand Total
Packing	25	41	69	2	88	68	293
Boning	4	11	21	2	84	132	254
Cartons	10	16	16	3	38	44	127
Trimming	7	15	20	3	39	39	123
General Labouring	6	10	26		40	38	120
Bagging	8	13	31	1	27	25	105
Racks	9	16	25		40	13	103
Gutting	1	3	9	2	35	51	101
Cleaning		1	3		17	59	80
Pelting	1	1	9	1	18	47	77
Gut Trays	13	18	16	2	11	11	71
Sawyer			4		17	42	63
Wrapping	3	7	16		24	13	63
Y-Cut		3	3		12	43	61
Skirting	5	5	10		27	9	56
Scales Operations	1	2	8		23	18	52
Tripe Operator	3	4	5	1	18	17	48
Detain			2		12	33	47
Chillers		5	6		12	23	46
Butcher	1	3	3		4	29	40
Sticking	1	2	6		6	23	38
Lifting	1	3	5	1	8	19	37
Flay	1	1	2		19	14	37
Pre-Trim	2	3	4	1	15	12	37
Broomie	2	3	8	1	9	13	36
Pallet Store Worker	6	5	4		4	13	32
Paint Table		3	2		7	19	31
Cod	1	1	1		7	21	31
Forequarter Trim & Wash	1	5	6		8	9	29
Boning - Aitch Boning			2		9	18	29
Loading Out	1	2	4		10	12	29

Pre-op Clean Up					3	23	26
Boning - Tunnel Leg		1	4		5	15	25
Skins	2	4	2		4	12	24
Stairways		1	1		7	13	22
Hang up Fore/Hind Leg		1			3	16	20
Offal			1		5	14	20
Vacuum Machine	1		7		3	8	19
Supervising					1	17	18
Halal Slaughtering	1	1	4	1	2	8	17
Operator	1				2	14	17
Soup Stock Worker					1	15	16
Stringing		1	4		4	6	15
Bobby Calf Boning					6	9	15
Forklift Driver		1	1			12	14
Petfood					1	13	14
Maintenance					3	10	13
Graders			1		3	8	12
Shepherding			1		4	7	12
Carcass Relocating / off floor		1	1		3	7	12
Leakers	1	2	3	1	3	2	12
Tunnel Boning					3	9	12
Yard					4	8	12
Fitting			1		4	6	11
Fleshing	1	1	1		4	4	11
Skids			1		2	7	10
Legging			2	2	2	4	10
Flap Press			2		2	6	10
Hanging			2		3	5	10
Ticketing		2	2		1	5	10
Boning - Leg Loins		1	2		3	4	10
Boning - Trim Loin	1	1	4		3	1	10
Bunger		1	1		1	7	10
Grand Total	**121**	**221**	**394**	**24**	**783**	**1222**	**2765**

Note. Tasks that cause more than 10 musculoskeletal injuries make up 85.2% of all reported musculoskeletal disorders.

Appendix G - Mataura Plant Data Tables

This appendix is a comprehensive account of the analysed data, as indicated by the table header. It offers readers an opportunity to gain a thorough understanding of the various injury types and tasks performed within the plant and the associated injury risks that are present. By examining the detailed information presented in this appendix, readers can obtain valuable insights into the scope of the incidents. This provides a valuable resource for enhancing comprehension of the overall injury landscape within the plant and aids in identifying areas where injury prevention measures can be implemented effectively.

Table G47

Mataura Plant Musculoskeletal Injury Causing Tasks by Department across Years of Experience

		Experience						
Department	**Task Description**	**First Wk**	**First Mth**	**1-6 Mths**	**6 Mths to 1 Yr**	**1-5 Yrs**	**Over 5 Yrs**	**Total**
Beef Boning	Boning		3	3		27	47	80
	Carcase Handling			1		4	13	18
	Carton Handling	1		3		8	13	25
	Clean Up (Wash downs)		3	6		10	3	22
	Floors		2	1		9	11	23
	Knife			11		13	15	39
	Packing	5	6	22		42	51	126
	Trimming	1	3	12		31	32	79
Total		**7**	**17**	**59**		**144**	**185**	**412**
Beef Slaughter	Carcase Handling	1		4		16	30	51
	Floors		2	10		5	10	27
	Halal Slaughtering			3		8	11	22
	Hide Pulling		1	2		2	12	17
	Knife	1	3	11	1	19	9	44
	Legging			2		13	24	39
	Packing		1	2		8	5	16

	Saws					7	10	17
Total		**2**	**7**	**34**	**1**	**78**	**111**	**233**
Beef Offal	Amenities			1		1		2
	Carton Handling					2		2
	Clean Up (Wash downs)					1	1	2
	Doors			1			1	2
	Knife		1	1		1	1	4
	Offal			2		1	2	5
	Offal recovery		5	14		6	7	32
	Packing		1	3		3	2	9
Total			**7**	**22**		**15**	**14**	**58**
Fitters	Amenities						2	2
	Floors					1	3	4
	Ladders					1	1	2
	Maintenance Work Shops					1	1	2
	Stairways		1				2	3
Total			**1**	**0**		**3**	**9**	**13**
Hide Processing	Forklifts						2	2
	Hide Pulling		1	2		6	5	14
Total			**1**	**2**		**6**	**7**	**16**
Chillers	Carton Handling			1		2	1	4
	Chamber hand					2		2
	Floors						2	2
Total				**1**		**4**	**3**	**8**
Beef Chillers	Carcase Handling						1	1
	Chillers					2	1	3
	Floors						1	1
	Forklifts						1	1
Total				**0**		**2**	**4**	**6**
Beef Tripe	Offal						1	1
	Offal recovery			1			1	2
	Packing					1		1
Total				**1**		**1**	**2**	**4**
Grand Total		**9**	**33**	**119**	**1**	**253**	**335**	**750**

Note. The risk of musculoskeletal injuries increases as individuals gain more experience, indicating that effectively managing workload and incorporating adequate recovery time can be crucial in reducing the occurrence of such injuries.

Appendix H - Nelson Plant Data Tables

This appendix is a comprehensive account of the analysed data, as indicated by the table header. It offers readers an opportunity to gain a thorough understanding of the various injury types and tasks performed within the plant and the associated injury risks that are present. By examining the detailed information presented in this appendix, readers can obtain valuable insights into the scope of the incidents. This provides a valuable resource for enhancing comprehension of the overall injury landscape within the plant and aids in identifying areas where injury prevention measures can be implemented effectively.

Table H53

Nelson Seasonal Incidents by Task Description

	Season					
Task description	**16/17**	**17/18**	**18/19**	**19/20**	**20/21**	**Total**
Acid Tank					1	1
Amenities		10	3	2	3	18
Bagging		1	1	1		3
Band Saw	1	1	4			6
Blast Loader			1			1
Bobby Calf Boning	2	2	1			5
Bobby Calf Yards		1				1
Boning	14	12	11	3	6	46
Boning - Aitch Boning	3	2	4	1	1	11
Boning - Leg Loins				1		1
Boning - Tunnel Shoulder		2				2
Boxes/Pallets			1	1	2	4
Butcher	1	1	1		2	5
Cartons	2	8	3	3	4	20
Chillers	1	6	6	5	3	21
Chine Saw Operator					2	2
Clean Overheads	1	2				3
Cleaning	21	8	10	19	9	67
Clerical	1					1
Cock Removal		1		2		3

Computer Entry				2		2
Condemned Area	1	1				2
Cutting				1		1
Dagger	1		1		1	3
Detain	2	4	3	6	2	17
Electrical Work	4	2				6
Engineering	1	2	1	1		5
First Aid				1		1
Fitters Mate				2		2
Fitting		2				2
Flay	1	4				5
Flay Shoulder		2				2
Floor Scrubbing Operator	1					1
Floors	2				1	3
Forklift Driver	1	1	4	2	1	9
Gambrel	5	1	1		1	8
General Labouring		1				1
Gland Removal				5	2	7
Graders	1	2	3	1	5	12
Gutting	2	1	6	1	3	13
Halal Slaughtering	3	4	7	7	4	25
Hang up Fore/Hind Leg	2		1		1	4
Hanging		1			2	3
Hide General	1					1
Kidney Enucleator		2		2		4
Kidney Fat Removal	1					1
Labelling		1		1	1	3
Laboratory Operator		2		1		3
Leading Hand		1	1	1		3
Legging				1		1
Lifting	4	3		1	1	9
Lifting Down	1					1
Loader Driving	1				1	2
Loading Out	3	4	2		1	10
Maintenance	1	1	3	1		6
Miscellaneous	18	6	1			25
Offal	6	4	8	10	12	40
Packing	11	10	16	12	14	63
Packing B/Pack	5	1	1	1	8	16
Packing Wrapped	2				1	3
Pelt House Operator		1			1	2

Pelting	3	1	4		1	9
Petfood			1			1
Pizzel	1	4	2			7
Pre-op Clean Up		3				3
Pre-Trim	3		2		4	9
Quality Control	2	3	2	2		9
Racks	1		4	2	2	9
Railing In/Out	2	1				3
Ramps					1	1
Ringing	2		1		1	4
Rip Down	1	10	6	5	2	24
Rodder		1		1		2
Runner			1	1		2
Salting		1	3		1	5
Salting Hides		1				1
Sawyer	3	2	5	13	4	27
Scales Operations			1			1
Setting Out	4					4
Shepherding	9	5	6	22	12	54
Shrink Wrap Operator					1	1
Skids	1	4	1	3		9
Skins	2	1	3	8	2	16
Spare Cut		1				1
Stairways	2					2
Staking			1		1	2
Steam Vac Operator		1				1
Sticking		1				1
Strapping	5	1		1		7
Sterilising					1	1
Stringing		1	1	1		3
Stunning			1		5	6
Supervising	1	5	11	4	5	26
Tail Removal					1	1
Tractor Driver	1					1
Training	2				1	3
Trimming	9	5	4			18
Tripe Operator	3		1	4	3	11
Trolley Operator				1		1
Tunnel Boning	2	4			2	8
Tutor				1	1	2
Unloading Trucks	1					1

Vacuum Machine	1					1
Viscera Table					1	1
Viscera Trays			1			1
Wash	1		1	2	3	7
Weighing		1				1
Wide to Narrow		1	4			5
Wrapping	3	3	4	1		11
Yard	1	5				6
Y-Cut	9	6	12	5	8	40
Grand Total	**203**	**193**	**188**	**175**	**159**	**918**

Table H59

Nelson Musculoskeletal Injuries by Task and Experience

Task description	First Week	First Month	1-6 Months	6 Months to 1 Year	1-5 Years	Over Five Years	Grand Total
Acid Tank		1					1
Amenities			1	1	4	12	18
Bagging			1			2	3
Band Saw			1	1	1	3	6
Blast Loader						1	1
Bobby Calf Boning					3	2	5
Bobby Calf Yards						1	1
Boning		5	8	3	9	21	46
Boning - Aitch Boning			1	1	6	3	11
Boning - Leg Loins			1				1
Boning - Tunnel Shoulder					2		2
Boxes/Pallets					3	1	4
Butcher				1	1	3	5
Cartons		3	3		7	7	20
Chillers		2	2	1	7	9	21
Chine Saw Operator						2	2
Clean Overheads						3	3
Cleaning	1	5	13	7	14	27	67
Clerical					1		1
Cock Removal			1	1	1		3

Computer Entry					1	1	2
Condemned Area					2		2
Cutting					1		1
Dagger			1		1	1	3
Detain		1		1	5	10	17
Electrical Work						6	6
Engineering					1	4	5
First Aid					1		1
Fitters Mate						2	2
Fitting						2	2
Flay			1		1	3	5
Flay Shoulder					2		2
Floor Scrubbing Operator					1		1
Floors			1	1		1	3
Forklift Driver		1	2	1	2	3	9
Gambrel	1		3		3	1	8
General Labouring						1	1
Gland Removal	1	2	1		2	1	7
Graders			4	1	2	5	12
Gutting			3	1	4	5	13
Halal Slaughtering		1		1	4	19	25
Hang up Fore/Hind Leg				1	2	1	4
Hanging				2	1		3
Hide General					1		1
Kidney Enucleator			1	1	1	1	4
Kidney Fat Removal					1		1
Labelling				1	1	1	3
Laboratory Operator				1	2		3

Leading Hand					1	2	3
Legging					1		1
Lifting					2	7	9
Lifting Down						1	1
Loader Driving		2					2
Loading Out	1	2	1		2	4	10
Maintenance					1	5	6
Miscellaneous		2	1	1	7	14	25
Offal	5	4	7	5	11	8	40
Packing	2	4	11	5	12	29	63
Packing B/Pack			3	1	4	8	16
Packing Wrapped					2	1	3
Pelt House Operator			1		1		2
Pelting		1	2		3	3	9
Petfood			1				1
Pizzel			2		4	1	7
Pre-op Clean Up						3	3
Pre-Trim		1	2	1	4	1	9
Quality Control			1		1	7	9
Racks			4	1	3	1	9
Railing In/Out	1					2	3
Ramps		1					1
Ringing	1		1		1	1	4
Rip Down			3	1	6	14	24
Rodder	1					1	2
Runner			1			1	2
Salting		1	1	2	1		5
Salting Hides						1	1

Sawyer				1	8	18	27
Scales Operations						1	1
Setting Out					2	2	4
Shepherding	2	12	7	5	14	14	54
Shrink Wrap Operator						1	1
Skids				1	3	5	9
Skins	2		3	1	10		16
Spare Cut					1		1
Stairways						2	2
Staking		1				1	2
Steam Vac Operator					1		1
Sticking						1	1
Strapping			2		5		7
Sterilising					1		1
Stringing	1	1	1				3
Stunning	1	1	2		1	1	6
Supervising						26	26
Tail Removal					1		1
Tractor Driver						1	1
Training	2		1				3
Trimming	1	1	2	3	7	4	18
Tripe Operator	1		2		4	4	11
Trolley Operator					1		1
Tunnel Boning			2		2	4	8
Tutor					2		2
Unloading Trucks					1		1
Vacuum Machine					1		1
Viscera Table	1						1

Viscera Trays						1	1
Wash	1	1	3		2		7
Weighing						1	1
Wide to Narrow					2	3	5
Wrapping	2	2	4		1	2	11
Yard	1	1	1	1	1	1	6
Y-Cut			3		12	25	40
Grand Total	**29**	**59**	**124**	**57**	**251**	**398**	**918**

Note. Tasks are in alphabetical order, with the top (tasks with more than 15 incidents) injury-causing tasks highlighted. The risk of musculoskeletal injuries increases as individuals gain more experience, indicating that effectively managing workload and incorporating adequate recovery time can be crucial in reducing the occurrence of such injuries.

Appendix I - Pukeuri Plant Data Tables

This appendix is a comprehensive account of the analysed data, as indicated by the table header. It offers readers an opportunity to gain a thorough understanding of the various injury types and tasks performed within the plant and the associated injury risks that are present. By examining the detailed information presented in this appendix, readers can obtain valuable insights into the scope of the incidents. This provides a valuable resource for enhancing comprehension of the overall injury landscape within the plant and aids in identifying areas where injury prevention measures can be implemented effectively.

Table I62

Pukeuri All Incidents by Task

Incidents by task	**Number of incidents**
Acid Tank	1
Amenities	20
Anal Bung Application	2
Arriving on Plant	1
Bagging	11
Band Saw	2
Barrows	21
Beef Slaughter A Grade	22
Beef Slaughter B Grade	44
Beef Slaughter C Grade	26
Bin Man	1
Blocking	1
Blood	3
Blood Drier	1
Blood man	3
Bobby Calf Boning	6
Bobby Calf Yards	3
Boiler house	2
Boilerman	9
Boning	421
Boning - Aitch Boning	4
Boning - Leg Loins	3
Boning - Trim Loin	2
Boning - Tunnel Leg	1
Boning - Tunnel Shoulder	1
Box Boy	9

Boxes/Pallets	8
Brisket Chopper	6
Brisket Roller	3
Broom - Wash to Detain	2
Broomie	48
Bump Cutter	10
Butcher	72
Captive Bolt	1
Carcass Relocating / off floor	42
Carpenter	1
Carton Tunnel	73
Cartons	221
Casings	2
Chain Grader	1
Chair and Shackle	62
Checking	6
Chemicals	2
Chillers	42
Chopper	2
Clean Overheads	2
Cleaning	116
Clerical	4
Cock Removal	12
Cod	1
Cod Removal	2
Computer Entry	7
Cooling Floor Grader	51
Cutting	13
Dagger	1
De-gambrel	3
Detain	119
Dining Room	5
Dolly man	1
Drafter	2
Driers	3
Driving Locomotive	1
Electrical Work	8
Engine Room Operator	3
Engineering	3
Farm Work	1
First Aid	2
Fitters Mate	27
Fitting	51
Flap Press	1
Flay	44

Flay Shoulder	3
Floor Scrubbing Operator	1
Fore/Hind leg Hang-up	1
Forequarter Trim & Wash Control	1
Forklift Driver	24
Gambrel	8
General Labouring	183
General Maintenance	1
Gland Removal	5
Graders	120
Green Runners	13
Green Skins Selection	9
Gut Trays	92
Gutting	108
Halal Slaughtering	33
Hallways	3
Hang up Fore/Hind Leg	6
Hanging	5
Head and Tongue	2
Head Removal	2
Hide Fleshing	1
Hide General	1
Hide Pullers	17
Hides Grading	2
Hides Tannery	4
Hind Puller Trim	1
Horsing Up	3
Hydro Operator	32
Jack Hammer	1
Janitor	38
Kidney Enucleator	169
Kidney Fat Removal	9
Kidney Pulling	60
Kidney Remover	29
Knife Sharpening	2
Labelling	6
Laboratory Operator	5
Laundry	3
Leading Hand	28
Leakers	7
Leaving the Plant	9
Legging	2
Lifting	32
Loader Driving	2
Loading Drums	1

Loading Out	32
Locker Room	3
Maintenance	10
Medical	3
Mincing Machine	1
Miscellaneous	28
Neck Boning	3
Non-Work Compo	1
Offal	14
Opening Up	2
Operator	2
Packing	204
Packing B/Pack	3
Packing Vacuumed	4
Packing Wrapped	1
Paint Mixing	3
Paint Table	28
Painting	3
Pallet Store Worker	1
Pelt Challenges	5
Pelt House Operator	9
Pelting	38
Pens	2
Pluck	5
Plumbing	8
Pre-op Clean Up	14
Pressers	1
Pre-Trim	2
Pre-Wash Trim	1
Pull Down	1
Pullers	9
Pullers Assistant	4
Punching Down	1
Quality Control	37
Quartering Beef	7
Racks	3
Railing In/Out	1
Ramps	1
Rear Leg Hang Up	1
Rescue Squad Training	2
Ringing	2
Rodder	2
Runner	39
Salting	1
Salting Hides	2

Saw Dusting	1
Sawyer	77
Scales Operations	2
Scribing	14
Scrubber Units	1
Setting Out	2
Shackling	10
Shaking Out	1
Shank Saw	1
Sheet metal	5
Shepherding	64
Shoulder Puller	1
Showering	1
Shrink Wrap Operator	1
Shunting	2
Silver Skinner	1
Skids	25
Skinning	3
Skins	93
Skirt Removal	2
Skirting	5
Spinal Cord Remover	9
Stairways	10
Staking	1
Steam Vac Operator	6
Sticking	24
Stomachs	2
Strapping	32
Sterilising	2
Stringing	53
Stunning	1
Supervising	40
Tail Removal	20
Tallow	3
Technician	2
Thumb Tool	3
Ticket Operator	2
Ticketing	6
Training	32
Trimming	145
Tripe Operator	127
Tunnel Boning	7
Tunnel Punch	39
Urine Extraction	2
Vacuum Machine	13

Vacuum Pump Operator	5
Vallero Drum Operator	1
Viscera Table	2
Wash	10
Wastewater	4
Watchman	1
Weasand Clip	1
Welding	3
Wet Blue General	1
Wheeler	3
Wizard Knife	2
Wool Driers	5
Wool Pressing	2
Wool Pulling	11
Wrapping	3
Yard	36
Y-Cut	67
Grand Total	**4385**

Table I63

Pukeuri Plant Musculoskeletal Injuries by Task and Experience

	Experience						
Tasks	**First Week**	**First Month**	**One to Six Months**	**Six Months to One Year**	**One to Five Years**	**Over Five Years**	**Total**
Acid Tank			1				1
Amenities			1		2	7	10
Anal Bung Application		2					2
Bagging		1	1		4	2	8
Band Saw					1	1	2
Barrows		1	5		8	1	15
Beef Slaughter A Grade	1		1		6	5	13
Beef Slaughter B Grade	1	2	1	1	17	6	28
Beef Slaughter C Grade		1	6	1	8		16
Bin Man					1		1
Blocking		1					1
Blood	1				2		3
Blood man		1					1
Bobby Calf Boning					1	2	3
Bobby Calf Yards	1				1		2
Boiler house						1	1
Boilerman				1	5	2	8
Boning	10	26	40	9	163	96	344
Boning - Aitch Boning					1	3	4

Boning - Leg Loins				1		2	3
Boning - Trim Loin			1				1
Boning - Tunnel Leg					1		1
Boning - Tunnel Shoulder			1				1
Box Boy	1	2	1		1	2	7
Boxes/Pallets	1				1	6	8
Brisket Chopper					3		3
Brisket Roller						1	1
Broom - Wash to Detain			1				1
Broomie	5	4	9	2	8	7	35
Bump Cutter					1	1	2
Butcher	1	3	5	1	22	21	53
Carcass Relocating / off floor	1	6	2	2	12	15	38
Carpenter						1	1
Carton Tunnel	1	3	5		32	15	56
Cartons	13	11	23	2	101	42	192
Casings					1		1
Chain Grader			1				1
Chair and Shackle	3	11	16	3	10	2	45
Checking			1		4		5
Chillers		2	4		17	11	34
Chopper			2				2
Cleaning	4	4	6	1	33	17	65
Clerical					1	3	4
Cock Removal		2	1		3		6
Cod Removal						1	1
Computer Entry				1	5	1	7

Cooling Floor Grader		2	4	1	27	10	44
Cutting	1		1		3	2	7
De-gambrel						2	2
Detain	6	3	8	2	47	25	91
Dining Room					1		1
Dolly man					1		1
Drafter					2		2
Driers						2	2
Driving Locomotive						1	1
Electrical Work					1	1	2
Engine Room Operator		1			1		2
Engineering						2	2
Farm Work						1	1
First Aid					1	1	2
Fitters Mate	2				9	6	17
Fitting		1	5		6	10	22
Flap Press					1		1
Flay	1	2	2		12	14	31
Flay Shoulder						1	1
Floor Scrubbing Operator			1				1
Fore/Hind leg Hang-up						1	1
Forequarter Trim & Wash Control	1						1
Forklift Driver					13	8	21
Gambrel					1	6	7
General Labouring	7	18	20	9	72	20	146
General Maintenance						1	1

Gland Removal					1		1
Graders	2	9	13	1	45	17	87
Green Runners	1	2	1	2	2	2	10
Green Skins Selection	2	1			1	3	7
Gut Trays	10	14	13	1	21	16	75
Gutting	4	7	7	1	35	24	78
Halal Slaughtering			4		18		22
Hallways						1	1
Hang up Fore/Hind Leg					4	1	5
Hanging			2			1	3
Head Removal						1	1
Hide Fleshing						1	1
Hide General		1					1
Hide Pullers				1	5	1	7
Hides Grading				1	1		2
Hides Tannery		1			1		2
Horsing Up			1		1		2
Hydro Operator	3	1	4		7	13	28
Jack Hammer			1				1
Janitor	1	1	2	1	12	9	26
Kidney Enucleator	21	46	25	5	37	5	139
Kidney Fat Removal	1		2		2		5
Kidney Pulling	5	17	8	1	13	3	47
Kidney Remover		6	8	2	3		19
Labelling					4	1	5
Laboratory Operator			1		3	1	5
Laundry					1	1	2

Leading Hand		1	1		6	11	19
Leakers					4	1	5
Leaving the Plant			1		2	1	4
Lifting		2	3	1	11	14	31
Loader Driving						2	2
Loading Drums					1		1
Loading Out		1			6	15	22
Locker Room		1					1
Maintenance	1	1			4		6
Medical	1		1			1	3
Mincing Machine					1		1
Miscellaneous			1		11	9	21
Offal					2	6	8
Operator	1		1				2
Packing	9	6	18	5	76	51	165
Packing B/Pack						3	3
Packing Vacuumed	1				2	1	4
Paint Mixing						2	2
Paint Table			2		3	10	15
Painting						1	1
Pelt Challenges		1	1		1	1	4
Pelt House Operator					1	5	6
Pelting		5	6		11	7	29
Pens					1		1
Pluck		1					1
Plumbing			1			2	3
Pre-op Clean Up			1			8	9

Pressers	1						1
Pre-Trim					1	1	2
Pre-Wash Trim	1						1
Pull Down		1					1
Pullers	1	1	1		3	1	7
Pullers Assistant			1		2		3
Punching Down					1		1
Quality Control		3	6	2	11	6	28
Quartering Beef				1	1	1	3
Racks			1		1	1	3
Railing In/Out	1						1
Ramps					1		1
Rear Leg Hang Up			1				1
Rescue Squad Training					1	1	2
Ringing	1						1
Rodder			1			1	2
Runner	4	3	5		11	10	33
Salting					1		1
Saw Dusting						1	1
Sawyer	1	3	3		25	18	50
Scales Operations					1		1
Scribing					2	4	6
Scrubber Units			1				1
Setting Out						1	1
Shackling	1	2	2		1	1	7
Shaking Out						1	1
Shank Saw					1		1

Sheetmetal						2	2
Shepherding	1	7	8	1	24	3	44
Shoulder Puller						1	1
Showering			1				1
Silver Skinner			1				1
Skids	3		4	1	5	4	17
Skinning		1				1	2
Skins	2	3	7	1	31	29	73
Skirting			2		1	1	4
Spinal Cord Remover		1	3		1		5
Stairways		1			1	3	5
Staking						1	1
Steam Vac Operator		1			2	1	4
Sticking	1	1	4		5	5	16
Stomachs		1			1		2
Strapping	3	2	1		11	4	21
Stringing	5	12	18	3	11		49
Stunning						1	1
Supervising				1	11	16	28
Tail Removal	3	2	1	1	3		10
Thumb Tool				1		1	2
Ticket Operator					2		2
Ticketing			1		4	1	6
Training	2	7	8	1	3	1	22
Trimming	5	6	9	2	49	29	100
Tripe Operator	6	16	24	5	28	28	107
Tunnel Boning		2			2	2	6

Tunnel Punch	1	4	2		6	18	31
Vacuum Machine		1	1		6	3	11
Vacuum Pump Operator		1	1		2		4
Vallero Drum Operator						1	1
Viscera Table					1		1
Wash					1	2	3
Wastewater					2	1	3
Weasand Clip					1		1
Welding					1		1
Wet Blue General					1		1
Wheeler	1				1		2
Wool Driers						4	4
Wool Pressing						2	2
Wool Pulling				1		7	8
Wrapping					1	1	2
Yard			1	2	7	11	21
Y-Cut	2	3	4	4	16	18	47
Grand Total	**171**	**320**	**428**	**86**	**1339**	**890**	**3234**

Appendix J - Smithfield Plant Data Tables

This appendix serves as a comprehensive account of the analysed data, as indicated by the table header. It offers readers an opportunity to gain a thorough understanding of the various injury types and tasks performed within the plant and the associated injury risks that are present. By examining the detailed information presented in this appendix, readers can obtain valuable insights into the scope of the incidents. This provides a valuable resource for enhancing comprehension of the overall injury landscape within the plant and aids in identifying areas where injury prevention measures can be implemented effectively.

Table J75

Smithfield Musculoskeletal Injuries by Task and Experience

	Experience						
Task Description	**First Week**	**First Month**	**One to Six Months**	**Six Months to One Year**	**One to Five Years**	**Over Five Years**	**Total**
Amenities			2		2	3	7
Anal Bung Application			1				1
Anus Cut				1		1	2
Bagging				1	3	2	6
Bin Man		1		1	2	2	6
Blood Drier					1	1	2
Boilerman					1	1	2
Boning	1	5	14	3	76	40	139
Boning - Aitch Boning			1		2	3	6

Boning - Femur Leg			1	1	1	3
Boning - Fleece Shoulder				1	2	3
Boning - Leg Loins				2	1	3
Boning - Trim Loin				1		1
Boning - Trim Shoulder				1		1
Boning - Tunnel Leg			1			1
Box Boy				2	2	4
Boxes/Pallets		1		4	2	7
Brisket Chopper		1		1	2	4
Broomie		2	1	5	10	18
Bunger					1	1
Butcher				13	7	20
Carcass Relocating / off floor		5	3	15	10	33
Carpenter					3	3
Carton Scanning			1	1		2
Cartons		3		10	6	19
Checking		1		2	3	6
Chemical Storeman					1	1
Chillers	1	3		6		10
Clean Overheads					1	1
Cleaning		4	1	15	12	32
Clerical				2	3	5
Cod Area				3		3
Cod Removal				1	1	2
Company Meat Inspector		1	2	26	13	42
Conditioning				1		1
Cooling Floor Grader				4		4
Cutting	1	1		8		10

De-gambrel	1				1		2
Detain					15	7	22
Driving						1	1
Electrical Work					1	1	2
Engine Room Operator			1				1
Engineering					5		5
Fitters Mate						1	1
Fitting					1		1
Flap Press					3		3
Flay						1	1
Flay Brisket					1		1
Floors			1				1
Forklift Driver		1	1		2	11	15
Gambrel					1	1	2
General Labouring	1	4	9	6	25	25	70
General Maintenance					1	1	2
Gland Removal					2		2
Graders					1	7	8
Greasing					1		1
Green Runners		1			1	1	3
Green Skins Selection						1	1
Gut Trays		1	3	1	5	2	12
Gutting	1	2	1		23	10	37
Halal Slaughtering					3	4	7
Hang up Fore/Hind Leg		1	3	2	4	2	12
Hanging						1	1
Hide Pullers			1				1
Janitor			1		1		2

Kidney Enucleator	1	2	3				6
Kidney Fat Removal		1			1	1	3
Kidney Pulling	1	2			3	1	7
Kidney Remover		1	5		1		7
Knife Sharpening						2	2
Labelling			1				1
Laboratory Operator						1	1
Laundry						2	2
Leading Hand					1	2	3
Leakers					1	1	2
Legging					4		4
Lifting	3	5	4	1	34	8	55
Loading Out		1	2	2	23	5	33
Locker Room			1			1	2
Maintenance					4	2	6
Mechanical						1	1
Medical						1	1
Miscellaneous						1	1
Neck Boning					1		1
Neck Breaker			2				2
Offal		1	1		4	3	9
Opening Up			1			3	4
Operator					1		1
Packing		6	9	1	37	16	69
Packing B/Pack			1		1	2	4
Packing Vacuumed					1	1	2
Packing Wrapped					1		1
Pallet Store Worker					1		1

Pelt Challenges					1	1
Pelting			1	2	1	4
Petfood		1	1			2
Pizzel	1				1	2
Pluck				1	1	2
Plumbing					1	1
Pre-Inspection - Carcass Trim				1		1
Pressers			1			1
Pre-Trim					1	1
Pull Back				1		1
Pull Down				1		1
Quality Control				1	4	5
Racks				2	3	5
Railing In/Out					2	2
Retailing					1	1
Ringing				1		1
Rodder	1				1	2
Roller Coater	3	2	2	1	1	9
Rover					1	1
Runner		2	1	13	4	20
Sawyer				3	5	8
Scales Operations				2	2	4
Scraping		1		1		2
Services				1		1
Setting Out			1			1
Shepherding	1	1	3	11	5	21
Showering					1	1
Shunting				2	1	3

Silver Skinner					1		1
Skids		1			2	1	4
Skinning					1	3	4
Skins	1	1			4	2	8
Skirt Removal			2		1	1	4
Skirting					1		1
Spleen Removal					2	2	4
Stairways			1		4	4	9
Staking					6	2	8
Sticking		1			5	9	15
Strapping				1	2	3	6
Stringing		1	2	1	3		7
Stunning					1		1
Supervising				1	4	7	12
Tail Removal		3	1		3		7
Tail Remover			1				1
Technician					1		1
Ticketing					2	3	5
Training			2	2	1		5
Transfer					1	1	2
Trimming		1	16	6	28	3	54
Tripe Operator		3	3	1	7	2	16
Tunnel Boning				2	5	4	11
Tunnel Punch					4	2	6
Tying						1	1
Vacuum Machine			2		1		3
Venison Boning					3		3
Venison Labouring		1			1	1	3

Venison Slaughter					1		1
Viscera Table	2	2	2		4	5	15
Viscera Trays					3	3	3
Wash				1	1	3	8
Wrapping					1	1	2
Yard		1	3		1		5
Y-Cut		1		1	15	6	23
Grand Total	**12**	**59**	**133**	**55**	**592**	**371**	**1222**

Note. Table J75 presents musculoskeletal injuries at Smithfield categorised by task and experience. Analysing the data in three distinct ways, considering the experience and the tasks associated with the incidents, we can gain insights into the impact of ageing on injury rates for physical tasks, the time needed to become proficient in a task, and the identification of physically demanding tasks (such as Packing and Boning). This information is valuable for determining the appropriate placement and training requirements for new and existing employees.

Appendix K - Focus Group Discussion

This appendix presents a comprehensive report on the Focus Group Discussion on May 7th, 2021. The discussion revolved around interventions aimed at addressing Musculoskeletal Disorders at AGL. This Focus Group discussion occurred within the context of the weekly Health and Safety meeting, specifically focusing on the Injury Prevention agenda.

This appendix provides readers with a valuable opportunity to thoroughly understand the topic by exploring the various discussion points. The aim was to address research questions five and six:

- Research question five - Which MSD prevention interventions have been effective for addressing MSD at AGL?
- Research question six - What barriers to MSD prevention exist at AGL?

Table K1 shows the demographic information of the focus group participants.

Table K1

Demographic information of the focus group participants

Participant	Gender	Age	Ethnicity	Role
RP	Male	60	Other European	Grp Process Safety Manager
HP	Male	54	Other European	MSK Injury Prevention Manager
SJ	Female	61	NZ European	Injury Management Officer
KB	Female	66	NZ European	Grp Health & Wellbeing Manager
CD	Female	37	Hispanic	Health and Safety Advisor
KC	Female	56	Maori	Plant HS Manager
ML	Male	54	Maori	Plant Health and Safety Manager
DW	Female	59	Maori	Plant Health and Safety Manager
DA	Male	54	NZ European	Plant Health and Safety Manager
ES	Female	30	Maori	Health and Safety Advisor
GA	Male	49	Other European	Plant Health and Safety Manager

The focus group's transcribed information plays a crucial role in enhancing our understanding of the overall injury landscape within the plants at AGL by identifying successful interventions and potential barriers to musculoskeletal disorder (MSD) prevention. Moreover, it assists in identifying specific areas where effective injury prevention measures can be implemented.

Transcribed notes from the Focus Group Discussion that was held on 7 May 2021:

Focus Group Discussion – Interventions for Addressing Musculoskeletal Disorders at AGL (Weekly Health and Safety meeting with Injury Prevention agenda)

Present at the discussion:

Rob Peterson (RP), Hennie Pienaar (HP), Sue Johnson (SJ), Karen Birch (KB), Caroline Dill-Moraes (CD), Karen Coe (KC), Mark Lewis (ML), Donna Wilson (DW), David Armstrong (DA), Ezralee Simpson (ES), Greg Allan (GA).

Dialogue:

RP

- Opened the meeting and shared the agenda and the planned activities.

HP

- Shared MSI contributing factors identified from secondary data during the past 15 months in the following categories:
- **Job Design**
    - Task Rotation
    - Task Specific Design (e.g., Bobby calf breakdown)
    - Rest/Recovery Breaks/Stretching breaks.
    - Work Pace and Equipment design
    - Physical Task Requirements
- **Organisational Design**
    - Recruitment and Retention
    - Workflow (Extended hours)
    - Remuneration / Job Grades
    - Job Allocation
    - Attendance (Absenteeism)
    - Workplace Culture (our values)
    - Staff Participation
    - Shift Design
    - Health and Safety Management

    - Early Reporting and Injury Management
    - Maintenance
- **Physical Design**
    - Plant Design
    - Workspace and Equipment Design
    - Knife and Glove/Mesh Design
    - Thermal Environment

HP

- Prompted group discussion and answered questions related to their observations about MSD injury prevention interventions at individual plants…
    - What past interventions were successful?
    - What present interventions were successful?
    - What factors contributed to the success of these interventions?
    - Which interventions were less successful? Why?
    - What learnings (both positive and negative) can be taken from past interventions?
    - What were the MSI contributing factors?
    - What were the MSI-preventing factors?
    - Any barriers or limitations for MSI injury prevention?
    - Any other MSD injury prevention strategies you are aware of?

RP

- Intro to TRIFR data – brief discussion about what it looks like…
- three plants with the lowest MSI components @ 50% of TRIFR

HP

- Early reporting – Pukeuri shows an increase in Discomfort reporting with a drop in TRIFR Year on Year
- Metrix – Discomfort vs FA (First Aid)
- Discomfort (Year on Year) - Uniformity is required when reporting data for comparisons.
- Report data range 1/4/20-31/3/21

ML

- Mentioned that was the case (increased discomfort reporting) at Levin in the previous year – an increase in discomfort reporting that resulted in a drop in TRIFR in the following year.

Contributing factors:

- Stretching – posters
- Chiropractor 1day x week
- Rooms - Early reporting of injuries
- Educate SV + employees on the benefits of how to ease workers into their job roles.
- Once discomfort is identified, move towards a prevention focus, easing people into their job tasks by starting on lighter tasks.
- Hands-on focus, acting fast and working with the SV to find solutions.
- More detached since Work Aon has become involved, not engaged 100%. It was better when we were directly involved.
- It is essential that HSM are fully aware of what is going on (KC agrees)

DW

- Having a Metrix – that defines a drop-off point for discomforts to become a FA
- More consistency in tracking these.

DA

- It is best to look at year-on-year data and where changes were/are noticed.
- Discomfort reporting – an essential aspect of plant culture that leads to easy interaction - and trust in the medical centre.
- SV involvement is a significant improvement at Smithfield
- Health Safety Managers - relationship with Aon work/ non-work = treat injuries the same regardless of where it happened – still impacts on work, brings it back to plant culture of we care
- Different treatment is a barrier to recovery and needs a change in work culture.

ML

- Supports DA statements about treatment culture – treats all injuries accordingly, which aids and speeds up employee recovery.

ES

- Suggest making use of 5-year data to make comparisons with

RP

- Silver bullet?
- Need more data to work with
- MSI part of TRIFR has improved from 60-70% MSI to 50%.
  Early notification (ML)
- Plant Culture change (DA)
- Challenge for larger plants (RP)
- Stretching impact?

DA

- Select employees carefully.
- Identify high-risk risks and do evaluations on functional work capacity. Identified parties are notified that they are not suitable for the industry – worked with Union to give them exist strategies.

RP

- Questioned HP about injury latency factors for MSI and overuse injuries. How do we know?

HP

- Response varied factors involved: work experience, tasks they have been performing, past work experience/factors, age, physical condition, physical attributes, and underlying health conditions.
- Can happen within two weeks, depending on the factors involved (age, gender, ethnicity, nature of previous work, etc.)
- Support DA's statement of being more selective with our medicals.
- Not selective enough due to staffing shortages.

RP

Determine – Data or numbers of less suitable employees, identified yet employed….

DA

- What % of pre-employment at-risk employees were employed or wrongly placed despite medical team recommendations?
- % Across all plants of pre-employment medicals that are declined or # of employees with restrictions identified that are employed.
- Smithfield 73% suitable (37% - not employed)
- Not the same at other plants

RP

- Agree – numbers of persons that are employed with restrictions?
- What percentage of persons with restrictions get injured?
- Knowingly employ people at risk – What percentage get hurt compared to those with no limitations or clear medicals?

ML

- Another side - Seniority typically gets direct passage into the new season regardless of their physical condition.
- Stated looking at employees from the seniority group that are not suitable.
- Made use of a top injured list of people on site to determine the top 10, which included older staff in the industry for the past 20 years.
- Came down to body breakdown – goal was to find these individuals positions within the business that are more suitable and less likely to hurt them. Discussed their current work/injury status with them and the longevity of their roles (5 years)
- Seniority vs not suitable?
- For injured on-site list. Find other positions within the organisation with options. There has not been a single injury since.

KC

- Be proactive rather than reactive.
- Change management and ergonomics: have to work with what we have.
- Business moving forward … Build plant for people and not for machines.
- Improved + good training.
- Increased speed – plant not designed for it.

DW

- Definitions & Metrix- Manage with what we have - eliminate.
- Identify what we do wrong and stop doing it when it leads to similar results.
- Metrix and definitions must be aligned and clear – we all must be doing the same things.
- Take our suggestions to the business and challenge the business to support change.
- Cannot do any more until pending issues are addressed. Putting the numbers together and planning what needs to happen.

RP

- New culture of change, e.g. Provention worked but was not sustained.
- Need for leadership to demonstrate and lead by example.

- Support needed for a safety culture by leadership = Loss of this culture focus?

ML

- Head office culture- Seasons shortened – no breaks for workers, lack of adequate maintenance – lack of funds for improved ergonomic designs.
- Evident at plant level that it is production before Health and Safety.
- Poor stock quality – little is being done about changing this.
- Lack of investment to stay on top of MS issues.

RP

- Senior leadership focus may have drifted.
- PM – where support has maintained a more focused approach… are they the sites with better outcomes? Your thoughts?

DA

- In the past, there used to be a queue to work at AGL. Smithfield used to accept all who turned up for job interviews—employment without medicals. Not anymore. We reversed that mindset. It was a proactive change that made a difference. Determine how many people are turned away on medical grounds. HR has a perception to employ all.

GA

- Rejected medicals at LNV: 52/632 (8%) + 15 Drug fails – rejected.

DA

- Rejected medicals at SMI 60/281 (21%) ± 15=DRUG FAILS (excl.)
- Trend across other plants? Does this correlate with MSI?
- Ongoing pressure from SV to get positions filled.

RP

- Who do we accept – set threshold = how many got hurt? (Borderline cases)
- Rate and threshold (set acceptance rate – then determine threshold)

GA

- New starters: <6 months - 30 recordable injuries from this group

DW

- Age range for this group? 18-late 40. (GA)
- PUK: Recordables old employees- F/A & Discomfort

GA

- Not job ready sign off too fast… in the past, start on Thursday, followed by a weekend rest.

DW

- Good info on what we know - what will we do with it?

RP

- Report findings to SLT- back-up with data.
- Data analysis
- Change data needs to be accurate.

GA

- The drug test example is not well supported on the ground. Drug and Alcohol do not involve all communications, which creates a gap in the business.

DW

- The HS Group agenda will be put forward, with planning discussions and actions for change, supported by group data collected and shared with SLT.
- RP suggest these findings be presented to David Surveyor (DS)

DA

- HS Group discussion to work/plan for actions required at/from the corporate level as well as actions required at the plant level.
- Two groups – plant vs corporate level changes/interventions to be determined.

RP

- Plant and site culture effects to be addressed are at the plant level—SV & PM, etc. Frontline leaders will have the greatest influence on change.
- Focus may have dropped over the past few years, e.g., on plant culture safety walks. Does data for this exist? Is SI down? Safety walk frequency may have dropped.

ML

- Resources for production have dropped, along with less time for H/S tasks.
- More hours are required from HSM, along with a lack of resources and training opportunities.
- Absenteeism leads to staffing pressure on some who are not fit for work.
- Budgets lacking or limited – More resources required. Ergonomics e.g. (KC)
- Get together more often to discuss these matters.

RP

- Will have to work with what we have got.
- Interesting data will be used to find possible links between extended hours and injury rates.

GA

- Extended hours linked to injuries - need data.
- What sites did extended hours? LNV x 2, PUK, Levin, Dannevirke, Nelson
- LNV: Extended hours before Christmas – first time.

RP

- Data to support our findings … extended hours correlate to increased injury rates.

GA

There is limited time to look at such things.

RP

- How do we make stuff happen?
- Open question – what are the pathways for change?

DA

- Different – peer review all medicals – DA, ML, KC & GA

- How many new employees are employed against medical advice?

RP/DA

- RP – When not medically approved – accountability lies with?
- GA – Shared list of people ignoring medical advice.

DW

- 3X LTI's cases at PUK where people were employed against advice.

RP

- For this to work, we need leadership support for actions to follow when medical advice is ignored.

DA

- Suggests HP reports to SLT the number of employees injured when employed against medical advice. Forward stats to HP.

GA

- MSI causes? Our battle? = ELT should make it happen

RP

- Do they know/have the information they need?
- This is = stay managing upwards = cause & effect… do this expect this, this will happen.
- ELT is the decision maker.

DA

- Work can be done at plant level. Examples of failed medical procedures, conversations that followed, and the decision-making process were also provided.

Interventions and strategies identified that are effective in managing MSD:

- *Discomfort reporting* - Increased reporting, early reporting of injuries at room level (x3)
- Stretching (awareness – more posters in rooms)
- Educate SV (+ employees) on the benefits of how to ease workers into their job roles (x2)
- Once discomfort is identified, move towards a prevention focus, easing people back into their job tasks by starting on lighter tasks.
- Hands-on focus with new injuries, act fast, and work with the SV to find solutions.
- It is important that HSMs are fully aware of what is going on with injuries.
- Chiropractor 1-day x week
- Discomfort reporting: An important aspect is plant culture, which leads to easy interaction. Build trust in the medical centre to deal with injuries effectively.
- SV involvement leads to significant improvement (at Smithfield)
- Treatment of work/non-work injuries – use the same strategy regardless of where it happened. It still impacts work and brings it back to the plant culture of we care; if not, it becomes a barrier to recovery. Need this change in work culture (x2)
- Careful employee selection
- Evaluate high-risk employees – supported with work capacity testing and develop exit strategies with union support.
- Identify persons at risk - make use of a top injured list.
- Continued support for interventions that work. Manual handling skills training.
- Improved + good training.
- Well-maintained plant and equipment
- Ensure good stock quality.
- More comprehensive pre-employment medicals with specific selection criteria
- Ease people into their new roles. For example, start new starters on a Thursday, followed by a weekend of rest.
- Frontline leaders have the greatest influence on change. e.g. plant culture safety walks.
- Peer review all medicals.

Challenges (barriers) that impact MSI injury rates:

- Impact of "Seniority" - direct passage into the new season regardless of their physical condition.
    - Determine which employees from the seniority group are not suitable.
    - Discussions with this group—the goal is to find these individuals positions within the business that are more suitable and less likely to hurt them.
    - Discussed their current work/injury status and the longevity of their roles (5 years)
    - Seniority vs not suitable?

- Ensure people are job-ready and **not** signed off too fast.
- Change in plant culture of we care – if not it becomes a barrier to recovery. Need this change in work culture (x2)
- Resources for production have dropped, along with less time for H/S tasks.
- More hours are required from HSM, along with a lack of resources and training opportunities.
- Absenteeism leads to staffing pressure on some who are not fit for work.
- Budgets lacking or limited – More resources required. Ergonomics e.g.
- Impact of extended hours
- Poor stock quality.

Action Points from the group discussion:

- Making use of 5-year data to make comparisons with and track changes.
- **Collect data** of less suitable employees that were identified – yet employed and then injured.
    - What % of pre-employment at-risk employees were employed or wrongly placed despite medical team recommendations?
    - % Across all plants of pre-employment medicals that are declined or # of employees with restrictions identified that are employed
    - What percentage of persons with restrictions get injured?
    - Knowingly employ people at risk – What percentage get hurt compared to those with no limitations or clear medicals?

- Be proactive rather than reactive.
- Change management and ergonomics: have to work with what we have.
- Business moving forward … Build plant for people and not for machines.
- Careful consideration for increased speed/tally – plant not designed for it.
- Identify what we do wrong and stop doing it when it leads to similar results.
- Metrix and definitions need to be aligned and clear—we all need to be doing the same things. Safety policies and practices need to be aligned.
- Take our suggestions to the business and challenge the business to support change.
- Strategy to ensure good stock quality.
- Plants with stronger leadership focus on supporting safety initiatives... are they the plants with the better safety performance records?
- **Collect data** and compare rejected pre-employment medical data.
    - Any correlations between % of injuries and rejection rates across the business
    - Review selection criteria and set a threshold (how many got hurt?)
    - Rate and threshold (acceptance rate then determine threshold)

- **Report** the good info of what we know (supported with data) to SLT.
    - Plan an HS Group agenda for SLT (supported by collected data) with planning discussion, including actions for change.
    - Include actions required at corporate and plant levels.
    - Two groups – plant vs corporate level changes/interventions to be determined.

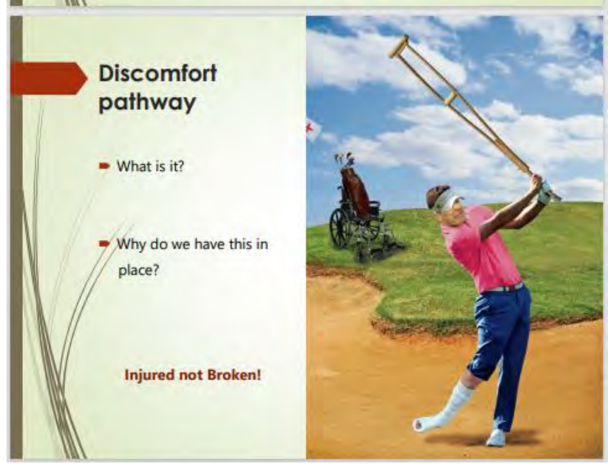
- Determine Plant safety culture initiated by SV, PM, etc. (frontline leaders)—Has it Dropped or increased over the past few years, e.g., plant culture safety walks? Does data for this exist? Is SI down? Is safety walk frequency that may have dropped?

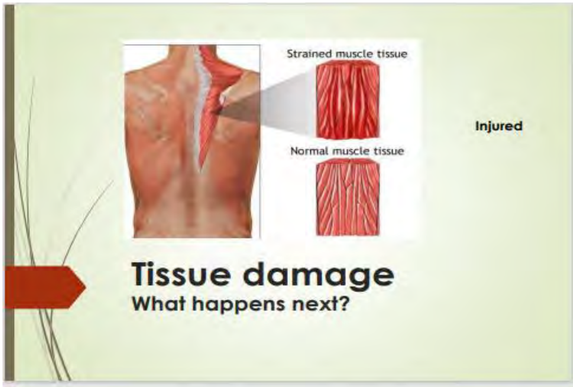
- Determine possible links between extended hours and injury rates. Need data.

- Determine the number of employees who were employed against medical advice or approval. Who will be accountable for these decisions? Determine what steps we need to follow when this happens.

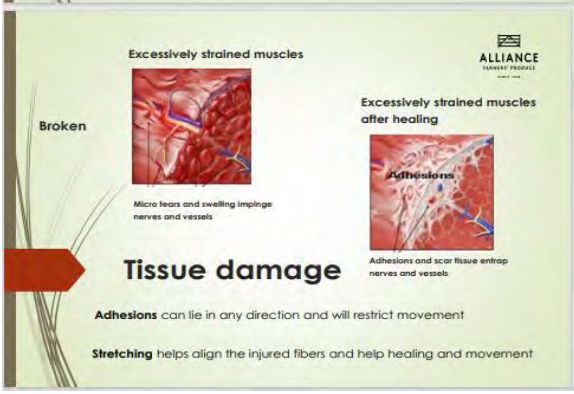
Appendix L – Supervisors Injury Management Workshop

This appendix introduces the Supervisors' Injury Prevention Workshop, implemented throughout AGL, to enhance supervisors' comprehension of injury prevention. The workshop covers topics such as identifying injured employees, understanding best practices for injury prevention, and considering reintegrating them into their roles. The Supervisors' Injury Management Workshop has been conducted for all supervisors across the group.




Strained muscle tissue
Normal muscle tissue
Injured
Tissue damage
What happens next?

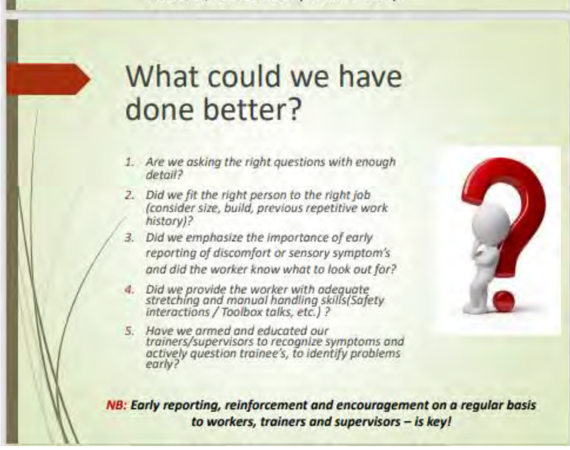

Stretching
Helps – Why?
When or how often?
How long for?
Which stretches to do?
Activity 2 – Small group
Stretching discussion
5 minutes
A longer muscle is a stronger muscle!


Excessively strained muscles
ALLIANCE
Broken
Excessively strained muscles after healing
Micro tears and swelling impinge nerves and vessels
Adhesions
Tissue damage
Adhesions and scar tissue entrap nerves and vessels
Adhesions can lie in any direction and will restrict movement
Stretching helps align the injured fibers and help healing and movement


CASE STUDY
New employee
Trainee in gut trays – "kidney popper"
During week 2 of Kidney Popping training - worker develops pins & needles into the left thumb, index and middle fingers at night.
Thoughts?
Implications:
New employee
New tasks
Activity 3 – Small group
Discussion
5 minutes


Ideal outcome
A course of 4 -6 physio treatments is administered leading to a gradual resolution of the numbness and nocturnal waking, recovery of hand function and a graduated return to kidney popping training with some restrictions - back to full duties.
Cost $500- 750
Less than ideal outcome
Failure of nerve recovery with ongoing constant nerve compression signs & symptoms
Referral to company GP for review.
Likely referral for Nerve conduction studies and onward referral to an Orthopaedic Surgeon .
Treatment may require surgery
Cost including lost work time $19500
NB: Early reporting, reinforcement and encouragement on a regular basis to workers, trainers and supervisors – is key!


Early Identification
If this Carpal tunnel had been picked earlier (week 2 or 3), we would expect it to have resolved quickly (Nurse Triage, immediate splinting , stretching +-ve Physio) with minimal interruption of work practice .
NB: Early reporting, reinforcement and encouragement on a regular basis to workers, trainers and supervisors – is key!


What could we have done better?
1. Are we asking the right questions with enough detail?
2. Did we fit the right person to the right job (consider size, build, previous repetitive work history)?
3. Did we emphasize the importance of early reporting of discomfort or sensory symptom's and did the worker know what to look out for?
4. Did we provide the worker with adequate stretching and manual handling skills(Safety interactions / Toolbox talks, etc.) ?
5. Have we armed and educated our trainers/supervisors to recognize symptoms and actively question trainee's, to identify problems early?
NB: Early reporting, reinforcement and encouragement on a regular basis to workers, trainers and supervisors – is key!


Activity 4 – Whole group
discussion
5 minutes
Think about your "employees" including the supervisors in the production line
1. In the past – How have you known that someone is in the "discomfort" injury zone?
2. In the past - How have employees tried to hide their injuries? Why?
3. What have you done about it?
4. How could we have avoided this?
NB: Early reporting, reinforcement and encouragement on a regular basis to workers, trainers and supervisors – is key!

Appendix M – Pre-employment Medical Examination

This appendix introduces the recently developed Pre-employment Medical Examination form, which includes enhanced physical testing to enhance employee selection and placement. This is a key component of the injury prevention initiative aimed at more effectively positioning new employees and lowering the risk of injuries. The researcher was responsible for coordinating the creation of this form, which is currently implemented throughout the entire group.

ALLIANCE
FARMERS' PRODUCE

Pre-employment Medical Examination

NAME		Date of Birth	

CONSENT FOR MEDICAL EXAMINATION

I consent to all results of the medical examination being held in the Lorneville Medical Centre and understand that in the collection, use and storage of information Alliance Group will at all times comply with the obligations of the Privacy Act 1993 and the Health Information Privacy Code 1994.

I recognise and have been explained the reasoning and importance of the medical examination/health testing or as defined above and have been given all of the information to make an informed decision. I further understand that should I wish to make any future claims in relation to the above through Alliance Group that my choice to decline the above health testing may be detrimental towards this application acceptance.

I realise that I have the right to withdraw my consent at any time and that I will be given a copy of the results should I request them at the time of testing. Failure to consent will not allow the medical part of the application to proceed, thus your application will be withdrawn.

I have read, understood, and agree to the terms of this consent form.

I consent			I do not consent	

Signature of Applicant ________________________ Date ___/___/_____

Person completing medical: ________________________

Prior to completing the AGL pre-employment Medical Examination the person completing this medical confirms that they have sighted and discussed with applicant the AGL Pre-employment health screen questionnaire.

Signature: ____________________ Date ___/___/_____

PRE-EMPLOYMENT MEDICAL

NAME		DOB	

Visual acuity	*Do you have any problems with your eyesight?* *Yes* ☐ *No* ☐
	Distance R) 6/_______ L) 6/_______ Near) N ________ *With / Without aids*
	Colour Vision (*Ishihara Colour Plates*) Red/Green deficiency ☐ Total Colour Deficiency ☐ Normal ☐
Lung function	*Do you have any problems with your breathing or lungs?* *Yes* ☐ *No* ☐ *Do you ever suffer from shortness of breath with daily activities?* *Yes* ☐ *No* ☐
	Peak Flow __________________ L/min *(best of 3 tests)*
Height and Weight	Standing Height (cm): ______ Body weight (kg): ______
Body Structure - *Visual exam, posture, torso, scoliosis, scars/deformity, manual handling ability*	Notes: Good ☐ Average ☐ Poor ☐
Cardiovascular	Resting Pulse (BPM) .... regular / irregular BP; R)_____/_____ BP; L)_____/_____
	Blood sugar level _________________ mmol/L
Cardio-respiratory fitness (3-min step test)	1-min post-test HR ____ (bpm) Score: _______ Good ☐ Average ☐ Poor ☐

Strength and mobility (AROM)

Wrists/Hands *Tenderness, redness, swelling, contractures, visible wounds/scarring*	Phalen's; ☐+ve ☐-ve R) L) Tinel's; ☐+ve ☐-ve R) L) Finkelstein's; ☐+ve ☐-ve R) L)
Grip strength test(kg) *Record highest test result of 2 attempts* (Minimum score required: Male = 30 / Female = 20) Measured in kg	Dominant Hand: Right / Left R) _____ L) _____
Shoulders/Elbows *Swelling, tenderness, inflammation, pain on palpation (all bony landmarks), ROM, visual inspection, dislocation, history*	ULTT; ☐+ve ☐-ve R) L) Cozen's; ☐+ve ☐-ve R) L) Drop arm test; ☐+ve ☐-ve R) L) Apley Scratch Test (circle one): High Med Low
Resisted ROM	RROM: R) L) Abd & Add Flex & Extn Pro & Sup Int & Ext rotation Isometric shoulder test: ________

Spinal & Core mobility *Bend to touch toes, Twist from R to L and L to R with feet not moving, Tilt head all four directions, Lean side to side with arm alongside body*	
Sit and reach test *(Flexibility low back/hamstrings)*	Distance in cm:_____
Balance and Co-ordination **Single leg balance test (in sec)** *(eyes open)*	Record single leg balance time 1 min or until failure (max): R) _____ L) _____ (sec)
LOWER LIMB mobility & strength	
Semi-squat test	*HIGH 20 seconds / MED 15-19 seconds / LOW less than 15 seconds*
Standing to kneeling and kneeling to standing -	*HIGH completes with hands behind back* *MED requires one arm push through leg to stand* *LOW……uses both arms to push up/lower*

OTOSCOPIC EXAMINATION (Nurse to complete prior to hearing test)									
	Right				**Left**				**Comments**
Canals clear	*Yes*		*No*		*Yes*		*No*		
Normal eardrums	*Yes*		*No*		*Yes*		*No*		
Perforations	*Yes*		*No*		*Yes*		*No*		
Referral	**Yes**		**No**		**Reason:**				

NURSES Notes

Referral completed for --

Clearance awaited for --

Clearance received --

MEDICAL GRADING FOR POSITION

NAME	

A) Suitable for all production work

B) Suitable defined departments (Refer comments below)

C) Suitable for Labouring and packing tasks

D) Medical on hold (reviewed 1 week)

E) Industry Unsuitable

COMMENTS (i.e. behaviour during Medical)

NAME OF EXAMINER:_______________________ **SIGNATURE:**_______________________

DATE:_______________________

(Medical grading page to be sent to Employment office.)

Appendix N – New Improved Format for Standard Operating Procedures

This appendix illustrates the enhanced Standard Operating Procedures. These procedures include the correct and highlighted visual cues to emphasise key points. This format aligns with the best practices for the given task.

ALLIANCE

LNV FP BCBD SOP xxxx/x
Page 1 of 3

SAFE OPERATING PROCEDURE

Further Processing: Bobby calf breakdown **21 September 2020**

LNV FP BCBD SOP XXXXX:

TASK DESCRIPTION

Breaking down the bobby calves:

To remove (free) meat from spine, remove legs, ribs and deliver sides (& legs) to tables for legs to be deboned.

PPE REQUIRED							
	Safety Boots	Hearing and Eye protection	Hair net (+ facial hair net)	White Apron or Smock	Mesh apron	CRG/Mesh	Nitrile gloves

TASK HAZARDS		
	• Slippery & uneven surfaces • Other people working close by • Knives • Constant bending/pulling/lifting/twisting	• Trip hazard • Moving machinery – carcass conveyor/chain • Infections

EMPLOYEE REQUIREMENTS BEFORE STARTING WORK / PRE-REQUISITE TRAINING

- Be signed off as competent at performing this task,
- Have been made aware of any Task and Department hazards and evacuation training
- Knife sharpening training
- Hygiene requirements understood
- Manual handling skills training
- Good understanding of task stretching requirements

PRE-OPERATION CHECKS

- PPE is compliant and in good condition
- Knife in good condition and properly sharpened
- Check floor and work area is clear of hazards

LNV FP BCBD SOP xxxx/x
Page 2 of 3

Bobby calf breakdown task

STEPS:

Stage 1:

1. Mark down backbone to free meat around neck and release paddywhack.
2. Ensure knife runs against backbone tilted towards featherbone (feel knife running on bone).
3. Non knife hand supports carcass at loin area.
4. Knife pushes against ball of index finger.
5. Cut down to neck on both sides.
6. Clear neck up to 1st rib.

Stage 2:

7. Mark ribs (both sides) – with angled knife – start at 13th rib.
8. Start on left side, cut gam cord – hold onto the hind leg & cut against Aitch bone to release pelvis.
9. Free leg from pelvis – mark tender loin.
10. Free loin from backbone.
11. Pull side (keep elbows close to sides) – then remove leg and place on table. Remove side from spine.
12. Repeat on R-side. Free pelvis & spine by pulling down (keep elbows close to sides) rather than twisting wrist.
13. Break away ribs from spine by pushing down knife between cartilage joints.
14. Cut side from leg -cut gam cord and place on table.

Important points:

15. Maintain a good "hold" of the carcass side so to ensure it won't be dropped.
16. Maintain good posture, bend knees – back straight (as much as possible) and do not twist – move your feet rather than twisting to avoid pressure on your back.
17. Use gravity and your body weight as mush as possible during the downward pull and keep your elbows close to your body.
18. Ensure good grip and strong wrist position (see image).
19. Minimise bone chips. Ensure cartilage, bone and bone chips are removed.
20. Utilize stoppages and stretch the working muscles and/or drop arms to side "shake" wrist/arm to relax.
21. Rotate task every 15 min.

HYGIENE REQUIREMENTS:

22. **Do NOT** at any time put hands down anal/aitch bone area -this causes contamination to the other areas of the carcass.
23. Work in a tidy manner.

Key Points

Mark down backbone (both sides).

Hold onto the hind leg & cut against aitch bone to release pelvis.

Mark ribs.

Break away ribs from spine by pushing down knife between cartilage joints.

Note that the wrist is angled downwards 10-15°.

Knife against backbone tilted towards featherbone.

Good grip with strong wrist position.

LNV FP BCBD SOP xxxx/x
Page 3 of 3

For competency sign off for **LNV FP BCBD SOP xxx** refer CURO and/or **Form LNV xxx**	
References – Also refer to (e.g. other tasks/documents)	

I have read and understand the tasks listed on this SOP and agree to comply with all requirements to comply with all requirements		
Employee Name	Employee Signature	Date

For competency sign off and competency review dates for **LNV FP BCBD SOP** xxx also refer CURO and/or Form LNV xxx	
Initial Competency level: Leaner, Competent, Tutor (L C T) Circle	
Trainer Name	Signature
Assessor's Name	Signature

Reviewed on Date:	Employee Signature	Assessor Signature:	L C T (Circle)
Reviewed on Date:	Employee Signature	Assessor Signature:	L C T (Circle)
Reviewed on Date:	Employee Signature	Assessor Signature:	L C T (Circle)

Appendix O – Primed for the Gates – Injury Prevention Induction Program

This appendix contains the 60-minute workshop, which the researcher developed as an educational tool to mitigate musculoskeletal disorders. The extensive workshop addresses various aspects, including prompt injury reporting, emphasis on ergonomic risk factors, fatigue management, hydration, manual handling skills, correct work posture, dynamic warm-up, and stretches for injury prevention.

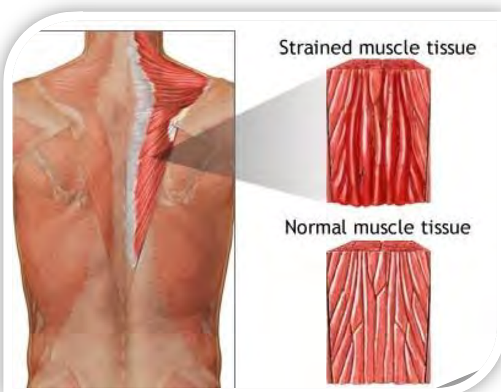
Prevent your injuries from getting worse

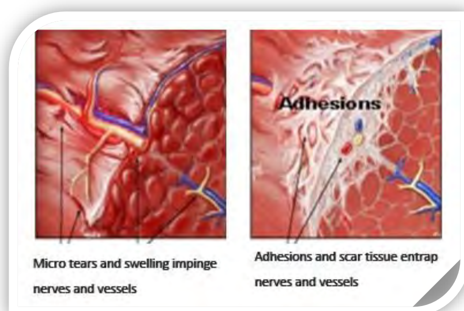
Remember to report your injuries early!

When you feel discomfort, avoid tissue damage

Report your injury and stretch it out.

Broken

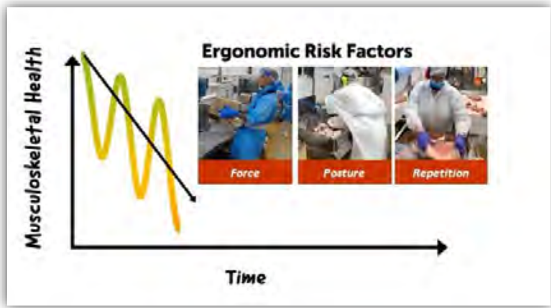




Stretching helps align the injured fibers and help healing and movement

Injured

Focus on reducing Ergonomic risk factors



Reduce Musculoskeletal Injuries…
Make use of every opportunity to reduce local soft tissue fatigue and look out for micro pauses to recover.

Be willing to support your workmates to find better (safer) and easier ways to get the job done.

Reduce workplace risk factors:

- **Forceful Exertions** → Use correct technique and reduce load when possible
- **High Task Repetition** → Support and encourage frequent task rotation
- **Repetitive/Sustained Awkward Postures** → Focus on good work postures

Managing Fatigue

Know when you feel tired:

- Daydreaming, slow reaction times.
- Increased risk-taking.
- Poor communication.
- Poor judgement of distance or time.
- Sore or tired eyes, blurred vision.
- Nodding off for a fraction of a second.
- Impatience, restlessness, irritability.
- Taking safety short cuts such as not bothering to wear safety equipment.

You are in control of ….

- ✓ **Getting enough sleep (8-10hrs)**
- ✓ **Making healthier food choices**
- ✓ **Drinking enough water (2 liters/day)**

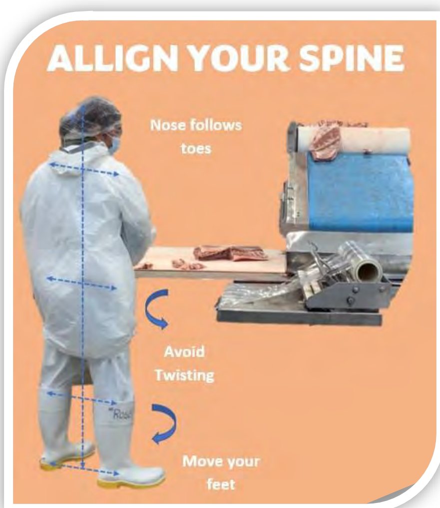

You are in control of your own wellbeing...
Take care of yourself!


Good manual handling skills and good work posture... Makes work easier!
Think about how you move, lift, and handle items during all work tasks
Reduces your risk of injuries!
Focus on good posture and alignment it will reduce your injury risk!

Balance tips....

Remember...
Being off balance will increase your risk of injury

Anti-twisting tips....

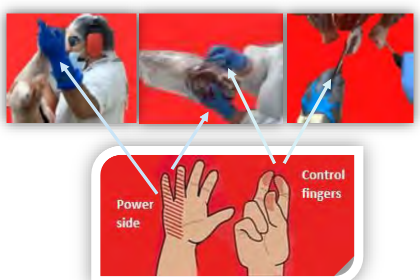


Remember...
Move your feet to reduce the risk of injury

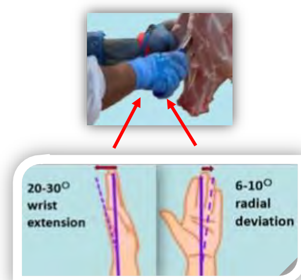
Safer, stronger, shoulder tips....

Remember...
Arms close to your body reduce the risk of injury

Pain free wrists and hands tips....



Remember...



Pushing...
Only use power side of your hand

Carrying and lifting...
Use the power side and AVOID weight on the index finger

Gripping...
Grip hard with your little and ring finger for more strength

Need power...
Align your wrist and use your power side to reduce injury risk

**Reduce your risk of injury…
strengthen your forearms and hands**

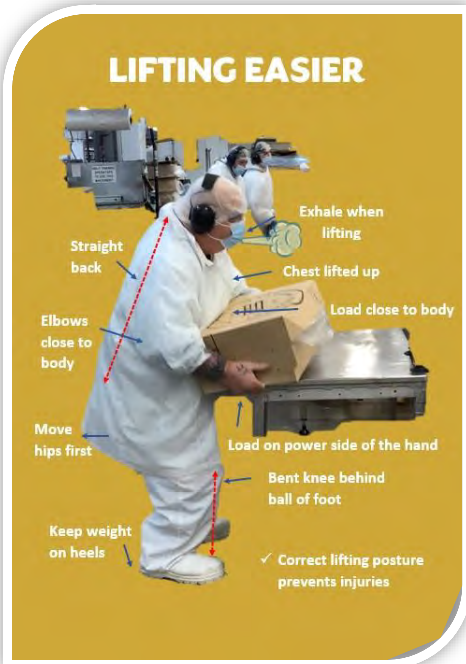
- Squeeze for 5 seconds
- Relax – change hands
- Repeat 10 times
- Both hands
- Do up to 4 x daily

Breathing tips….

Breathing out will protect your back and reduce discomfort – control your abdominal muscles!

Remember ….

Breathe out to reduce the risk of harm when lifting
Holding your breath will increase risk!



Lifting tips....

When lifting:
Move hips first, chest up and drive your heels down.

Remember ....
Good lifting technique and posture reduces risk of injury!

Benefits of dynamic stretching for our Employees

- ✓ *Prepares the body for the stress of work*
- ✓ *Starts the shift with a safety focus*
- ✓ *Reduces their risk of injury*
- ✓ *Improves strength and balance*
- ✓ *Flexible muscles are less likely to get hurt with sudden moves during work*
- ✓ *Less muscle tension - helps muscles to relax*
- ✓ *Help to reduce or manage stress*
- ✓ *Help relieve arthritis, back, and knee pain*
- ✓ *Shows our employees we care by investing time into their well-being*

A longer muscle is a stronger muscle!

5- minute: Dynamic stretching + warm up routine

1. Dynamic lunge- start with a forward lunge hands on hips (those with less balance) Progress to reaching up to the roof with arms and slight trunk extension (for those with good balance) OR add a trunk rotation (for those able that safely can).

Benefits:

- ✓ Warm-up
- ✓ Strength
- ✓ Balance
- ✓ Flexibility
- ✓ Coordination

"Dynamic lunge"

Repeat 4 x 4 sec hold

5- minute: Dynamic stretching + warm up routine

2. Side Step with cross arm stretch for rotator cuff and rhomboids

Benefits:

- ✓ Warm-up
- ✓ Strength
- ✓ Balance
- ✓ Flexibility
- ✓ Coordination

"Side Step"

Repeat 4 x 4 sec hold

5- minute: Dynamic stretching + warm up routine

3. Squat and reach – develops good work & lifting posture

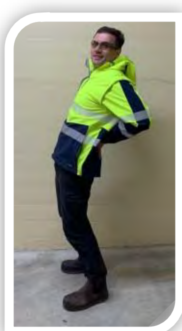
Benefits:
- ✓ Warm-up
- ✓ Strength
- ✓ Balance
- ✓ Flexibility
- ✓ Coordination

"Squat and reach"

Repeat 4 x 4 sec hold

5- minute: Dynamic stretching + warm up routine

4. Lumbar extensions – reduce tension & stretches lower back



Benefits:
- ✓ Flexibility
- ✓ Muscle tension relief

"Stretch your back"

Hold pose for 15 sec

5- minute: Dynamic stretching + warm up routine

5. Lumbar side flexion with contralateral arm reaching overhead (leg crossed in front for those able to maintain balance).

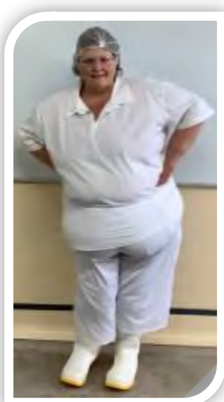
"Ballerina"

Benefits:
- ✓ Warm-up
- ✓ Improved ROM
- ✓ Balance
- ✓ Flexibility
- ✓ Coordination

Repeat 4 x 4 sec hold

5- minute: Dynamic stretching + warm up routine

6. Standing hip circles with hands on hips



"Do the twist"

Benefits:
- ✓ Warm-up
- ✓ Improved ROM
- ✓ Balance
- ✓ Flexibility
- ✓ Coordination

4 clockwise and 4 anti -clockwise circles

5- minute: Dynamic stretching + warm up routine

7. Trunk rotations

Benefits:
- ✓ Warm-up
- ✓ Improved ROM
- ✓ Flexibility
- ✓ Strength

"Washing Machine"

Repeat 4 left – 4 right…

5- minute: Dynamic stretching + warm up routine

8. Backward arm circles start small and get bigger-9/10 workers here are tight anteriorly and need a exercise that opens the anterior chest/shoulder area.

Benefits:
- ✓ Warm-up
- ✓ Improved ROM
- ✓ Flexibility

"Windmills"

4 small - 4 medium backward circles

5- minute: Dynamic stretching + warm up routine

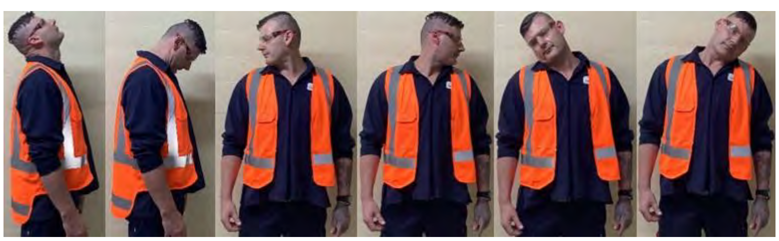
9. Chest expansions (squeeze shoulder blades together) with straight arms progress intohugging yourself.

Benefits:
- ✓ Warm-up
- ✓ Improved ROM
- ✓ Flexibility

"Self love" ***Repeat 4 x 4 sec***

5- minute: Dynamic stretching + warm up routine

10. Neck warm-up flex/ext. followed by lateral rotation and flexion.



Benefits:
- ✓ Warm-up
- ✓ Improved ROM
- ✓ Flexibility
- ✓ Tension release

"Check out the talent" ***Repeat 4 x 4 sec***

5- minute: Dynamic stretching + warm up routine

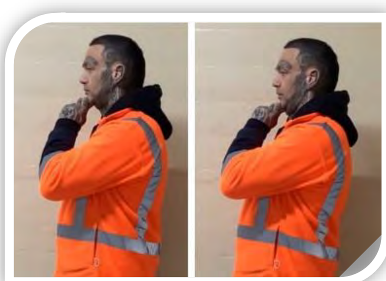
11. Combination nerve sliders/flossing exercises (bilateral)

Benefits:
- ✓ Improved ROM
- ✓ Flexibility
- ✓ Nerve flossing
- ✓ Injury prevention

"Bollywood" ***Repeat 4 x 4 sec movement***

5- minute: Dynamic stretching + warm up routine

12. Chin tucks/retractions(neutral head position)

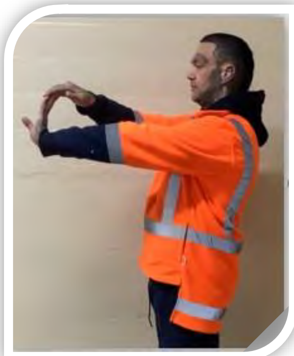


Benefits:
- ✓ Tension release
- ✓ Injury prevention

"Double chins" ***Hold pose for 15 sec***

5- minute: Dynamic stretching + warm up routine

13. Wrist flexor stretch with elbow extension



Benefits:
- ✓ Tension release
- ✓ Injury prevention
- ✓ Nerve slider
- ✓ Flexibility

"Stop the traffic"

Repeat 4 x 4 sec movement (both arms)

5- minute: Dynamic stretching + warm up routine

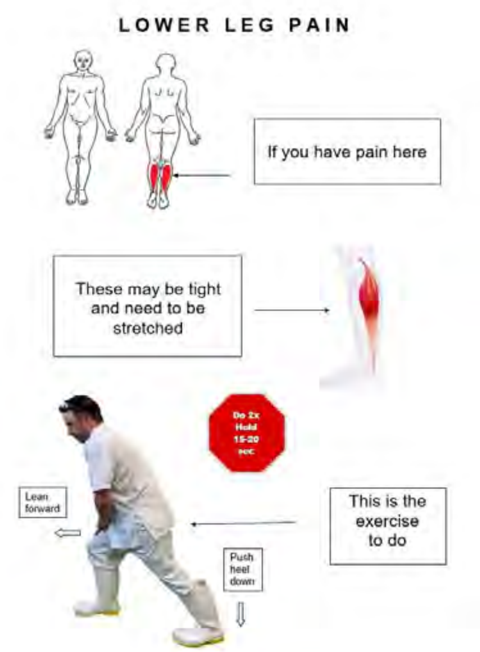
14. Wrist extensor stretch with elbow extension

Benefits:
- ✓ Tension release
- ✓ Injury prevention
- ✓ Nerve slider
- ✓ Flexibility

"Show your bling"

Repeat 4 x 4 sec movement (both arms)

Injury Prevention Stretching



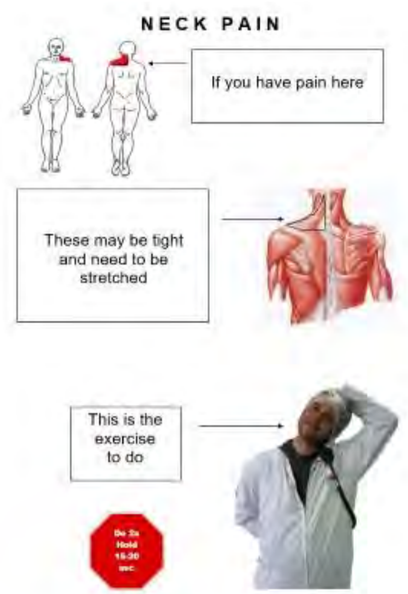
When should we stretch?

After a short warm -up – before starting to work
Stretch at least 15 -20 sec per muscle
During short work breaks
When your muscles hurt or feel tight
After work to relax your muscles
Cool down stretches should be held for 30 -60 sec
Stretching should be done as a preventative measure

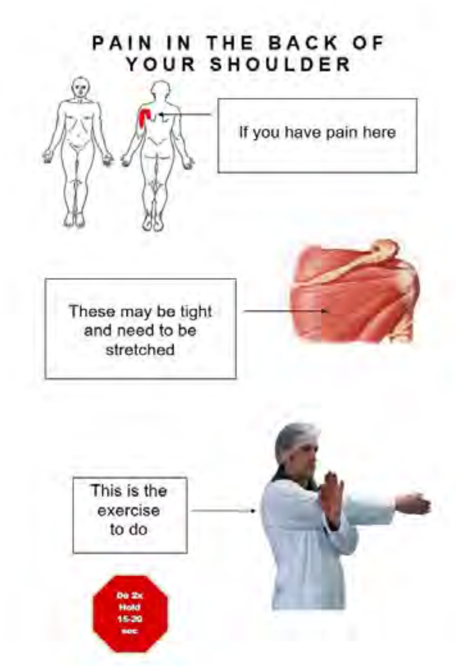
Why do we stretch?

If you do not stretch your muscle will cool in a tight, shortened position and may cause you pain.
This puts you on the back foot the next time you go to work or use that muscle.

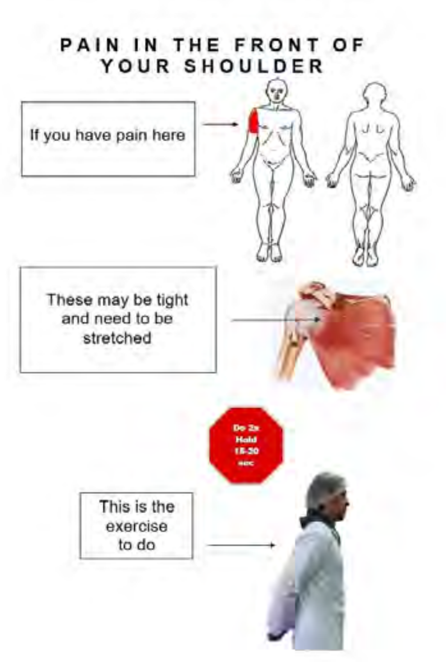
Injury Prevention Stretching



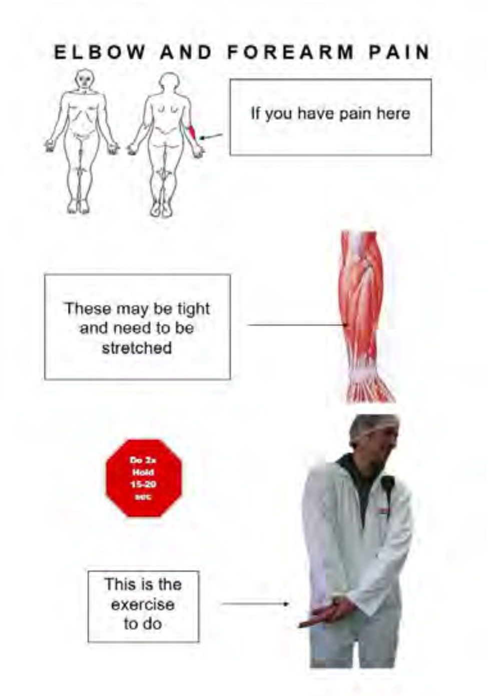
Injury Prevention Stretching

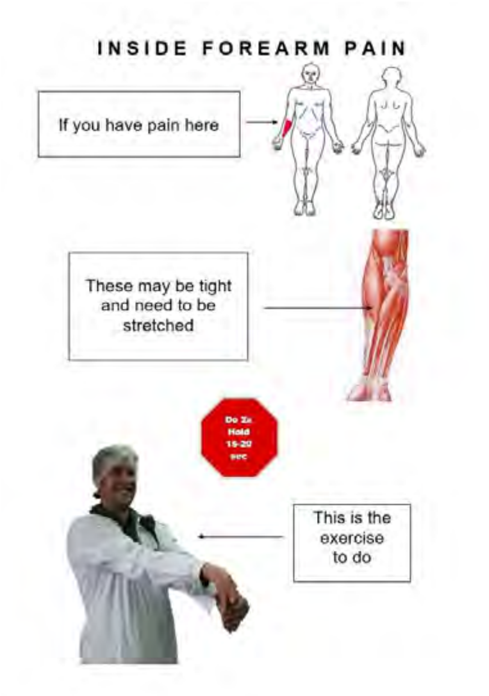


Injury Prevention Stretching

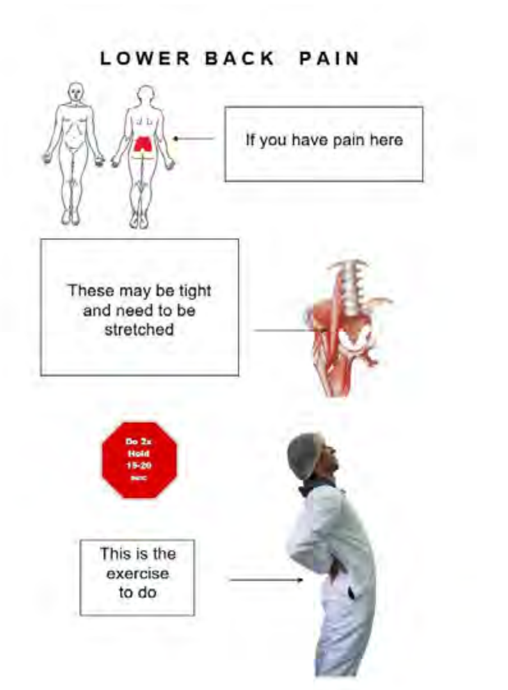


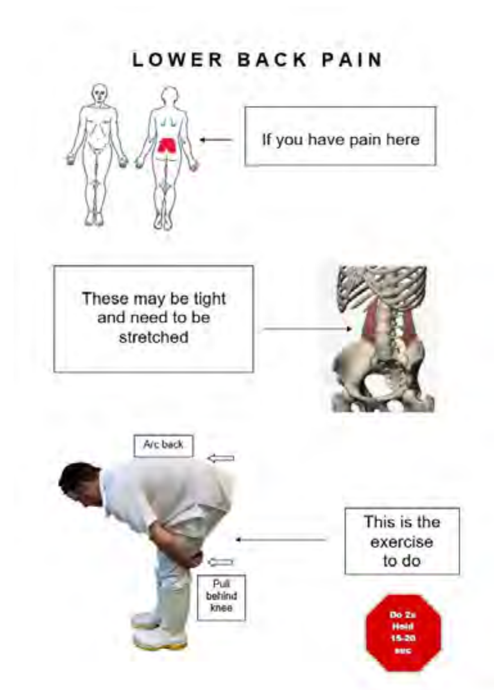
Injury Prevention Stretching



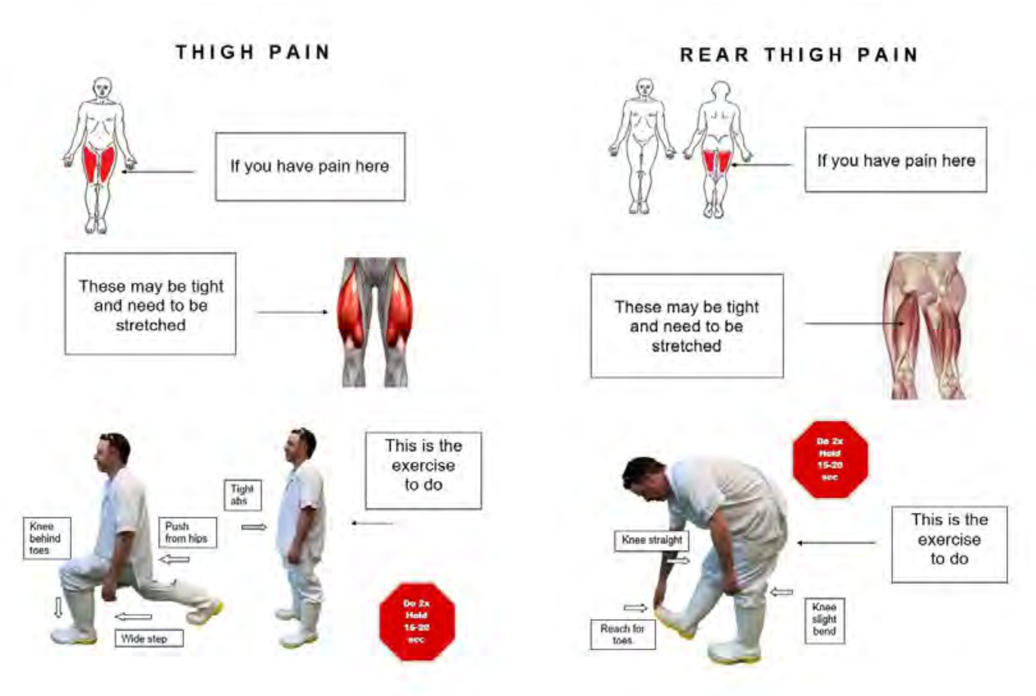


Injury Prevention Stretching



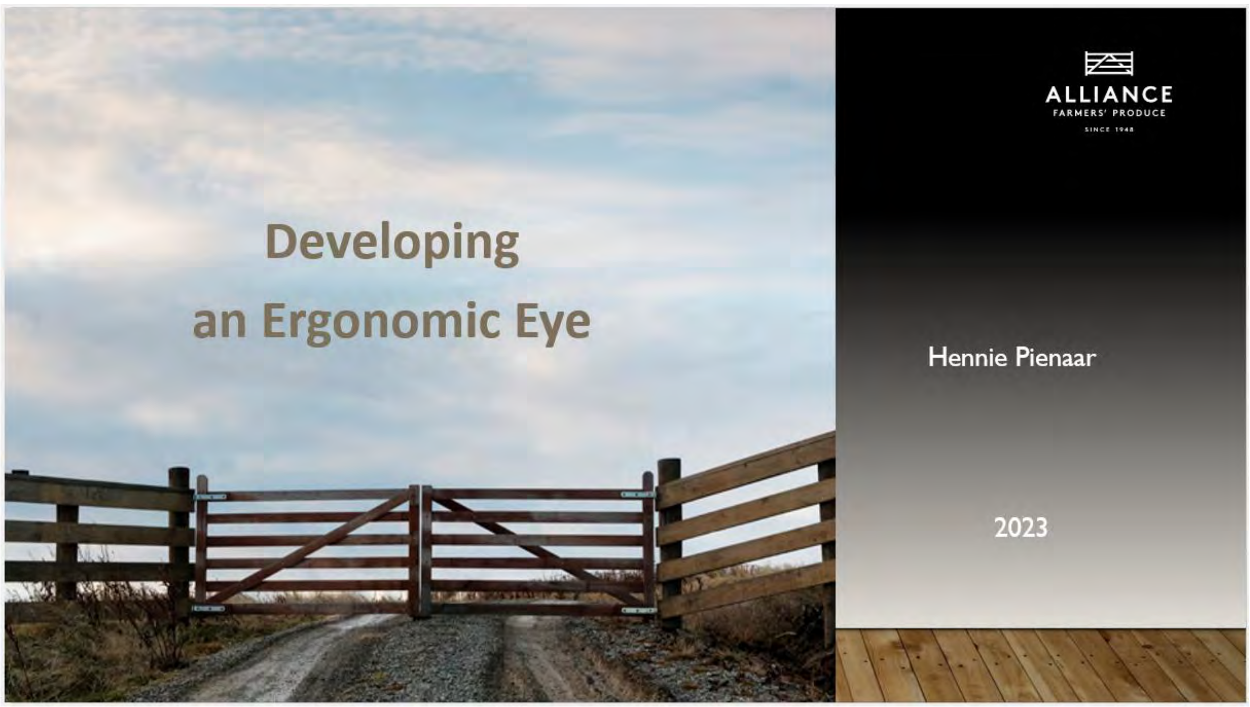


Injury Prevention Stretching



Appendix P – Developing an Ergonomic Eye Workshop

This appendix comprises the materials from a 60-minute workshop. The workshop was put together (by the researcher) as an educational resource for middle management and supervisory staff, aiming to enhance change management skills and raise awareness regarding ergonomic aspects in the workplace. It underscores the importance of considering these factors to mitigate the risk of musculoskeletal injuries in the workplace. The comprehensive workshop delves into diverse ergonomic considerations and presents strategies for their integration, fostering a healthier approach to preventing musculoskeletal injuries.



Overview

- Ergonomics - Benefits to Musculoskeletal Injury (MSI) prevention
- A healthier approach to Musculoskeletal Injury (MSI) prevention
- Ergonomic Risk Factors in the Workplace
- Developing your Ergonomic Eye
- Fundamental Ergonomic principles for Work Performance

ALLIANCE FARMERS' PRODUCE SINCE 1948

Ergonomics - an applied science concerned with designing and arranging things people use and do so that the people and things interact most efficiently and safely.

The Fence or the Ambulance?

ALLIANCE FARMERS' PRODUCE SINCE 1948

Just as relevant 127 years after it was first written:

"To rescue the fallen is good, but 'tis best to prevent other people from falling. Better put a strong fence round the top of the cliff, than an ambulance down in the valley."
Joseph Malins - 1895

"Prevention is better than Cure"

Ergonomics

Benefits of a healthier approach to MSI prevention

1. Reduces costs

By systematically reducing ergonomic risk factors, we can prevent costly MSDs.

2. Improves productivity

By designing a job to allow for good posture, less exertion, fewer motions and better heights and reaches, the workstation becomes more efficient.

3. Improves quality

Poor ergonomics leads to frustrated and fatigued employees with limited ability to deliver best work practice.

A review of 250 case studies on the effects of ergonomics showed that ergonomics can have a profound impact on an organisation - Washington State Department of Labour and Industries

Ergonomics

Benefits of a healthier approach to MSI prevention

4. Improves employee engagement

Employees value company efforts to ensure their health and safety. Lack of fatigue and discomfort during their workday, it can reduce staff turnover, decrease absenteeism, improve morale and increase employee involvement.

5. Creates a better safety culture

Ergonomics shows our company's commitment to health and safety as a core value. Healthy employees are our most valuable asset; creating and fostering the safety & health culture at our company will lead to better human performance in our organisation.

A review of 250 case studies on the effects of ergonomics showed that ergonomics can have a profound impact on an organisation - Washington State Department of Labour and Industries

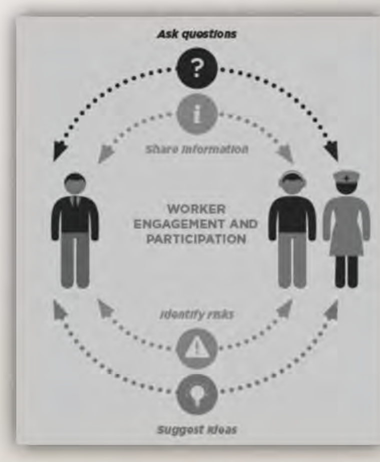
A healthier approach to Musculoskeletal Injury (MSI) Prevention

ALLIANCE
FARMERS' PRODUCE
SINCE 1948

Our goal is to reduce MSI risk factors by proactively engaging employees in the injury prevention principles, which employees can use to improve work methods and body mechanics.

Employees need to be aware of ergonomic issues in the workplace as well.

Employees need to be educated and motivated to use warm up, stretching programs and recovery tools to ensure that fatigue doesn't turn into discomfort, pain, or a musculoskeletal injury.



MSD prevention is a shared responsibility

A healthier approach to Musculoskeletal Injury Prevention

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- Task technique training
- Work posture and ergonomic awareness
- Self-care, Health & Wellbeing
- Manual handling skills training
- Stretching and Fatigue management training

- Root cause analysis
- Risk assessment
- Engineering controls
- Administrative controls
- Proactive design guidelines

The major workplace ergonomic risk factors to consider are:
Forceful Exertions - Repetitive/Sustained Awkward Postures - High Task Repetition

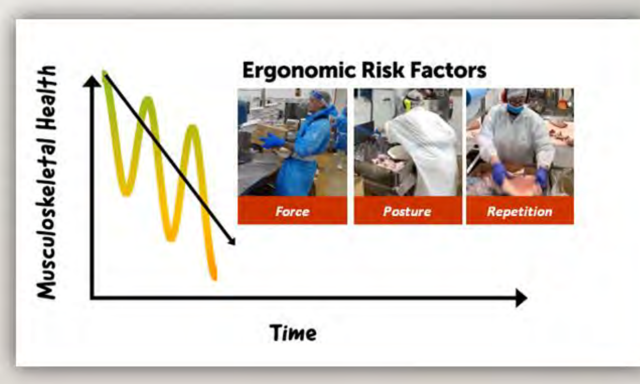
"Recent studies in the field of ergonomics identify both occupational and non-occupational risk factors which lead to MSDs." Mark Middlesworth (Founder of ErgoPlus)

Ergonomic Risk Factors in the Workplace

ALLIANCE
FARMERS' PRODUCE
SINCE 1948

- ✓ **Most important factor for MSD causation:**
  "balance between local soft tissue fatigue and the individual's ability to recover"

- ✓ **Adequate blood supply to the soft tissues performing work, will sustain metabolic balance and prevent excessive fatigue.**



"One important key to maintaining this critical balance is the relationship between work and human factors. Leading people is the art of injury prevention" Mark Middlesworth (Founder of ErgoPlus)

Ergonomic Risk Factors in the Workplace

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FARMERS' PRODUCE
SINCE 1948

Forceful Exertions
Muscle effort increases in response to high force requirements, increasing associated fatigue which can lead to MSI.

Repetitive/Sustained Awkward Postures
Place excessive force on joints and overload the muscles and tendons. Mid-range joint motion are most efficient. Increased MSI-risk when working outside joint range repetitively or for sustained periods without adequate recovery time.

High Task Repetition
Repetitive tasks and cycles are often controlled by hourly or daily production targets and work processes.

Ergonomic Risk Factors Controls

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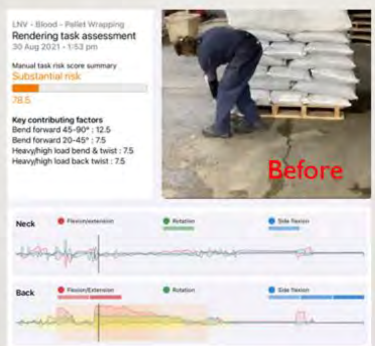
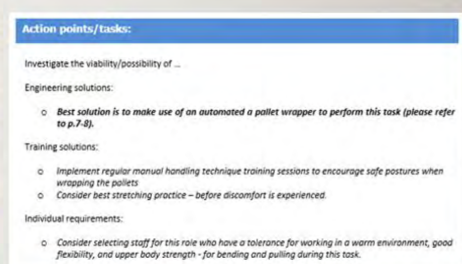
Engineering Controls

- ✓ *Aimed at eliminating excessive force - mechanical assists, counterbalance systems, adjustable height lift tables and workstations, powered equipment and ergonomic tools that will reduce work effort and muscle exertions.*
- ✓ *Eliminate or reduce awkward postures with ergonomic modifications to workstations and work tools that seek to maintain mid joint range of motion for vulnerable joints*
- ✓ *Eliminating excessive force and awkward posture will reduce fatigue and allow high repetition tasks to be performed without a significant increase in MSI risk.*

Engineering solution eliminate risk

MSI PREDICTION SOFTWARE APPLICATION





Action points/tasks:

Investigate the viability/possibility of ...

Engineering solutions:

- ***Best solution is to make use of an automated a pallet wrapper to perform this task (please refer to p.7-8).***

Training solutions:

- *Implement regular manual handling technique training sessions to encourage safe postures when wrapping the pallets*
- *Consider best stretching practice – before discomfort is experienced.*

Individual requirements:

- *Consider selecting staff for this role who have a tolerance for working in a warm environment, good flexibility, and upper body strength - for bending and pulling during this task.*

Ergonomic Risk Factor Controls

ALLIANCE FARMERS' PRODUCE SINCE 1948

Work Practice

- ✓ *Work process improvements such as using carts and dollies to reduce lifting and carrying demands, sliding objects instead of carrying or lifting, and eliminating any reaching obstruction to reduce the lever arm required to lift the object.*

- ✓ *Implement work procedures that limit and reduce awkward postures. Train employees to embrace proper work technique and take ownership of self-care by avoiding awkward postures when possible.*

- ✓ *Reduce MSI risk by providing safe and effective work procedures. Employees to be trained on correct work technique (e.g. lifting) and encouraged to accept individual responsibilities for MSI prevention.*

Correct posture and technique training – SOP's

Bobby calf breakdown task

STEPS:

Stage 1:

1. Mark down backbone to free meat around neck and release paddywhack.
2. Ensure knife runs against backbone tilted towards featherbone (feel knife running on bone).
3. Non knife hand supports carcass at loin area.
4. Knife pushes against ball of index finger.
5. Cut down to neck on both sides.
6. Clear neck up to 1st rib.

Stage 2:

7. Mark ribs (both sides) – with angled knife – start at 13th rib.
8. Start on left side, cut gam cord – hold onto the hind leg & cut against Aitch bone to release pelvis.
9. Free leg from pelvis – mark tender loin.
10. Free loin from backbone.
11. Pull side (keep elbows close to sides) – then remove leg and place on table. Remove side from spine.
12. Repeat on R-side. Free pelvis & spine by pulling down (keep elbows close to sides) rather than twisting wrist.
13. Break away ribs from spine by pushing down knife between cartilage joints.
14. Cut side from leg -cut gam cord and place on table.

Important points:

15. Maintain a good "hold" of the carcass side so to ensure it won't be dropped.
16. Maintain good posture, bend knees – back straight (as much as possible) and do not twist – move your feet rather than twisting to avoid pressure on your back.
17. Use gravity and your body weight as mush as possible during the downward pull and keep your elbows close to your body.
18. Ensure good grip and strong wrist position (see image).
19. Minimise bone chips. Ensure cartilage, bone and bone chips are removed.
20. Utilize stoppages and stretch the working muscles and/or drop arms to side "shake" wrist/arm to relax.
21. Rotate task every 15 min.

HYGIENE REQUIREMENTS:

22. **Do NOT** at any time put hands down anal/aitch bone area -this causes contamination to the other areas of the carcass.
23. Work in a tidy manner.

Key Points

Mark down backbone (both sides).

Hold onto the hind leg & cut against aitch bone to release pelvis.

Mark ribs.

Break away ribs from spine by pushing down knife between cartilage joints.

Note that the wrist is angled downwards 10-15°.

Knife against backbone tilted towards featherbone.

Good grip with strong wrist position.

Ergonomic Risk Factor Controls

Work Practice

✓ **Job Rotation**

Job task enlargement is a way to reduce duration, frequency and severity of MSI risk factors. Employees are to rotate between workstations and tasks to avoid prolonged periods (>15 min) of performing a single task, thereby reducing fatigue that can lead to MSI.

✓ **Counteractive Stretch Breaks**

Implement rest or stretch breaks to provide an opportunity to counteract repeated or sustained awkward postures and allow for adequate recovery time – especially when increasing job load.

A job is considered highly repetitive if the cycle time is 30 seconds or less.

Lorneville SLB Chain 1 - Shoulder pull
Codding Rotation task assessment
13 Oct 2021 - 12:22 pm
pre

Manual task risk score summary
Substantial risk
175.0

Key contributing factors
Back twist >60° : 75.0
Forward reaching : 15.0
Load is animate or unpredictable : 15.0
Very heavy load handled without mechanical assistance : 12.5

MSI PREDICTION SOFTWARE APPLICATION

Action points/tasks:

Investigate the viability/possibility of ...

Engineering solutions:

- *Raise chain (or deepen pit) to allow for downward (gravity pull) pull of fleece or*
- *Relocate/move guarding approx. 200-300mm outwards and enlarge pit (refer to picture on p.7)*

Training solutions:

- ***Implement regular manual handling technique training sessions to encourage safe postures when performing the task.***
- *Develop a training video of best practice for performing this task*
- *Develop pictorial SOP that highlights best technique to perform this task*
- *Consider best stretching practice – before discomfort is experienced.*

Individual requirements:

- *Consider selecting staff for this role who have a tolerance for working in a warm environment, with good coordination, good flexibility, and upper body strength – for bending, and pulling during this task.*
- *Task is better suited to persons with a medium stature.*

Improved technique training reducing risk

MSI PREDICTION SOFTWARE APPLICATION

Improve rotation sequence – reducing risk

Lorneville SLB Chain 1 - Cod Removal
Codding Rotation task assessment
13 Oct 2021 - 12:00 pm
pre

Manual task risk score summary
High risk
292.5

Key contributing factors
Back twist >60° : 50.0
Bend forward 20-45° : 45.0
Bend and twist : 40.0
Back twist 40-60° : 30.0

2 x

Lorneville SLB Chain 1 - Rip down
Codding Rotation task assessment
13 Oct 2021 - 12:09 pm
pre

Manual task risk score summary
Substantial risk
79.5

Key contributing factors
Forward reaching : 15.0
Back twist 20-40° : 10.0
Required to hold clear of body : 9.0
Heavy/high load back twist : 7.5

1 x

Lorneville SLB Chain 1 - Shoulder pull
Codding Rotation task assessment
13 Oct 2021 - 12:22 pm
pre

Manual task risk score summary
Substantial risk
175.0

Key contributing factors
Back twist >60° : 75.0
Forward reaching : 15.0
Load is animate or unpredictable : 15.0
Very heavy load handled without mechanical assistance : 12.5

MUSCULOSKELETAL INJURY (ACC) COSTS FY21

ALLIANCE
FARMERS' PRODUCE
SINCE 1948

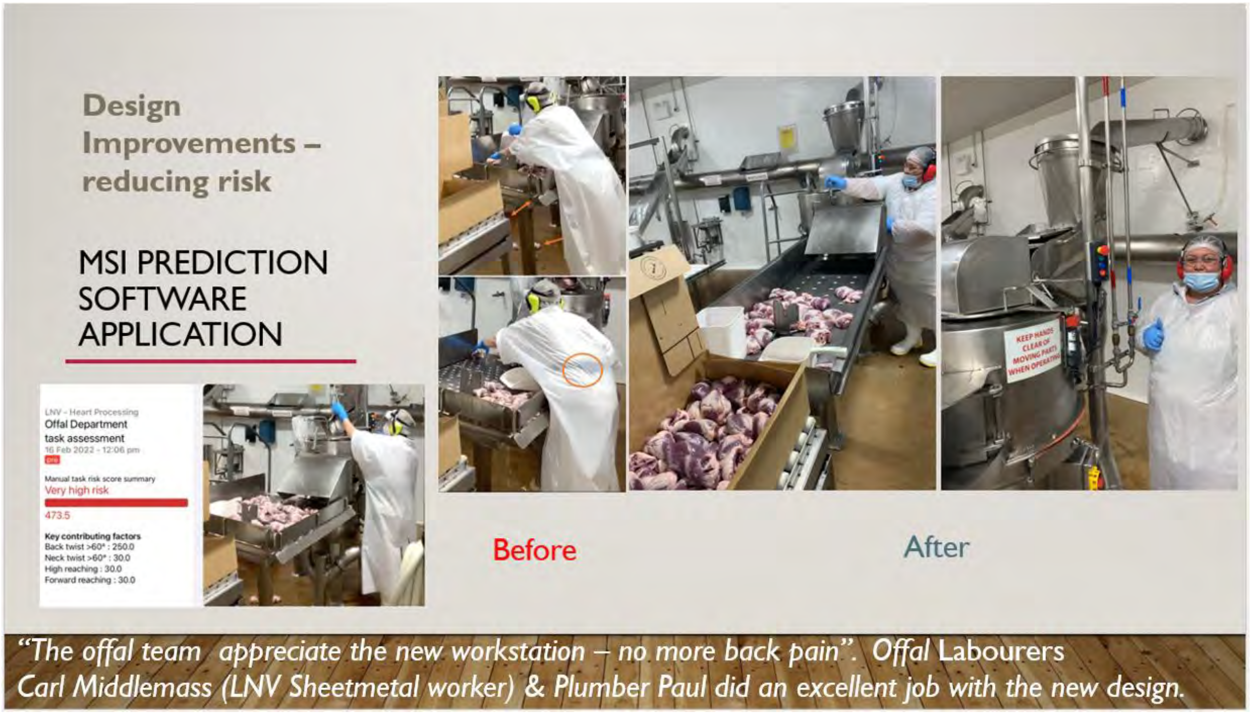
Musculoskeletal injury costs for financial year ending 2021	
Surgery Costs only	$ 69 007
Other treatments	$ 593 037
Weekly compensation	$ 531 861
Total direct costs	$ 1 193 905

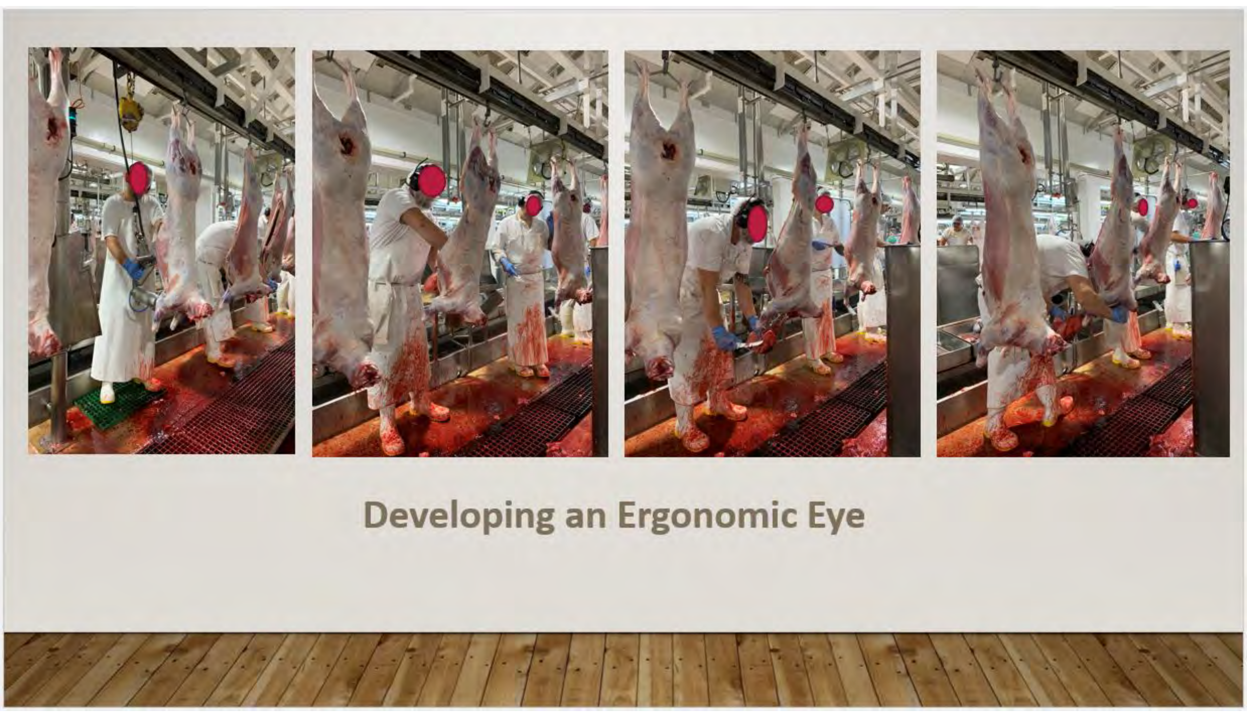
Indirect costs of MSD are not covered by ACC and include items such as wages paid during lost production time, training and compensating a replacement worker, administration time to file reports, absenteeism, overhead costs and often legal fees.

Indirect costs could be as much as 1-5 times the actual cost of the injury - Rick Barker, CPE


DANGER
Developing an Ergonomic Eye


Developing
an Ergonomic Eye


Design Improvements – reducing risk
MSI PREDICTION SOFTWARE APPLICATION
LNV - Heart Processing
Offal Department task assessment
16 Feb 2022 - 12:06 pm
Manual task risk score summary
Very high risk
473.5
Key contributing factors
Back twist >60° : 250.0
Neck twist >60° : 30.0
High reaching : 30.0
Forward reaching : 30.0
KEEP HANDS CLEAR OF MOVING PARTS WHEN OPERATING
Before
After
"The offal team appreciate the new workstation – no more back pain". Offal Labourers
Carl Middlemass (LNV Sheetmetal worker) & Plumber Paul did an excellent job with the new design.


Developing an Ergonomic Eye

Developing an Ergonomic Eye

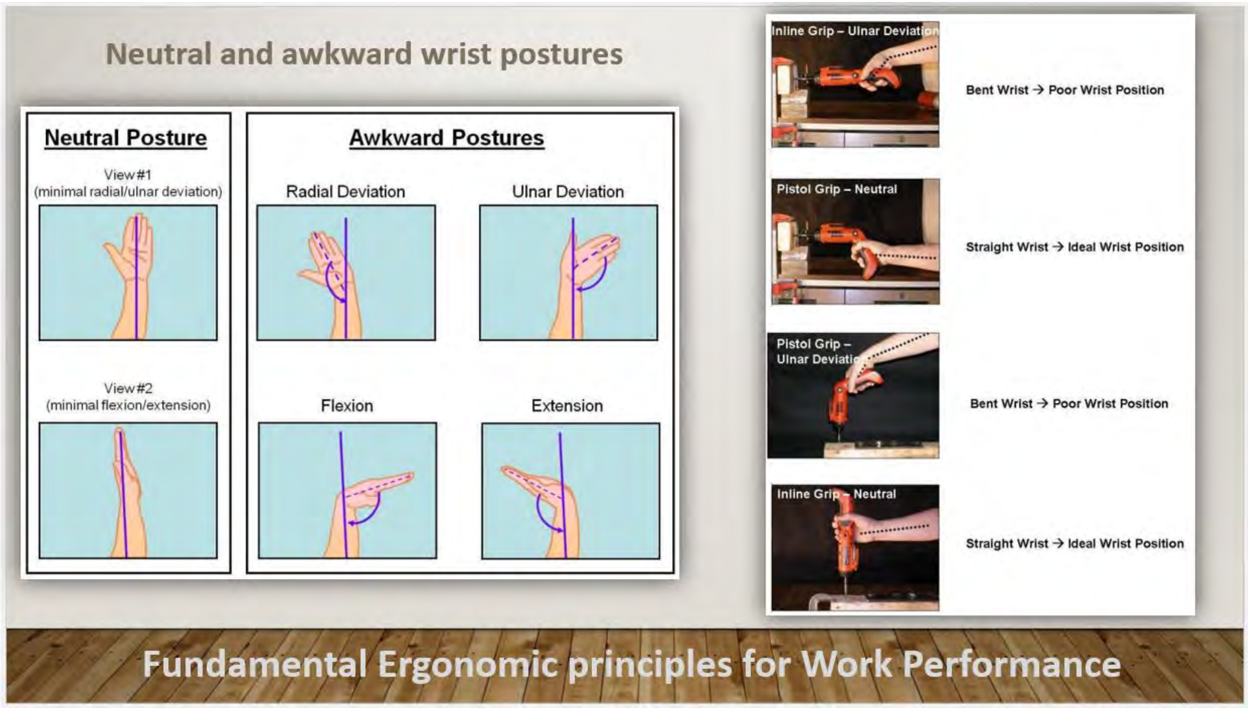
Maintain Neutral Posture

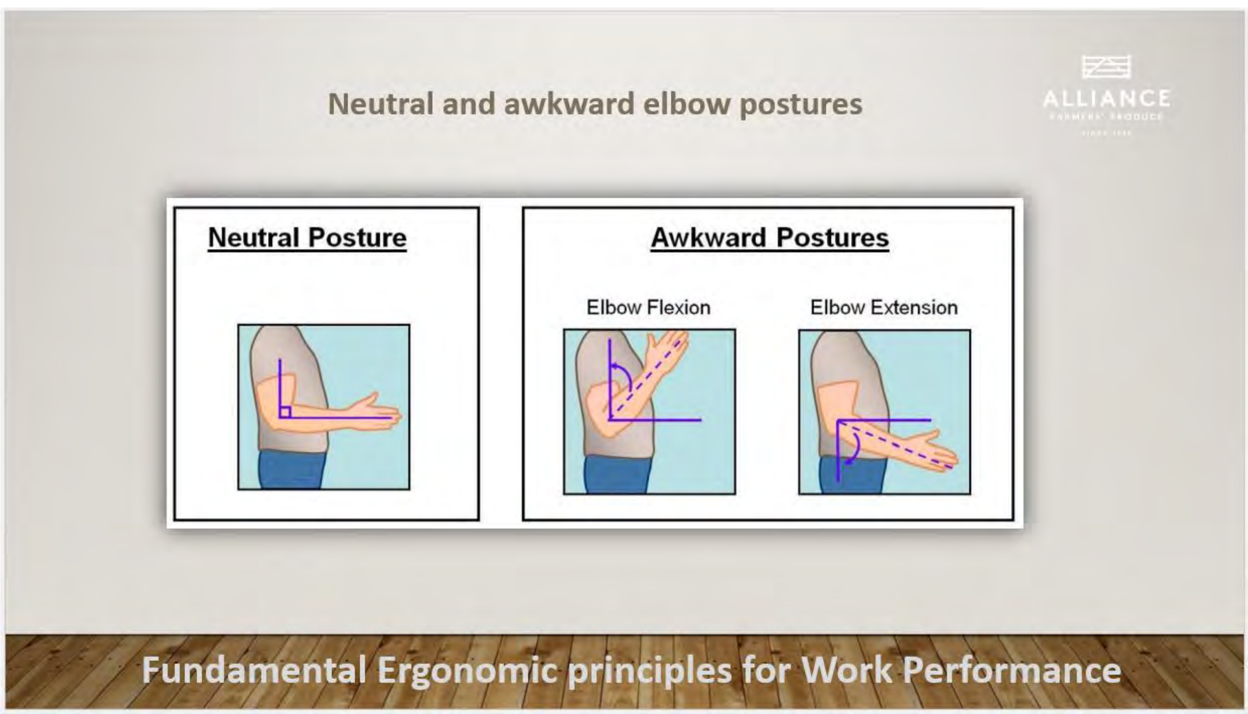
- Body is aligned and balanced
- Minimal stress on the body and joints
- Minimal stress applied to muscles, tendons, nerves and bones
- Allows for maximum control and force production.

Principles

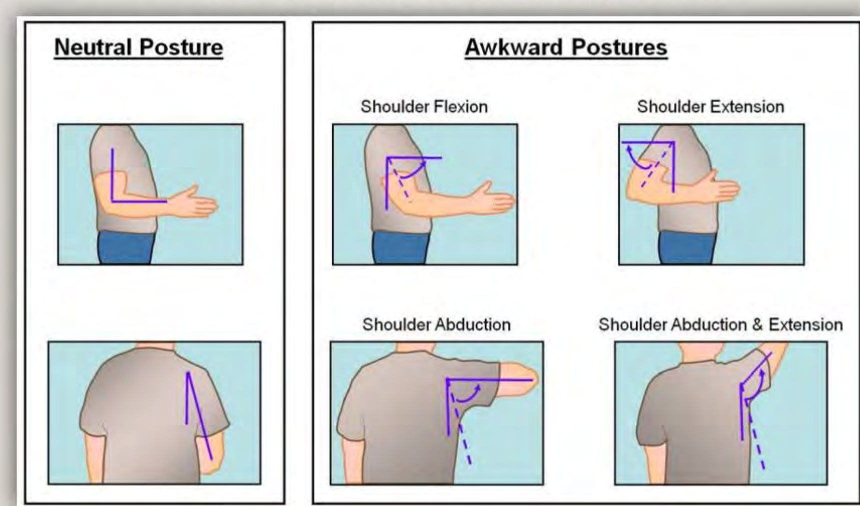
- **Use neutral postures:**
  - **Maximum muscle force producible in neutral postures is greater than maximum muscle force producible in awkward postures.**
  - **Fatigue occurs sooner when working in awkward postures.**
  - **Working in extreme awkward postures (near extreme ranges of motion) causes stress on muscles and joints.**

Fundamental Ergonomic principles for Work Performance


Neutral and awkward wrist postures
Neutral Posture
View #1
(minimal radial/ulnar deviation)
View #2
(minimal flexion/extension)
Awkward Postures
Radial Deviation
Ulnar Deviation
Flexion
Extension
Inline Grip – Ulnar Deviation
Bent Wrist → Poor Wrist Position
Pistol Grip – Neutral
Straight Wrist → Ideal Wrist Position
Bent Wrist → Poor Wrist Position
Inline Grip – Neutral
Straight Wrist → Ideal Wrist Position
Fundamental Ergonomic principles for Work Performance


Neutral and awkward elbow postures
ALLIANCE
Neutral Posture
Awkward Postures
Elbow Flexion
Elbow Extension
Fundamental Ergonomic principles for Work Performance

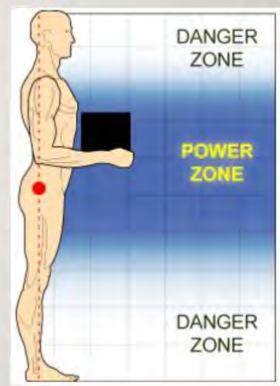
Neutral and awkward shoulder postures



Fundamental Ergonomic principles for Work Performance

Work in the Power (comfort) Zone

- The power zone for lifting is close to the body, between mi-thigh and mid-chest height. This zone is where the arms and back can lift the most with the least amount of effort.
- Can also be called the “handshake zone” or “comfort zone.” - minimizing excessive reach and maintaining a neutral posture.
- Working in this range ensures that you are working from proper heights and reaches, which reduces MSD risk factors and allows for more efficient and pain-free work.



Principles

- Reduce the weight of the object being lifted.
- Keep loads close to the body when lifting.

Fundamental Ergonomic principles for Work Performance

Take Home Messages

Allow for movement and stretching

Working for long periods of time in a static position will cause your body to fatigue.

Allow time to stretch.

Reduce Excessive Motions

Limiting excessive task repetition will reduce worker fatigue and the risk of MSD

Consider job enlargement, job rotation and counteractive stretch breaks.

Reduce Excessive Force

Eliminating excessive force requirements will reduce worker fatigue and the risk of MSD

Make use of mechanical assists, counter balance systems, adjustable height lift tables and workstations, powered equipment etc.

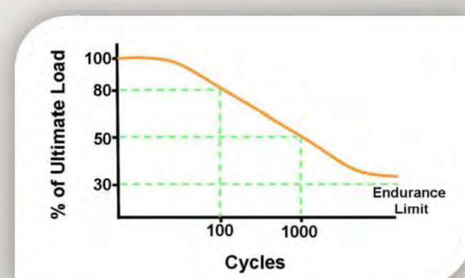
Fundamental Ergonomic principles for Work Performance

Take Home Messages

Fatigue load limits

Number of cycles that lead to failure of joints that cause MSDs varies between employees.

Efforts should be made to substantially decrease loading of all joints.



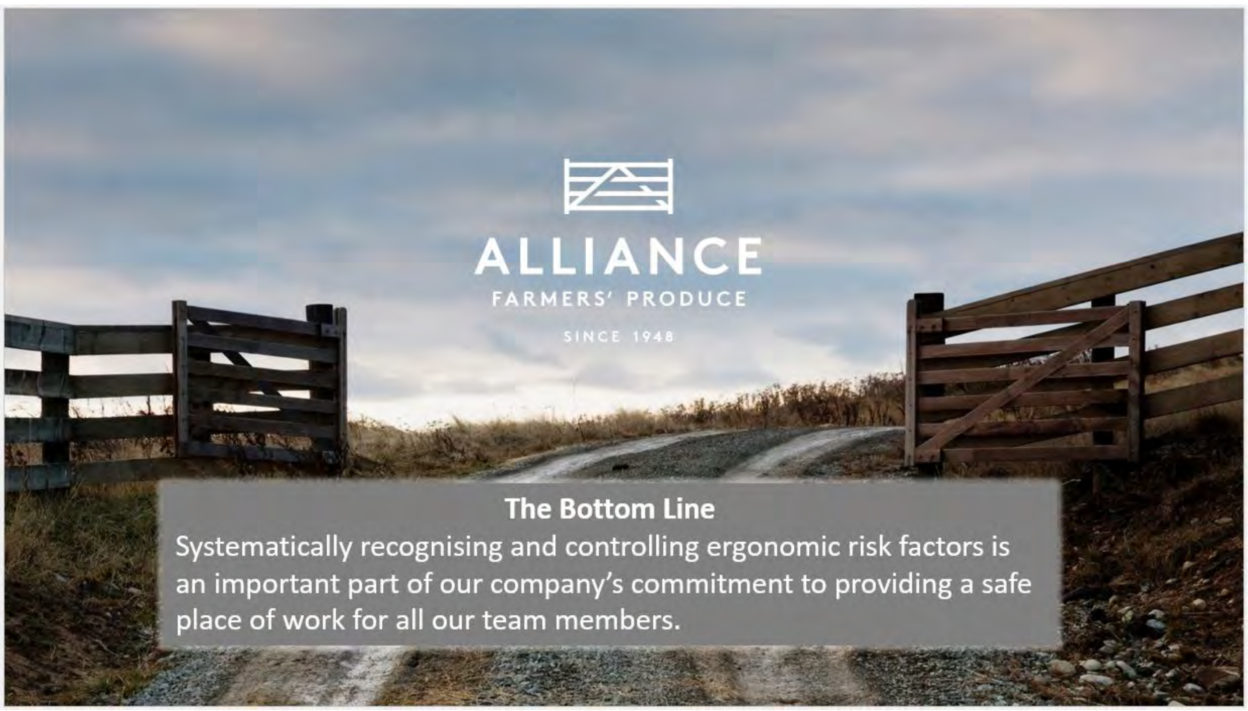
Fundamental Ergonomic principles for Work Performance

OTHER ELEMENTS OF NOTE THAT WILL CONTRIBUTE TO A DECREASE IN MSI

- Task specific training that includes a correct work posture focus.
- Maintaining sharper knives.
- Ensuring new staff is work ready.
- Employee wellbeing focus - holistic approach...
  Physical, mental, emotional, social and family support.
- Task rotations monitored and managed to give body time to recover (especially for new employees).
- Absenteeism managed to not overload workers who turn up.

Using a blunt knife is equivalent to 2 weeks of cutting force in a single shift

Sharper knives:
- ✓ less fatigue
- ✓ easier workday – more energy
- ✓ reducing injury risk
- ✓ relaxed grip, more comfortable and less force required



Appendix Q – Musculoskeletal Injury Prevention Program gains – positive feedback

Wednesday, 16 June 2021

Stretching, balance helps improve health, wellbeing

By Shawn McAvinue

Rural life > Other News

Hennie Pienaar

Physical therapist Hennie Pienaar opens his injury prevention workshops by asking meat industry staff if they want to live longer or die earlier.

Mr Pienaar began working for Alliance Group as its musculoskeletal injury prevention manager based in Invercargill about 15 months ago.

Alliance wanted to improve the "complete wellness" of its staff, improving their physical, mental and nutritional health, so they enjoyed their work, went home happy and maintained a healthy lifestyle, he said.

The meat processing industry had a "big struggle" to find staff so it was working to retain them.

The goal was to get 80% of Alliance staff to take the workshops by the end of September.

All the staff at the Pukeuri plant had completed the workshop, as had about 700 staff at the Lorneville plant and about 140 staff at the Mataura plant.

In workshops, he showed staff how to bend and move with good balance, making it possible for them to touch their toes.

"That's how they start believing."

He highlighted the importance of moving their feet when working, no matter what their role, to reduce injuries and feel more alert.

"Blood pooling occurs if you're not moving your feet."

In the workshop, the techniques he taught included how to increase grip strength so staff working with knives had the ability to use less energy to do the same task, leaving them feeling better at the end of the day.

Many staff "lived through pain" and the injury got worse over time.

Alliance staff were being asked to report injuries as soon as they were felt so they could be treated before they got worse.

The hope was for a trend to emerge of more injuries being reported but a fall in the seriousness of injuries.

In the workshop, he stressed the importance of stretching.

"A longer muscle is a stronger muscle."

- An article published in *Rural Life* highlights the progress in delivering the musculoskeletal injury prevention program.


Alliance Group Limited

We were thrilled to win the Primary & Primary Services Sector Award at the Southland Business Chamber Business Excellence Awards held in Invercargill on Friday night.

As Southland's largest employer, we have deep roots in the province. Also a finalist in the Workplace Well-being category, we are proud of the contribution our 2,500 people across our Invercargill office and our plants at Lorneville and Mataura make to Southland every day. These awards are wonderful recognition of the work they do every day to support our farmer shareholders and staff.

Congratulations to our Lorneville Plant Manager Shashank Pande and Musculoskeletal Injury Prevention Manager Hennie Pienaar for their huge contribution to these awards and for representing Alliance Group Limited with pride on Friday night.

#wearealliance #proud #forfarmers

o The LinkedIn post refers to a business excellence award received for significant contributions made in the Primary industry sector in the workplace wellbeing category.

o An e-mail from the Pukeuri Plant Manager recognising the value and benefits of the musculoskeletal injury prevention program. The extensive workshop addresses various aspects, including prompt injury reporting, emphasis on ergonomic risk factors, fatigue management, hydration, manual handling skills, correct work posture, dynamic warm-up, and stretches for injury prevention.

From: Phil Shuker <Phil.Shuker@alliance.co.nz>
Sent: Wednesday, 2 February 2022 8:10 am
To: Hennie Pienaar <Hennie.Pienaar@alliance.co.nz>
Subject: Well done

Congratulations re the award .
Your joining the company was a watershed moment. Only those who appreciate what you have to offer will capture all the potential benefits you can offer to each site.
Please call me when you have a min to spare
Regards
Phil

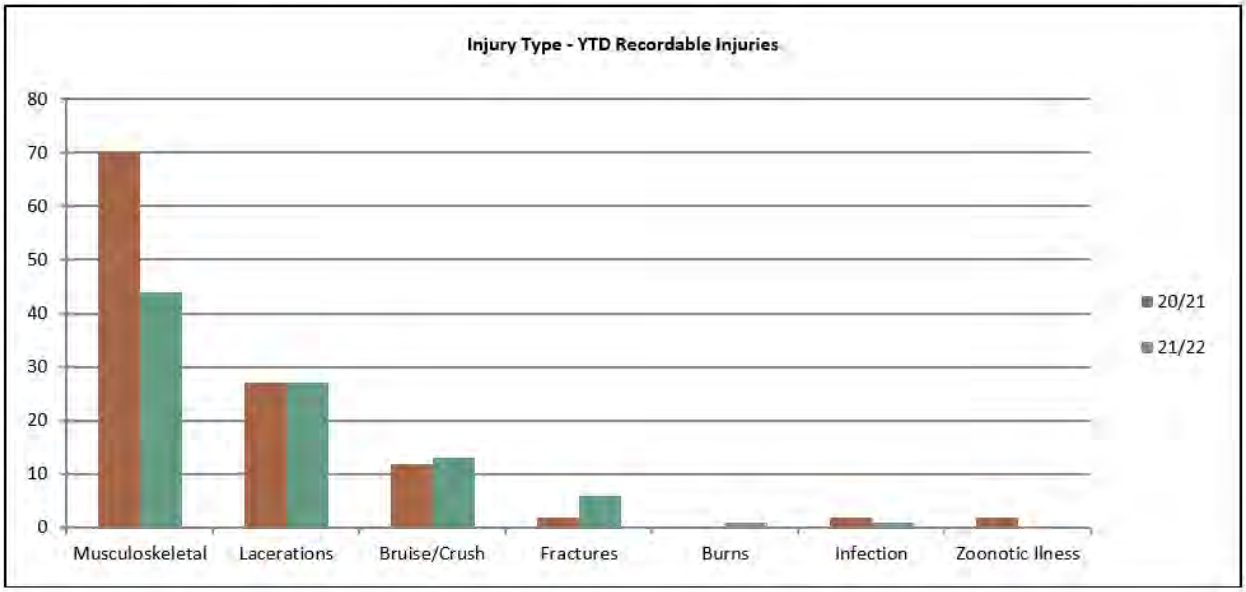
- An e-mail from David Moore, AGL Health and Safety Systems Coordinator, having noticed the significant drop in Musculoskeletal recordable injuries across AGL.

Well Done

DM David Moore
To Hennie Pienaar

You replied to this message on 28/07/2022 11:51 am.

Solid effort Hennie. I have no doubt you were a BIG part of this



David Moore
Health and Safety Systems Coordinator

ALLIANCE
FARMERS' PRODUCE
SINCE 1948

M: +64 20 4076 1758
Level 3, 123 Victoria Street
Christchurch Central 8013
https://www.alliance.co.nz/

- E-mails (p.486-487) Arnaud Daurat (Global CEO – EXOVANTAGE), with positive global feedback acknowledging the researchers' contributions to developing meat industry-specific exoskeletons.

Your pilot

AD Arnaud Daurat <arnaud@exxovantage.com>
To Hennie Pienaar

Retention Policy GDPR (5 years) Expires 18/02/2028

Hi Hennie,

I hope all is well with you and the family.

I just wanted to reconnect regarding your initiative.

We had some great feedback from meat processing plants so just wanted to know where are you at on your side?

I look forward to hearing back from you.

Kind regards,

Arnaud Daurat
Global Chief Executive Officer

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Your involvement in the development of a back exoskeleton for the Meat Industry.

AD Arnaud Daurat <arnaud@exxovantage.com>
To Hennie Pienaar

You forwarded this message on 4/06/2024 7:57 am.

Thank you for the phone conversation.

Great to hear that you are thrilled on developing this latest back exosuit with us!

As discussed, we have just manufactured a back exosuit for the Red Meat Industry to augment and protect staff while boning, carving, lifting and bending in cold stores and at bench height.

We value your expertise and would like your involvement in the development of the exosuit. And hopefully something of value for you as an Economist and for Alliance in developing exoskeletons for its industry. This is the first of 5 exoskeletons.

We are working towards making the exosuit the world's most cost effective, hygienic, breathable and lightest one (approx. 500g).

It is $790 +gst for one. They usually come in a box of 3 at $2,300 + gst.

Your feedback on developing the technology will be greatly appreciated.

Best regards,

Arnaud Daurat
Global Chief Executive Officer

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P: (+64) 9 475 5799
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W:exxovantage.com
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