

**INVESTIGATING MUSCULOSKELETAL
HEALTH IN THE WORKPLACE AMONG
EMPLOYEES WHO ARE EXPOSED TO HEAVY
LIFTING: A DESCRIPTIVE STUDY AND
CORRELATIONAL STUDY**

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Back pain

Distribution centre

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ABSTRACT

Background: Protecting and promoting health in the workplace is imperative, both for individual employee health and workplace productivity. High rates of workplace injuries, particularly in environments where high levels of physical activity are required, point to the need for effective occupational interventions, minimization of workplace inhibitors that increase the risk of developing musculoskeletal disorders (MSDs), and occupational management checks to reduce the onset of MSDs in the workplace. However, for these measures to be successful, it would be important to identify individual and workplace-related factors associated with the development and duration of MSDs.

Aim: To determine potential risk and protective factors associated with MSDs among employees in a workplace where heavy lifting is a key job function.

Methodology: A quantitative study was conducted, using retrospective workplace HR and clinic data pertaining to 111 employees in a heavy lifting workplace within a South African distribution centre. Descriptive and correlational analyses were conducted, to describe the extent and nature of MSD symptoms/injuries among these employees and investigate factors associated with MSDs. Data, relating to a two-year period (2015-2016), was collected from the distribution centre's onsite clinic patient files and employee records. The data was inputted into IBM SPSS software for analysis. Bi-variate and multivariate analyses were carried out, to determine which factors were associated with MSDs symptoms/injuries. Predictor variables tested were individual employee demographic characteristics, contract-related factors and productivity related data.

Results: The majority of the sample population that worked in the distribution centre at the time of data collection was relatively young (mean age of 31 years). Participants were mostly male (81.1%) and African (91%). More than half were on flexi-timer contracts (66.7%). A high percentage worked in the heavy lifting department (58.6%) and had a productivity score over 100% (45.9%), as measured by productivity objectives determined by the company. Over fifty-six percent of participants had visited the clinic for MSDs over the 2015-2016 two-year period and 82.5% of participants reported injuries/symptoms in the back and upper body (above the waist). In multivariate analysis, lower productivity (below 100%) was significantly associated with a higher number of visits to the clinic ($p=0.025$).

Conclusion: A high prevalence rate of MSDs found within the sample results suggest that employees experiencing MSDs were more likely to record lower productivity levels. These

findings should be considered when designing intervention programs within a heavy lifting workplace. Some recommendations emanating from the research included: The need for on-going monitoring of company level MSD-related data; improving employee knowledge of the occupational health risks and protective factors for MSD development and progression; and the need to further develop and evaluate interventions designed to reduce MSD injury/symptoms within workplace environments where employees are regularly exposed to heavy lifting.



DECLARATION

I declare that **Investigating musculoskeletal health in the workplace, among employees who are exposed to heavy lifting: a descriptive study**, has not been submitted for any degree or examination in any other university and that all the sources I have used or quoted have been indicated and acknowledged by complete references.

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Date: 23 October 2018

Signed:

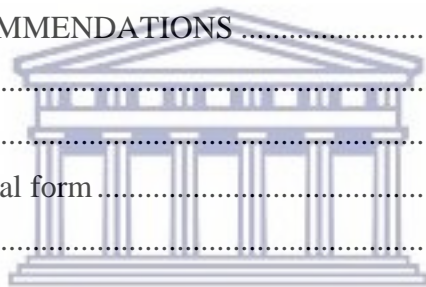


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ABBREVIATIONS

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MSDs- Musculoskeletal disorders

LBP – Lower back pain

DC – Distribution centre

DEFINITIONS

Musculoskeletal disorders: - injuries and disorders that affect the human body's movement or musculoskeletal system. In the case of an employee who reported to the clinic with an injury or symptom related to MSDs, these are classified in the research as either acute or chronic.

Heavy lifting environment: - Is a workplace in which employees are required to either lift, move or carry heavy equipment throughout the day in order to perform their job function.

Productivity rate: - This is the rate at which the employees pick the required material within a working day. This rate is determined by a monitoring system, and the minimum rate is set by the company in which the employee works.



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1. INTRODUCTION

1.1 Background

Protecting and promoting health in the workplace is imperative, both for individual employee health and workplace productivity. Employee health status and healthcare is a public health priority. In South Africa, 15 683 million people are economically active (Stats SA, 2016) and the health of individuals in the workplace is paramount in influencing public health outcomes. Ensuring that individual employees are safe and healthy throughout their employment tenure will have positive consequences both for overall population health and in terms of the burden on public health systems.

Good employee health is also important for the organisations that employ them and the wider economy. Healthy employees mean lower absenteeism rates, which in turn can positively affect production outcomes. High rates of absenteeism or injury can result in reduced production and ultimately affect revenue income, impacting on the company's capacity to survive, grow and be profitable in the longer term (Harter, 2001). Besides absenteeism, poor employee health can also impact the pace and quality of work. This can occur through lower overall employee production time due to clinic appointments, resting more frequently during working hours, changing job descriptions due to injury and producing a lower quality of product or service, as less attention and time is devoted to the job (The Standard, 2012). This can negatively affect productivity and possibly workplace relations and morale.

Employers have a significant role to play in ensuring workplace health, particularly those that expose their employees to specific or heightened health risks, as a result of the nature of the tasks carried out. For this to be achieved, employers need to have knowledge of what these risks are and the extent to which these heightened health risks impact production. Only then, can effective employee management and health promotion programs and initiatives, be tailored to ensure the wellbeing of employees and ultimately the productivity of the company (CIPID, 2007).

Musculoskeletal disorder (MSD) injuries and symptoms, resulting from occupational environments and tasks, represent a substantial and increasing phenomenon in the workplace, which raises a public health concern (Gunderson and Hyatt 2000). Population data related to musculoskeletal disorders (MSDs) is limited within South Africa. However, in the US it is estimated that, each year, 5% of American adult's experience episodes of musculoskeletal problems as a result of their occupational environment, and that MSDs affect close to 80% of

adults at some point in their lives (Gunderson and Hyatt, 2000). In the US musculoskeletal problems represent the second most common reason for work absenteeism, the third leading cause of total work disability and the leading cause of activity limitation amongst adults during their lifetime (Gunderson and Hyatt, 2000).

These MSDs, which commonly affect individuals during their working years, lead to large amounts of discomfort and pain for the individual, and an increased need for health care and expenditure. They also have a significant impact on business and productivity, due to the time lost in production days, as a result of high absenteeism or injury and the potential effects on overall work quality and capacity (Gunderson and Hyatt, 2000). The World Health Organisation (WHO) has classified work related injuries as multi-factorial, indicating that there could be a number of factors related to MSDs in the workplace, including physical, socio-cultural, individual and work organizational factors (Putz – Anderson et al., 1997). Workplace injuries, particularly in environments where high levels of physical activity are required, point to the need for effective occupational interventions, minimization of workplace inhibitors that could be increasing the risk of developing MSDs as well as the introduction of occupational management checks in order to reduce the onset of MSDs in the workplace.

It is clear that protecting musculoskeletal health and working to prevent musculoskeletal conditions before they occur or worsen, is imperative for the wellbeing of the country's working population, to lessen the burden on the public healthcare system, and to minimize their negative effects on employers and the broader economy. Appropriate and effective workplace knowledge of the factors associated with the prevalence of these conditions could direct employee health management strategies and interventions in the workplace.

1.2. Problem statement

MSDs in the workplace are increasing in South Africa and beyond. Data from high income countries such as the US show that the presence of MSDs is becoming the most expensive medical problem in industry (Gunderson and Hyatt, 2000). In particular, occupations such as nursing, truck driving and material handling jobs have been linked to the risk of developing these disorders (Gunderson and Hyatt, 2000). More specifically, in the developing world the burden of MSDs in terms of DALYS (Disability adjusted life years) is 2.5 times greater than that in the developed world (Gcelu and Kalla, 2015). South African studies on occupational health causes and factors related to the effects of heavy lifting on MSDs indicate that these health conditions are heavily impacting the working population (Gcelu and Kalla, 2015).

For example, a study that sought to identify the occupational risk factors of 336 steel workers, who developed lower back pain in the semi-automated South African steel industry, found that there were multiple factors such as twisting and bending, load carriage, prolonged sitting and kneeling and squatting, which were associated with the development of lower back pain. The study emphasised the need for multiple interventions within this occupational setting (Van Vuuren, Becker and Van Heerden, 2005)

The lack of national and global health policy and priorities in relation to MSDs, unfortunately contribute to this phenomenon. In South Africa there are challenges such as underfunding and the neglect of MSDs in public health, as most health research funding is spent on reducing communicable and non-communicable diseases (Gcelu and Kalla, 2015). In South Africa the Occupational Health and Safety Act (OHS) mandates employers to provide a safe working environment, and the Compensation for Occupational Injuries and Disease (COIDA) act indicates that all MSD injuries should be eligible for compensation if suffered in the workplace, with a specific instruction focusing on work related upper-limb injuries. However, there is no national legislation or framework that provides more specific guidelines for companies on how employees should be conducting heavy lifting at work, what weights they should be lifting and how frequently they should be lifting these weights. These process-related decisions are left up to the employer (Gcelu and Kalla, 2015).

Over and above funding constraints and policy limitations, insufficient attention has been afforded to research on this topic in South Africa. This includes research on protective and risk factors in the workplace that could be related to MSDs and would inform effective employee management strategies and interventions (Gcelu and Kalla, 2015).

This study aims to contribute to this gap by examining one distribution company where employees are prone to the development of MSDs. The research has gathered company data from a two-year period (2015-2016), including employee demographic, contract-related and productivity information, as well as employee clinic data related to MSD injuries and symptoms, with the objective of looking at relationships between these factors.

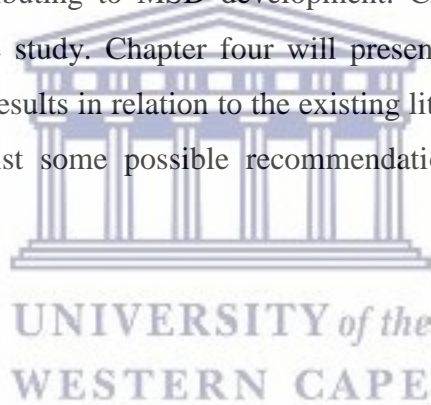
1.3. Aim

To determine prevalence, nature, potential risk and protective factors associated with MSDs among employees in a workplace where heavy lifting is a key job function.

1.4. Objectives

- To describe the extent and nature of the phenomenon of MSDs among employees in a heavy lifting workplace environment, based on available employer HR and workplace clinic data
- To determine whether employee socio-demographic characteristics, contract-related factors and productivity are associated with the occurrence, frequency and type of MSD symptoms/injury in this specific heavy lifting workplace environment.

This thesis will be presented in six chapters. This first chapter has provided an introduction and overview of the public health problem of interest and what this research aims to determine in order to contribute to addressing existing gaps. The second chapter will review the relevant literature, which will endeavour to define MSDs, examine prevalence rate of MSDs and look at the different factors contributing to MSD development. Chapter three will discuss the research methods used in the study. Chapter four will present the results of the research. Chapter five will discuss the results in relation to the existing literature. The last chapter will conclude the research and list some possible recommendations for future discussion or research.



2. LITERATURE REVIEW

Musculoskeletal disorders (MSDs) are becoming a global phenomenon and are increasing in the workplace and affecting employee health as well as production output. Understanding the effect that MSDs have in the workplace, and which risk factors are associated with MSD development, is essential to prevent the occurrence of MSDs. This literature review will begin by discussing the prevalence of MSDs in the world, Africa and South Africa. The review will then focus on different risk factors within the workplace that have been found to be associated with the development of MSDs. Finally, this section will discuss interventions that have shown success in reducing MSDs in the workplace.

2.1 Definition of MSDs and their relationship to the workplace

Musculoskeletal disorders (MSDs) can be defined as injuries and disorders that affect the human body's movement or musculoskeletal system. However, the presentations and causes of MSDs vary considerably, and this is of course also true of injuries in the workplace. Employees can injure themselves acutely, develop an injury over a prolonged period or be clinically diagnosed with an MSD (Middlesworth, 2016). It is further challenging to determine that a specific action led to a specific injury. Often the causal relationship of an MSD injury/symptom is difficult to determine (Middlesworth, 2016). As a result, it is challenging to determine that an injury is, in fact, related to the workplace environment. Injury or symptoms could be a result of actions performed outside the workplace but still present themselves at work. Although it is challenging to determine causality, there are circumstances where MSDs are likely to be caused by conditions in the workplace. Previous research that draws a causal relationship between MSD and the workplace environment is reviewed below, with a specific focus on employees who work in environments that consistently require them to bend, twist, lift heavy objects and perform specific flexions to perform critical job functions.

2.2 Prevalence of MSDs

The global prevalence rates of MSDs can help us gain a better understanding of the magnitude of the problem, the extent to which it is increasing, and its effects on health and quality of life. For example, the Global Burden of Disease (2015) report, which sourced data from 195 countries through different means (case reports, hospitals, national surveys, community surveys etc.), cited the change in prevalence rates in back pain, neck pain and osteoarthritis over a 10-year period (2005-2015). It showed that back pain increased in prevalence by 17.3% in 10 years, whilst neck pain and osteoarthritis prevalence increased by 21.1% and 31.9%

respectively in 10 years (Global Burden of Disease, 2015). It was also revealed that back and neck pain was the leading cause of disability in all high-income countries in 2015. Disability is defined as “covering impairments, activity limitations, and participation restrictions” (WHO, 2017: page 1). In middle aged adults, MSDs were the highest ranking conditions that caused disabilities and in older adults it remained a leading cause of disability (Global Burden of Disease, 2015).

Empirical studies from both high, low and middle income countries indicate a high prevalence of MSDs among workers, with specific focus on lower back pain as the type of MSD injury or symptom which is listed frequently in the studies

A prevalence study conducted with 8000 participants, 25 years and older, from a population register in the Netherlands, reported a 48% prevalence of self-reported MSDs for females and 41% for males. The most commonly reported MSDs were tendinitis and osteoarthritis, with half of the respondents receiving ongoing treatment for MSDs (Picavet and Hazes, 2003). A rubber factory in Iran also measured MSD prevalence amongst 454 factory workers. It found that, out of the 73.6% of workers that had recorded some kind of MSD injury/symptom during the last 12 months, 50.2% reported lower back pain, making lower back pain the most prevalent of MSDs amongst the sample population (Choobineh, Hamidreza-tabatabaei, Mokhtarzadeh and Salehi, 2007).

African studies reporting MSD prevalence rates, also reveal the extent to which the problem is affecting working populations. For example, a study which included 100 road construction workers in Nigeria showed that 66% of the construction workers reported having MSDs over a 12-month period, with lower back pain (55%) being the most frequently reported symptom amongst the workers (Egwuonwu, Mbaoma and Addullahi, 2016).

The existing South African literature on MSDs also provides some insight as to how common MSDs are among the working population, and what characteristics may be associated with these. A South African study, investigating the prevalence of MSDs amongst 85 office administrative workers in a private hospital over a 12-month period, reported an MSD prevalence rate of 76.1%, 71.8% of which included backache complaints (Zungu and Ndaba, 2009). The majority of the participants in this study had reported that they had been absent from work as result of backache or MSD related injuries/symptoms at some point in the 12 months recorded (Zungu and Ndaba, 2009). A systematic review of 27 epidemiological studies in Africa included 37% of data recorded from South African studies (Zungu and Ndaba, 2009).

This research attempted to determine the prevalence rate of lower back pain (LBP) within Africa. The research revealed that LBP was prevalent amongst scholars (18 years and below) at 12% and highly prevalent amongst adults (18 years and above) at 32%. What is also noteworthy is that 68% of the population that had LBP were employed individuals (Louw, Morris and Grimmer-Somers, 2007).

Understanding what parts of the body MSDs affect the most and which areas of the body are more prone to MSD development is also important, since different types of injuries may affect productivity and quality of life differently. A study conducted with 5654 workers from the aluminium industry in Norway investigated the most common types of injury, and how these could affect quality of life (Morken et al., 2002). The research found that MSDs affecting all body parts were associated with increased sickness and absence in the work place; however, this relationship was greatest for participants that reported LBP. LBP was the highest prevalence MSD-related injury/symptom reported. Participants who reported LBP very often reported difficulties in performing work functions and other physical related activities (Morken et al., 2002).

2.3 Demographic factors associated with MSDs in the workplace

It is also important to understand how frequency and types of MSDs may differ across different population groups and in different workplace environments. Unfortunately, there is limited South African literature in these areas, so we need to look at literature from high income countries.

In the USA, Andersson (1999) used the 1988 National Health Interview Survey to determine population characteristics associated with chronic MSDs. The study found that MSDs were the most prevalent type of impairment amongst adults over 65 years, with back and spinal injuries being the most frequent subcategory of MSD (Andersson, 1999). It also showed the prevalence of MSDs to be associated with demographic factors such as gender, ethnic background and age. The review concluded that more males than females experienced back and spinal injuries, and that the MSDs were common among Caucasian versus African Americans. The data also revealed, as one would expect, that higher age was associated with a greater likelihood of experiencing MSDs (Andersson, 1999). The finding regarding age was supported by another study conducted with 6000 adults in the United Kingdom, sampled from three family medicine practices. It found that prevalence of MSDs increased with age up until the age of 75 years, and then started to plateau. Disability prevalence also increased with age and was significantly greater over the age of 75 years (Urwin et al., 1998). A further Egyptian cross-sectional analysis

found MSD prevalence to be 44.7% among male and 55.3% among female patients (Galal, Ibrahim, El-Sayed Hammour and el-Belbasy 2003). It was determined that the highest contributor to MSD injury/symptom for both genders was back pain. The female cohort that reported back pain was found to be 8.4 years younger than that of the male cohort. Similarly, women with neck pain were on average 15.9 years younger than their male counterparts (Galal, Ibrahim, El-Sayed Hammour and el-Belbasy 2003). Factors associated with MSDs among men were accidents, strenuous work and smoking; for females they were hormonal medication, family history of MSDs and lack of physical exercise. The study concluded that female patients that suffer from MSDs are, on average, significantly younger than males and that different risk factors may be associated with MSDs for each gender (Galal, Ibrahim, El-Sayed Hammour and el-Belbasy 2003).

2.4 Contract-and workplace-related factors associated with MSDs

While socio-demographic characteristics can be predictors of MSDs, workplace characteristics or the workplace environment may also have a significant role to play in the causation and prevention of MSDs. The length that employees work for a company with a high MSD prevalence has been highlighted as a significant risk factor. A study with 339 male workers from a construction company in Riyadh, Saudi Arabia, found significant associations between MSDs among workers and long term work duration (Meo et al., 2013). The mean age of employees was 34 years and the mean duration that the employees had worked in the company was 5.7 years (Meo et al., 2013). The study concluded that the duration of employment with the company or exposure to specific work related tasks in the construction industry, such as lifting heavy objects and increased physical work in awkward positions, led to an increase in MSD injuries/symptoms amongst the sample participants (Meo et al., 2013).

A further study with 220 municipal solid waste workers in India supported the idea that the longer one works for a company with a high exposure to ergonomic challenges, the more chance one has of developing MSDs. Employees who worked as municipal solid waste workers experienced limited supervision around their job and the nature of their job involved lifting, bending and twisting throughout the day - making them high risk candidates for the development of MSDs. The research attributed a higher percentage of MSDs among these municipal solid waste workers to the longer duration of employment in the solid waste industry (Reddy and Yasobant, 2015). One would expect the more experienced workers to be less prone to injury. However, prevention techniques to limit MSD development were not shown as there

was limited supervision. Indicating that MSDs formed over-time due to the workers not displaying correct techniques when heavy lifting.

Working in departments that are predisposed to heavier lifting than other departments, such as workloads and lifting loads, can also contribute to the risk of injury, hampering productivity and contributing to a less healthy workforce. A study conducted in Denmark with concrete layers and carpenters found that about 68% of these employees bent and twisted their backs more than a quarter of the day while working, and that between 40 and 50% of these workers typically lifted loads that exceeded 16kg during working hours. Under these conditions, 40-50% of these workers reported back pain several times a week, as well as shoulder and neck pain (Bandt et al., 2015). The study also concluded that physical activities in the workplace, such as raised arms, repetitive movements and working in awkward positions, are common risk factors for neck and shoulder injuries (Bandt et al., 2015). This study also provides some guidelines as to threshold values for the minimum number of times a day beyond which heavy lifting can become a potential risk factor for MSD. A clustered randomised control trial of a cohort in Denmark attempted to understand which physical risk factors were affecting MSDs, such as lower back, shoulder and neck pain. It was determined that lifting loads of more than 25kgs and a frequency of more than 25 lifts per day increased the incidence of lower back pain by 4%, shoulder pain 32% and neck pain by 3.5% (Bandt et al., 2015).

2.5 Productivity related factors that affect MSDs

Since the relationship between productivity and MSDs can be bidirectional, it is important to review both the literature showing the effects of MSDs on productivity and the literature investigating the effects of higher productivity expectations on the occurrence of MSDs. Understanding the relationship between MSDs and employee productivity is important to determine the extent to which MSDs affect production outcomes in a business. A 2003 U.S. cross-sectional study measured lost production time as a result of common pain conditions (arthritis, headaches, back pain and other musculoskeletal disorders) using survey data from the American productivity audit (Stewart et al., 2003). The study showed that 13% of the total workforce sample experienced a loss in production time as a result of common pain conditions during a two-week period. It was also found that, among common pain conditions responsible for reduced production time, MSD pain contributed to 7% of the 13% reported (Stewart et al., 2003). A total of 5.5 hours per week was lost per participant due to MSD pain; this was the highest loss of all the sources of pain reported in the sample.

Another cross-sectional study conducted in the Netherlands with industrial and construction workers (Meerding, Ijzelenberg, Koopmanschap, Sevens and Burdof, 2005) found that 22% percent of industrial workers and 17% of construction workers reported work limitations as a result of health related problems. Out of these health related problems, MSD was shown to be the highest contributor: production losses, as a result of MSDs, were estimated at one hour per day for industrial workers and 1.5 hours per day for construction workers that reported health concerns (Meerding, Ijzelenberg, Koopmanschap, Sevens and Burdof, 2005).

Furthermore, the effects of productivity on the development of MSDs is also an important aspect to consider. Literature aimed at addressing a commissioned report on work-related MSDs by the US congress from the National Research Council and Institute of medicine, determined that certain psychosocial stressors such as high job demands and few rest times did contribute to the development of MSD injuries/symptoms. Even though these factors were less pronounced than physical factors such as weight of handling material and vibrations, by focusing on both factors prevention of MSD in the work place could be reduced (Punnett and Wegman, 2004)

Increased MSDs and work demands have a resounding effect on productivity in the workplace. Without an effective resolution to reduce MSD injuries/symptoms in a heavy lifting workplace, productivity in business will continue to be negatively affected.

2.6 Interventions to prevent the development of MSDs

It is clear, from the literature reviewed, that workplace intervention programmes are central to protect workers from musculoskeletal conditions, manage recovery from injury and prevent further injury or worsening of existing conditions. Employers have a responsibility to implement workplace health programmes for the wellbeing of their individual employees but should also have an interest to do so because of the potential effects on the productivity and success of the business (Middlesworth, 2016). Data from the US indicate that 33% of employee compensation claims are as a result of MSDs, with back pain comprising 45% of those injuries (Middlesworth pg 1, 2016), When an employee is diagnosed with a MSD he/she is likely to be away from work more often (11 days as opposed to the average 8 days). The average direct costs to company are workman's compensation claims, medical fees and in some cases legal fees. This data indicates that the direct and indirect costs of MSD on corporations can be huge and hamper productivity and ultimately profit margins (Middlesworth, 2016).

Workplace interventions may have various forms and components. Training employees on effective lifting techniques is likely to be one of the most effective interventions to reduce MSDs, although research on this is limited. A biomedical review in the US highlighted research on the influence of lifting techniques on MSD, particularly LBP, and sought to determine other mechanical or physiologic factors related to LBP (Hisang, Brogmus and Courtney, 1995). It found that, although there is some research on lifting techniques, there is very little scientific consensus on whether lifting techniques could be an effective intervention in reducing LBP. Nonetheless, the review makes general recommendations on prevention of the occurrence of LBP amongst the workforce (Hisang, Brogmus and Courtney, 1995). The authors note that heavy lifting or lifting of objects within the workplace will always remain and that employees will do the lifting in the way they have been taught. The review highlights these two constants (occupational safety in the workplace and training employees on heavy lifting techniques) as realities that should not be ignored within a workplace environment where employees are constantly exposed to heavy lifting opportunities (Hisang, Brogmus and Courtney, 1995).

A more recent systematic review of workplace interventions that prevent and manage MSD injuries/symptoms identified 30 intervention strategies from 61 different studies to reduce MSDs in the workplace. Of these, the resistance training intervention strategy used to prevent and manage MSD occurrence was selected as the most successful intervention. (Van Eerd et al, 2015). The recommendation of the research emphasised the need for work-based resistance training exercise programme amongst employees, such as dumbbell or kettlebell resistance training. Other evidence was found for stretching programs, mouse-use feedback and forearm support at workstations in preventing the development of upper extremity MSDs (Van Eerd et al, 2015)

Another potential strategy is scheduling a job rotation, using an algorithm to minimize the work load on specific body parts. This idea is known simply as 'job rotation' which means that jobs are scheduled systematically so that physical workloads are evenly distributed per body part (Song et al., 2016). However, authors highlight the need for additional research around algorithms that consider multiple work functions in job rotations, as well as the effects of these algorithms on productivity (Song et al., 2016).

A South African study, conducted with small scale farmers in an agricultural setting, argued that interventions should encompass both training and practical techniques to reduce the prevalence rate of MSDs. The study recommended interventions that focus on educating women on risks associated with poor ergonomic practices, encouraging overall healthy

behaviour and teaching correct ergonomic positions during working activities. It is also essential that the correct tools be used when performing the job function (Naidoo, 2011)

Considering the possible interventions listed above, it would be in the best interest of employers and individual workers to develop effective intervention programs to prevent MSDs. This will not only curb the MSD public health problem but also benefit productivity. It is, however, important to understand the characteristics of work activities and workplaces, as well as risk factors associated with MSD in each specific workplace and employee population, in order to develop effective work practices to mitigate and address these health problems.

2.7 Summary of literature review

The literature highlights that prevalence rates of MSDs are increasing globally, in Africa and South Africa. It also reveals that employee socio-demographic characteristics, work environments and job tasks can be significant contributors to these increases, particularly for jobs which are demanding physically. MSDs can both affect individual health and business productivity. However, there is a limited amount of literature investigating which types of organisations and employee populations are more susceptible to MSD development amongst their workforce. Furthermore, there is a particular lack of data relevant to the developing world context and, more specifically, to the South African context. There is clearly a need for further evidence on factors associated with a higher or lower risk of developing MSDs in specific South African high-risk workplace environments.

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3. METHODOLOGY

3.1 Study Design

This study is a cross-sectional correlational analysis of factors associated with musculoskeletal disorders in a heavy lifting workplace, using data collected by the employer and workplace clinic over the two-year 2015-2016 period. The design involved the use of retrospective data to investigate associations between individual socio-demographic factors, workplace-related factors and MSD-related outcomes. Descriptive data were used to present demographic, workplace-related and MSD-related characteristics for the sample. Bivariate and multivariate analyses were conducted to test for significant associations between these demographic, workplace-related factors and MSD-related outcomes, in order to identify potential risk and protective factors for MSDs.

3.2 Study setting

The setting of the study was a distribution centre, owned by a large food retail company, based in Durban, KwaZulu-Natal, South Africa. The location of the distribution warehouse was in an industrial development zone within Durban. There are multiple warehouses, producers and distribution centres in the area that employ large numbers of people from the surrounding communities. The majority of workers are low to medium income earners and many do not have access to private medical facilities, thus relying on their employer for increased access to healthcare. The distribution centre specialises in receiving perishable and non-perishable goods, storing them and then distributing them to their retail outlets. This distribution centre is one of the company's six centres in South Africa and has food retail outlets all over the world. For the sake of this study, only the non-perishable distribution centre was included, as the perishables centre is in a different location and access to clinic records was not possible.

At the distribution centre the majority of the employees were employed as “pickers”. These pickers are employees of the workforce that will pick up or take off the non-perishable items or boxes from the pallets or shelves, place them on their trolley or cart and take them to the

trucks for distribution, according to a generated order form. Only data from the 111 employees who were employed as pickers from January 2015 to December 2016 and still employed at the time of data collection (January 2017) in the assembly non-perishable department were included in the sample and analysis.

The picking is carried out according to orders received daily and incentives are offered from the company if employees pick at a higher rate than the average target set by the company. All pickers' performance is measured on the number of items they pick daily, and if they pick over their target amount they are rewarded through pay incentives. Most pickers will not necessarily pick heavy items (as the majority of picking is aided through machines that collect pallets of items). However, they are constantly turning, bending, twisting and lifting while picking. There are also different departments of picking which can be divided into three main areas: soft (this includes small non-perishables goods such as toiletries and detergents); cage (these are smaller non-perishable items such as packaged foods, soaps and household goods); and assembly (which comprises of large non-perishable items stored together). For the purpose of this study the three departments were classified into two main areas: heavy and non-heavy. The heavy department comprises the pickers in the assembly department and the non-heavy area includes the pickers in the cage and soft departments. This classification was deemed appropriate since items lifted by employees in the assembly department were considerably heavier than those lifted in the cage or soft departments. Unfortunately, it was not possible to quantify the different weights used by each department as this information was not available.

3.3 Population

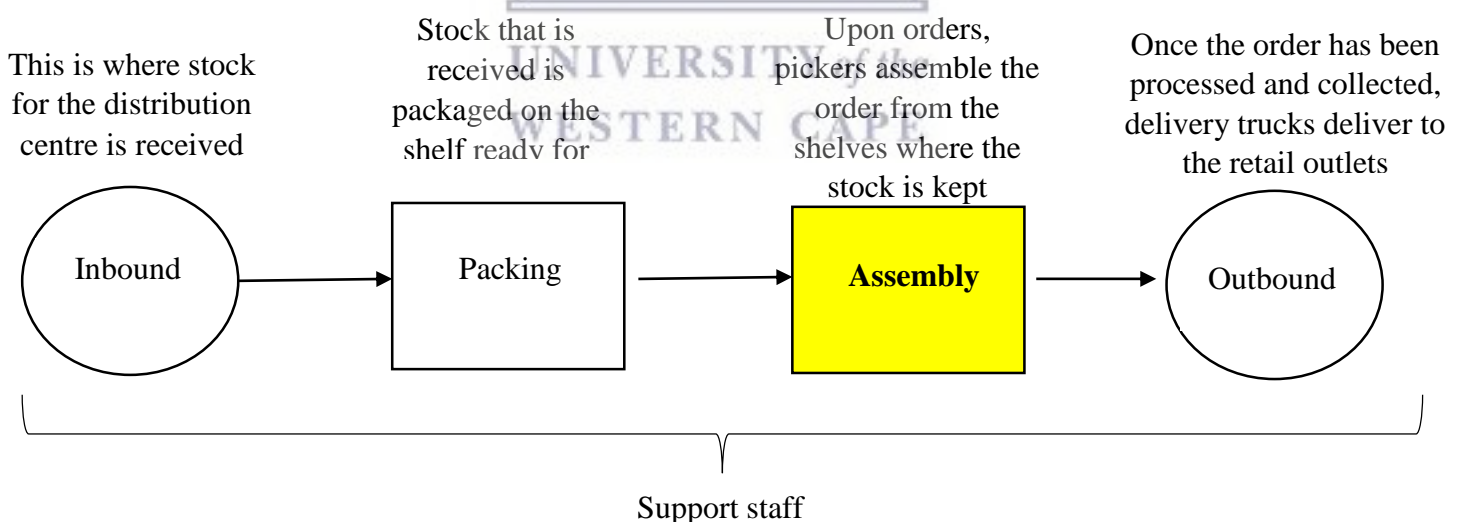
The study population consisted of employees in the non-perishables distribution warehouse of the corporate employer, who worked in the assembly department between 2015 – 2016 and for whom the company had productivity data. Productivity data was collected from the distribution centre and consisted of data that measured the rate at which pickers picked the required goods through each employees shift (this will be explained in more detail further on). Onsite clinic records were also collected for employees working in the assembly department, who visited the clinic at the distribution centre for MSD injuries or symptoms over the 2015-2016 two-year period. Employees from the assembly department who worked in the distribution centre over the 2015-2016 two-year period and never visited the clinic were also recorded. Employees reported injuries/symptoms at the onsite clinic if they failed to perform their assigned duties while at the workplace. It is difficult to determine whether the MSD injuries/symptoms reported were a result of employees' work functions or a result of other non - work related

activities or both, as there were no clear records of this. However, it is highly unlikely that employees of the company would not report their MSD symptoms/injuries to the onsite clinic and/or seek treatment elsewhere, given the probable limited access to other private health facilities and the fact that employees were only allowed to stop performing their job function for a period or take time off if they had reported their symptom/injury to the workplace clinic. It was only after they had done this, and the clinic had determined their prognosis, that they could continue working or access further treatment. This service was free of charge to employees and employees were only allowed to be reassigned to other job functions or take a break from that specific job function if the onsite clinic deemed it necessary.

3.4 Sample

Purposive sampling was conducted for this study. This non-probability form of sampling used selective criteria from the population to determine the sample, based on the objective of the study.

The sample was taken from the assembly department of the food retail company, which represents a specific stage and function within the distribution centre process. See the diagram below which outlines where the assembly department (highlighted in yellow) is positioned within the company's broader distribution process.



Pickers who were working in the assembly department at the time of data collection (2015-2016), for whom the company had collected productivity data, and were still employed at the time of data collection (January 2017) were included in the study sample, whether they had

visited the onsite clinic or not. Employees that resigned between 2015 and 2016 were not included in the sample.

3.5 Data Collection and management

Before the data collection could occur, the first step was to obtain permission from the distribution company providing the data. The company requested proof from the university that the research was part of a mini-thesis in public health, and permission had to be granted by the Human Resources executive for the company, before the researcher could proceed with the data collection process. This approval process took about a month.

Once the data collection process was approved, it was undertaken in three phases. The first phase involved collecting the basic employee data for each picker working in the assembly department at the time of data collection and over the 2015-2016 two-year period. This data was provided by the distribution centre and included information such as the contract type, the age, race and gender of the employee. Very little initial adjustment of the data was needed, as the majority was already in a usable form that could be coded in excel. Additional data provided, which was not directly relevant to the research, was removed from the spreadsheet.

The second phase of the data collection process involved liaising with the onsite clinic to obtain clinic data for all employees that had reported MSDs over the 2015-2016 two-year period. This data was more challenging to extract and organize as it was not available through a computerized database, so needed to be manually recorded. This information was recorded in patient files and extracted onto an excel sheet. Given concerns regarding confidentiality, the individual clinic injury/symptom data could not be linked with the specific employee's identity. The clinic therefore had to assign a unique identifying code to each employee, which was linked to his or her employee number. Clinic staff then recorded all MSD injuries/symptoms for each employee in the assembly department. These records included the date/s that the employee had visited the clinic, the reason for each visit (e.g.: backache, arm pain) and the department within which the employee was working.

The last phase of the collection process involved collecting the productivity data. The distribution company had a system in place which recorded the desired rate at which employees were to pick the required goods per picking cycle. This system was implemented in January 2015 and was still in place at the time of data collection (January 2017). The desired rates were based on an in-house standard which the distribution company set and varied in value depending on the contract type. These were then recorded in a percentage form and employees

were notified that if they picked over the required 100% of requested orders they would benefit from an incentive package, depending on the percentage achieved. The distribution company recorded the pickers' movements through an automated system that each employee would talk into once picking the required good. A percentage was recorded weekly and was measured from what was expected from them. Expectation levels were set at 100% and employees that performed below this level were considered to be performing below the required picking rate, while employees who performed above this level received an incentive. Permanent and part time pickers received a lower incentive rate compared to flexi-timer pickers.

The productivity data was recorded in the dataset as follows: an average percentage for the 2015-2016 two-year period was calculated for each participant, by dividing the sum of total weekly productivity values for the whole two-year period by the total number of weeks for which each participant presented productivity data. The data was categorized into three main groups based on their mean productivity value and expressed in the form of a percentage in relation to their performance objectives set by the company. These groups respectively comprised: participants that had a mean productivity value below 70%; participants that had a mean value between 70-100%; and participants with a mean value above 100%. Taking into consideration the data distribution, these groups were further classified into two groups in order to create a dichotomous variable for statistical analysis: below 100% and above 100% of performance objectives.

After the three different datasets were collected and entered using Microsoft Excel, the datasets were merged in Excel using the unique identifying number given to each participant. Once all the data was on a master list, data was coded and simplified into the variables presented in the results section (chapter 4). The dataset was then transferred to SPSS for analysis.

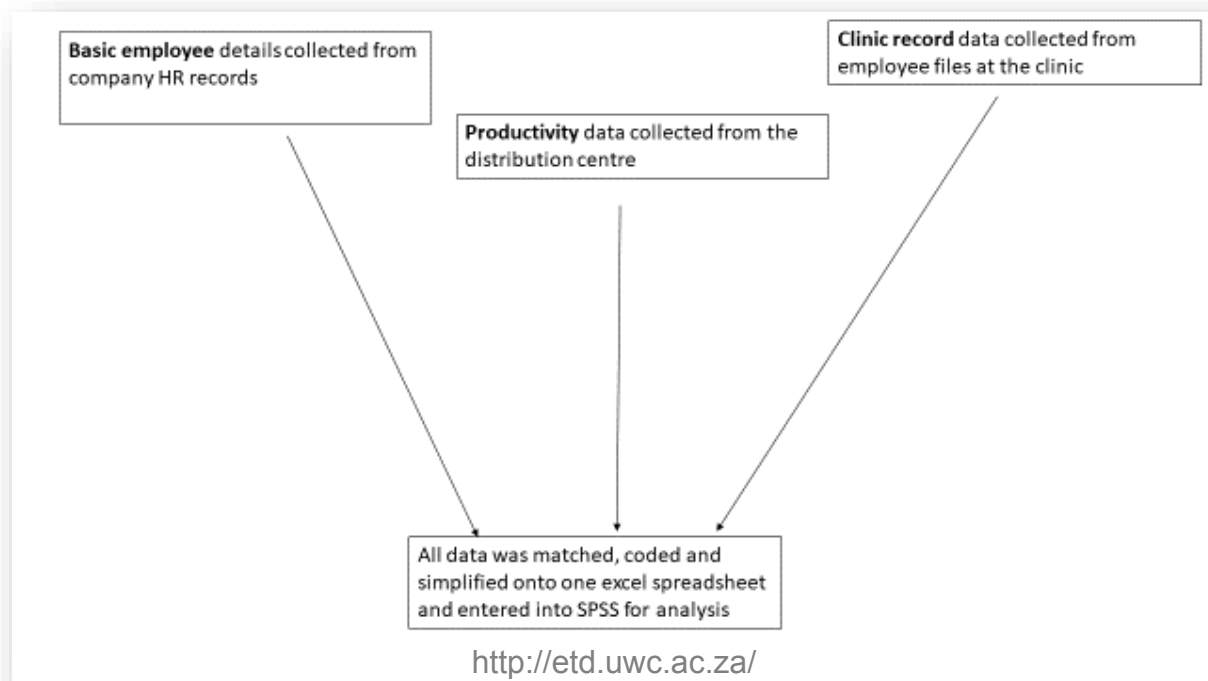


Figure 3.2: Types of data collected and then merged

3.6 Data analysis

Once all the data was received, the coding process began. The data was managed and analysed using IBM SPSS, a quantitative data analysis software programme. The clinic and employee data were prepared in order to be used to investigate possible associations between the various demographic variables, contract-related variables and variables indicating MSD symptoms/injuries (e.g. number of clinic visits).

Variables were computed from the raw data to record whether or not individual employees had visited the clinic over this period for an MSD-related symptom or injury, and the number of times each employee had visited the clinic (with number of visits recorded as '0' if the employee had not visited the clinic). Variables were also computed to indicate whether an employee's self-reported pain was in one specific part of his/her body throughout his/her clinic visits, or whether he/she had multiple areas of pain. Injury was categorised into four main areas of pain: 1. head, neck and shoulders; 2. back and arms; 3. hip, leg and feet; and 4. multiple groups (when injury or reported pain occurred in multiple groups, such as neck pain and backache or arm and neck pain).

Departments within the distribution company were recoded into either heavy departments (employees that were exposed to more lifting and excessive physical activity) or non-heavy departments (employees that were exposed to less physical activity and lighter material).

The first (descriptive) part of this study analysis extracted descriptive indicators such as frequency in numbers and percentages, mean, medians and standard deviations for continuous variables. These were organised and are reported in chapter 4, in table form for data that was categorical, and through a bar chart for data that was continuous.

The next stage consisted of bivariate tests to measure potential associations between key demographic, workplace-related and MSD-related variables. These tests included independent sample t-tests, chi-squared and Pearson correlation tests, depending on the nature of the variables tested (i.e. continuous versus binary). Results are reported in a table form in chapter 4, displaying significance levels, means and standard deviations. Outcome variables used as

indicators of MSD in the bivariate analysis included: location of injury (where the injury was located on the employee's body (e.g.: upper body/backache or lower body); whether or not employees visited the onsite clinic to report MSD injuries/symptoms or while working at the distribution centre; the total number of visits to the clinic between 2015-2016 (the number of times employees visited the on-site clinic at the distribution centre over the stated period to report MSD symptoms/injuries). Variables included in bivariate analysis were: individual demographic variables, specifically race of the employees, age of the employees at the time of data collection and gender of the employee; and employment-related variables, i.e. the type of contract that the employees were on, the type of department the employees were working in and the productivity variable.

The last stage of data analysis consisted of multivariate analysis. A linear regression was conducted, using total number of clinic visits for MSD-related symptoms/injuries (2015-2016) as the dependent variable. This dependant variable was chosen as it was the best indicator or proxy for ongoing MSD injuries/symptoms among employees from the data made available. The regressions aimed to determine which demographic, employment and productivity factors indicated above were significantly associated with the total number of visits (2015-2016) in a multivariate analysis, controlling for the other factors. Independent variables included in the regression were: age, race, gender, department, type of contract and productivity data. The results of the regression analysis, including significance levels, standardized coefficients and confidence intervals, will be illustrated in a separate table in the Results Section in chapter 4.

3.7 Reliability and Validity

The majority of the data collection and analysis involved the use of secondary data, consisting of previous company (HR and clinic) records. All data collected and analysed underwent strict validity and reliability procedures. Some of these measures are described below:

- A clear standard procedure was used when collecting the data from the distribution company. Collection of all the data involved initial communication with the company's HR executive and instruction was then issued to provide the data in an excel format for each dataset. Two out of the three datasets were provided through an electronic database system that produced a report with the relevant information. These two datasets were provided by the distribution company's HR executive. However, the clinic data was manually sourced through the distribution company's clinic records by one clinic nurse who managed all the patient files within the distribution company.

- Cross-checks were implemented within the dataset, across and within indicator variables. Data from merged datasets was randomly crosschecked with the original data received to ensure that the data had been correctly recorded and merged.
- The data provided by the company contained multiple outliers and clear errors. These included employment start dates that did not match clinic records, or clinic visit dates that did not tie up with other visits. If mistakes in the dates were clear, such as a year missing a digit or digits recorded in the wrong order, they were corrected. However, if dates were blank or variables had missing data for specific cases, these were coded as ‘missing’.
- Confidentiality was ensured using a blinding method: data was received with no reference to or disclosure of any employee names or other identifying information. All data was either coded by the distribution company, the clinic within the distribution company or the researcher. Employee numbers were used to match data from the three datasets received.

3.9 Ethical considerations

This research did not require primary data collection in the form of interviews or direct engagement with employee participants. Employee records, health status and employment history had been collected by the distribution company, which provided the candidate with the relevant data. However, maintaining confidentiality of employees’ sensitive information was very important as some of the data received were medical records; confidentiality had to be ensured and participants had to be protected from any potential harm. Data were therefore coded using numeric identifying numbers for participants, which were then linked to their employee numbers. Through this process, the participants’ identities were concealed or removed. All data was saved on password-protected files and machines, accessible only by the research candidate and his supervisors. Only aggregate and anonymous data was used in all reporting and communications; individual participants have not been referred to and will not be referred to using any form of identifying information.

This research was approved by the UWC Human and Social Sciences Research ethics committee: BM16/5/35, 28 July 2017 – 28 July 2018.

4. RESULTS

4.1 Descriptive Statistics

4.1.1 Demographic variables

The final sample for this study consisted of 111 pickers in the assembly department of the distribution centre, for whom productivity indicators and clinic data for 2015-2016 were available. Age was recorded for all 111 participants at the time of data collection in January 2017 and ranged from 24-44 years (Figure 4.1). The median age was 30 years and the mean age was 30.9 (SD=4.6) years.

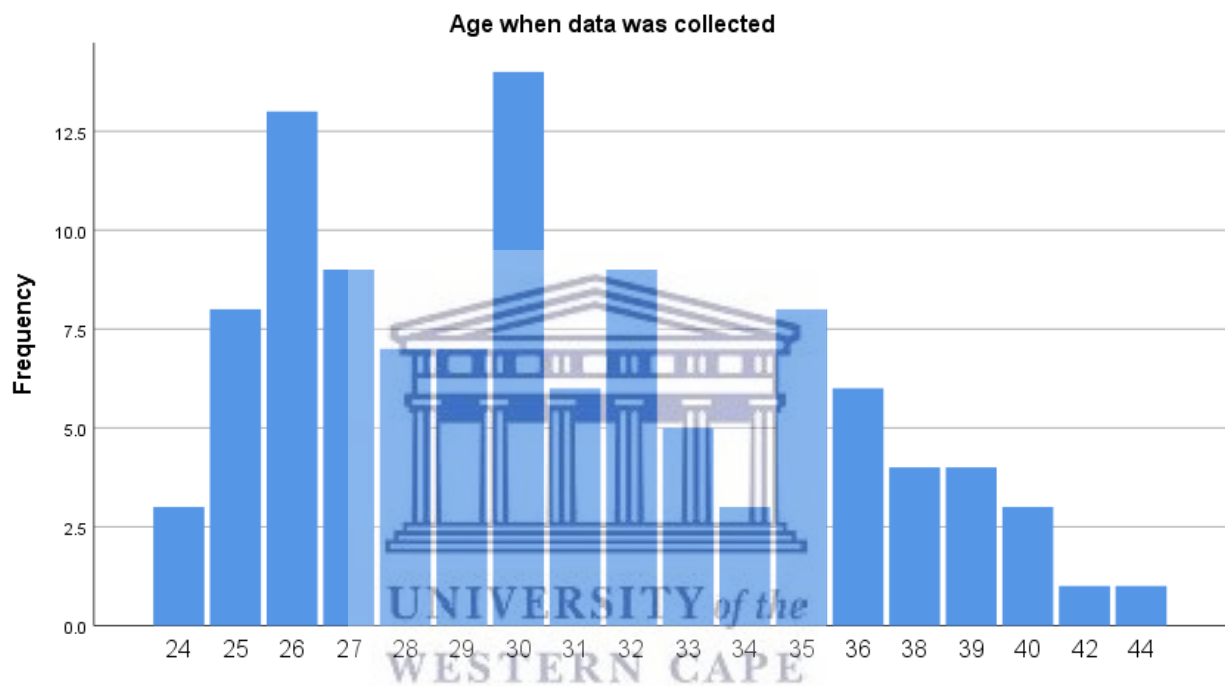


Figure 4.1: Age of study participants at the time of data collection

The race and gender data pertaining to the sample indicated that 91.0% of participants were Black African, and 8.1% were Indian (0.9% of the data was missing). Of these 111 participants, 81.1% were male while 18.9% were female. This is illustrated in table 4.1 below.

Table 4.1: Race and Gender breakdown of study participants (n=111)

	Frequency	Percentage
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	Black African	101	91.0%
Race	Indian	9	8.1%
	Missing	1	0.9%
	Male	90	81.1%
Gender	Female	21	18.9%

4.1.2 Employment related variables

The company used three types of employment contracts: flexi-timer, permanent and part-timer contracts. Employees on flexi-timer contracts and permanent contracts are both full time employees; however, these contracts differ in remuneration structures. Flexi-timer contracts have a lower basic wage, but provide more opportunity for incentives, while permanent contracts have a higher basic salary and less incentive structures. Part-timer contracts are for employees that are not permanent at the organization and do not work full time within the distribution centre. Table 4.2 summarises the distribution of these contract types.

The main contract type amongst the pickers in the distribution centre was Flexi-timer (66.7%), while the other two contract types were relatively equally distributed among the remaining workers. These results are indicative of the company's policy to move towards flexi-timer contracts, as the majority of part-timer and permanent contracts had been phased out by 2015.

Table 4.2 Distribution of contract types among study participants (n=111).

		Frequency	Percentage
	Flexi-timer	74	66.7%
Contract	Part-timer	16	14.4%
	Permanent	20	18.0%
	Missing	1	0.9%

The available data also indicate which department each participant worked in. The three main departments highlighted within the assembly department were: cage, soft and assembly. In the

soft and cage departments light non-perishable items are picked (e.g. toothpaste), while heavy non-perishables are picked in bulk in the assembly department (for example, bags of maize meal or 2l soft drinks). These department types can also be categorized into ‘heavy’ and ‘non-heavy’ departments. The heavy department includes all participants from the assembly’s section and the non-heavy department includes all participants from the cage and soft section. The table below summarizes the distribution of pickers in the heavy and non-heavy departments. The majority of the pickers fall into the heavy department (58.6%), however it is fairly evenly distributed, with 41.4% of the pickers working in the non-heavy departments.

Table 4.3 Department distribution for participants in the study (n=111).

	Frequency	Percentage
Department		
Heavy	65	58.6%
Non-heavy	46	41.4%

4.1.3 Productivity related variables

The productivity data indicates the quantity that participants pick on a weekly basis. This productivity data was collected by the company and is available for the 2-year period 2015 - 2016. Employees that achieved a productivity score over 100% of targets set by management, received incentives, whereas employees that achieved below 100% did not receive incentives. The productivity data shows that 45.9% of participants had a productivity picking average in the distribution centre of over 100%, while 34.2% of the participants scored between 70-100% and the remainder (19.8%) scored below 70%. Table 4.4 shows frequencies for different productivity groups.

Table 4.4 Productivity grouping distribution for participants in the study (n=111).

	Frequency	Percentage
Productivity		
<71%	22	19.8%
71-100%	38	34.2%
>100%	51	45.9%

4.2 Indicators of musculoskeletal disorders

The variables used in this study to indicate the presence and type of MSDs are: whether participants had visited the clinic for injury or symptoms of MSD; the total number of visits to the clinic made by individual participants; and the location of injury/symptoms that participants reported to the clinic.

Of the 111 pickers, over half (63) reported to the clinic at least once with one or more injuries/symptoms over the period of data collection (2015 and 2016), while the remaining 48 employees never reported an injury/symptom to the clinic over that period. The average number of clinic visits for MSD injuries/symptoms recorded per participant that reported to the clinic was 3.2. Table 4.5 summarizes the number of participants that visited and did not visit the clinic.

Table 4.4 Proportion of participants that visited and did not visit the clinic (n=111)

	Frequency	Percentage
Visit/No visit		
Visit	63	56.8%
No visit	48	43.2

The total number of clinic visits per participant ranged from 0 to 18 visits (Figure 4.2). The median total number of visits was 1 and the mean total number of visits was 1.8 (SD=2.9).

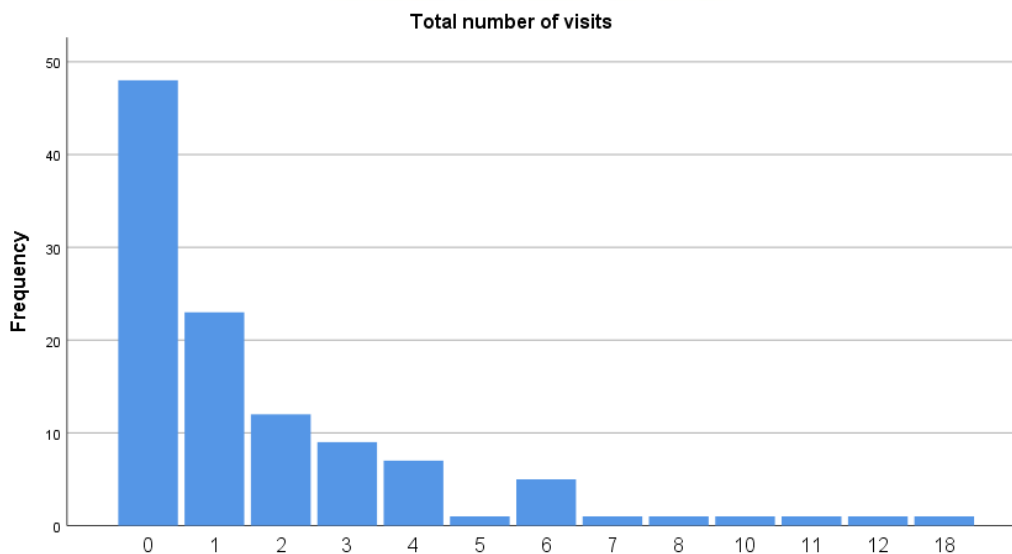


Figure 4.2: Total number of visits

The total number of MSD injuries/symptoms recorded amongst all the participants that visited the clinic was 203. Participants could have visited the clinic more than once for MSD injuries/symptoms – these visits were included in the total number of visits. Injuries/symptoms were further grouped into lower body pain (below the waist) and upper body pain (Backache and above the waist) Eleven (17.5%) out of 63 participants that reported MSD injuries/symptoms to the clinic reported injuries/symptoms in the lower body (below the waist), while the large majority (52 or 82.5%) of participants reported injuries/symptoms in the back and upper body (above the waist). Table 4.5 shows the proportion of participants reporting injuries/symptoms in each part of the body. Twenty-six out of 63 participants only recorded one kind of injury/symptom when visiting the clinic (41.3%) whilst 37 participants (58.7%) recorded more than one kind of injury/symptom when visiting the clinic.

Table 4.5: Location of injury/symptom of MSDs reported.

	Frequency	Percentage
Location of injury/symptom		
Back pain and upper body	52	82.5%
Lower body	11	17.5%

4.3 Bivariate analysis: associations between demographic characteristics, employment variables and MSD-related factors

Bivariate analysis was conducted to test for significant associations between participant demographic and employment-related variables (such as: age at time of data collection, race, gender, productivity, department, and contract type) and MSD-related factors (i.e.: total number of visits; whether participants had visited the clinic and whether the injury was located primarily in the back and upper body or lower body).

Table 4.6 below illustrates the statistical bivariate associations between these variables, and highlights associations that were statistically significant at the 0.05 level (in bold text). These associations were tested using Pearson’s correlations for the continuous variables, independent sample t-tests for continuous and categorical variables, and chi-squared tests where both variables were categorical variables.

Significant bivariate associations were found between the type of department and number of clinic visits, and between participant productivity and number of clinic visits recorded.

Participants with productivity levels below 100% had, on average, a higher number of visits to the clinic for MSD-related injuries/symptoms over the 2-year period ($p=0.001$). Pickers working in the heavy department also had a larger average number of clinic visits ($p=0.040$). None of the other associations reached significance at the $p < 0.05$ level. It is noteworthy that none of the demographic or contract-related variables were significantly associated with the location of injury.

Table 4.6: Summary of bi-variate analysis for employees who visited the clinic, the number of times they visited the clinic and their location of injury.

		Visited the clinic			Total number of clinic visits		Location of injury		<i>p</i>
		Yes	No	<i>p</i>		<i>p</i>	Back pain and Upper body	Lower body	
Demographic variables									
Age		31,0 (4,6)	30,4 (4,7)	0,647	-0,113	0,239	30,9 (4,8)	31,3 (3,9)	0,209
Gender	<i>Male</i>	84,1%	77,1%	0,348	2,0 (3,1)	0,151	86,5%	72,7%	0,255
	<i>Female</i>	15,9%	22,9%		1,2 (1,7)		13,5%	27,3%	
Race	<i>Black African</i>	91,9%	91,7%	0,959	1,9 (2,9)	0,520	90,2%	100%	0,279
	<i>Indian</i>	8,1%	8,3%		1,6 (2,0)		9,8%	0%	
Contract-related variables									
Type of contract	<i>Permanent</i>	16,1%	20,8%	0,526	1,4 (2,7)	0,465	13,7%	27%	0,268
	<i>Non-permanent</i>	83,9%	79,2%		1,9 (2,9)		86,3%	73%	
Department	<i>Heavy</i>	63,5%	52,1%	0,227	2,2 (3,2)	0,040	65,4%	54,5%	0,498
	<i>Non heavy</i>	36,5%	47,9%		1,3 (2,1)		34,6%	45,5%	
Productivity	<i>Above 100%</i>	55,8%	50%	0,569	1,1 (1,5)	0,001	43,3	46,7%	0,816
	<i>Below 100%</i>	44,2%	50%		2,4 (3,5)		56,7%	53,3%	

4.4 Multivariate analysis: predictors of MSD-related outcomes

A linear regression was conducted to test whether contract-related variables or productivity levels were significant predictors of total number of clinic visits, controlling for the demographic variables. The total number of clinic visits was chosen as the dependent variable, since it was likely to be the best proxy for the existence and duration of MSDs, given that all visits recorded to the clinic in this dataset were as a result of musculoskeletal symptoms or injuries. The independent variables included in the regressions were: age, race, gender, contract type, department and productivity.

Table 4.7 shows results for the linear regression predicting total number of visits. Controlling for age, gender and race, lower productivity was a significant predictor of a higher total number of clinic visits: participants whose productivity was below the 100% productivity mark had, on

average, a higher number of visits to the clinic for MSD-related symptoms or injuries (B=1.344, p=0.025). None of the other variables in the regression reached significance at the $p < .05$ level.

Table 4.7: Linear regression: Total number of visits

Dependent variable: Total number of visits (n=111)			
	B (unstandardized coefficient)	P	CI (confidence interval)
<i>Demographic variables</i>			
Age	-0,050	0,457	(-0,18 - 0,08)
Gender (Males to females)	-0,535	0,496	(-2,09 - 1,02)
Race (African to Indian)	-0,430	0,673	(-2,45 - 1,59)
<i>Contract-related variables</i>			
Type of contract (Permanent to non-permanent)	0,274	0,725	(-1,27 - 1,81)
Department (Heavy to non-heavy)	-0,807	0,294	(-2,33 - 0,711)
Productivity (Above 100% to below 100%)	1,344	0,025	(0,174 - 2,513)

4.5 Summary of results

The data from this study shows that the majority of the sample population working in the distribution centre at the time of data collection was relatively young (mean age = 30 years). Participants were mostly male (81.1%) and Black African (91.0%) and most participants were on non-permanent contracts (81.1%). A high percentage worked in the heavy department (58.6%) and the majority of the participants had a productivity score below 100% of desired output (54.0%). Around 57% of participants had visited the clinic for MSD injuries or symptoms over the 2015-2016 two-year period and the majority (52.5%) of the participants who visited the clinic reported back pain and upper body symptoms/injuries. Among participants that visited the clinic, the number of visits over the 2-year period ranged from 0 to 18. The average number of clinic visits per participant was 1.8 over this period.

In bivariate analysis, both lower productivity (p=0.001) and working in the heavy department (p=0.040) were significantly associated with a higher total number of clinic visits for MSD-related injuries or symptoms. In multivariate analysis, controlling for demographic variables, lower productivity (below 100%) was the only variable significantly associated with a higher number of visits to the clinic (p=0.025).

5. DISCUSSION

This study describes the extent and type of MSD symptoms/injury reported in a workplace where employees' jobs include heavy lifting and investigates demographic and contract-related factors associated with these MSD injuries/symptoms. While assumptions regarding causality cannot be made in cross-sectional analysis, some variables significantly associated with musculoskeletal pain and/or injury may indicate risk factors for MSDs. This study contributes to the existing literature aimed at assisting employers to determine which factors to look out for and address in the workplace environment, in order to prevent and manage the development of MSD injuries/symptoms amongst their workforce.

5.1 MSD occurrence and duration

One hundred and eleven participants were included in this study's sample and 63 of these participants reported MSD injuries/symptoms at the onsite clinic between 2015-2016, meaning that 57% of the sample visited the clinic. The average number of clinic visits for MSD injuries/symptoms among participants who visited the clinic for the period of 2015-2016 was 3.22 cases per participant.

Approximately 83% of participants suffered from back or upper body pain and 17.5% of the participants reported injury or symptoms in the lower body, which included leg, foot and hip pain. However, backache was by far the most commonly reported MSD injury/symptom, likely since participants at the distribution centre were regularly exposed to bending, twisting and lifting type actions. Bergquist – Ullman and Larsson (2014) explain that bending, along with the combination of weight lifting, can lead to back injury. Furthermore, flexion, rotation and bending are the most common factors associated with backache (Bergquist – Ullman and Larsson, 2014). The 2015 Global Burden of Disease report, which included 195 countries between the period of 2005 – 2016, indicates that the prevalence rate of backache increased by 17.3% in the previous 10 years. It also highlights that back pain was the leading cause of disability in all high-income countries in the year 2015 (Global Burden of Disease, 2015).

5.3 Contract related factors

5.3.1 Department

Approximately 41.4% of the participants in this study worked in the non-heavy department, while the remaining 58.6% worked in the heavy department. In bivariate analysis, a significant association was found between working in the heavy department and having made a higher average number of visits to the clinic. This association was not surprising, as one would have

predicted that employees who worked in the heavy department were more at risk for developing MSD injuries/symptoms. Furthermore, this association is supported by the existing literature. Bandt et al. (2015) concluded that 40-50% of concrete layers and carpenters in Denmark that frequently lift heavy weights during working hours reported MSD injuries/symptoms several times a week.

However, the association between working in the heavy department and a higher number of clinic visits did not remain significant in multivariate analysis, once other variables were controlled for. It should be noted that key information on the weight of the lifting loads and frequency of lifts in the various departments was not available for this employer. This would have been useful to determine the actual differences in average and maximum loads allowed across departments and to provide further insight on these findings.

5.3.2 Productivity

More than half (54.1%) of participants, for whom productivity data was available, performed below the 100% productivity benchmark set by the distribution centre. Participants that perform above this 100% are eligible to receive financial incentives from the company, but only 45.9% of participants in the sample were eligible on this basis. In both bivariate and multivariate analyses, performance below the required 100% was significantly associated with increased MSD injuries/symptoms clinic visits during 2015 and 2016. This may seem counterintuitive, as one could expect higher performance levels to lead to more injury and chronic MSD conditions. Instead, findings suggest that employees with MSD injuries/symptoms are less likely to be productive because of existing injury or symptoms, once again highlighting the possible bidirectional relationship between these variables. This finding is consistent with the US Stewart et al. (2003) study, which measured lost production time because of MSD injuries/symptoms. It found that 5.5 hours per week per participant of productivity or work time was lost because of MSD injuries/symptoms, resulting in a decrease in work production from those participants.

These findings highlight financial incentives linked to productivity as an important potential risk factor for the development or worsening of MSD injuries/symptoms among employees, in this company and more broadly, where productivity measures or goals are determined by employers and linked to monetary incentives. Some of the employees pushing themselves to produce productivity figures above the minimum incentive amount of 100% may already be suffering from MSD injuries/symptoms or at high risk of developing these. In some cases, employees may not be willing to address or report the condition for fear of not meeting the

required target and missing out on the financial incentive. This would adversely affect both the health and productivity of employees in the long run, as well as the reliability of health data collected. Similarly, employees that have reported MSD injuries/symptoms and have low productivity scores are also unable to reach financial incentives. This places them at a significant disadvantage as their MSD injury/symptom limits them from reward, due to an injury or symptom that was possibly caused by their job. To conclusively show this, long-term or cohort studies would need to be done.

5.3.3 Type of contract

In this study sample, there was no significant association between the participants' contract type and increased MSD injuries/symptoms. Studies conducted with workers in different countries and contexts have found similar associations. For example, a study of workers from a construction company in Riyadh, Saudi Arabia, found significant associations between MSD injuries/symptoms among workers and the length of work duration the average time that employers had worked for the company was 5.7 years (Meo et al., 2013). However, unlike the study in Riyadh, there was no significant associations found between the different contract types (Permanent, Flexi-timer and part-timer) The lack of a significant association in this study could have been as a result of the small sample size, with only 20 participants out of the 111 on permanent contracts.

5.3.4 Demographic variables

Socio-demographic factors such as age and gender were not significantly associated with the MSD-related indicators in this particular study. Some of these variables were found to be associated with MSD occurrence in previous studies. For example, a US National Health Interview Survey to determine population characteristics associated with chronic MSD, found that MSD injuries/symptoms were the most prevalent type of impairment amongst adults over 65 years (Anderson, 1999). The lack of a significant association between the age of participants and the likelihood of MSD injuries/symptoms in this research could have been a result of the relatively low average age of participants (30).

An Egyptian cross-sectional analysis suggests that female patients who suffer from MSD injuries/symptoms were, on average, significantly younger than males and that different risk factors may be associated with MSD for each gender (Galal, Ibrahim, El-Sayed Hammour and el-Belbasy 2003). This research found no associations in both the bivariate and multivariate analysis between the occurrence of MSD injuries/symptoms in female participants compared

to male participants, although an investigation of risk factors by gender was beyond the scope of this analysis.

5.3 Limitations

This research had several limitations. First, the sample size was relatively small. This is in part because the candidate struggled to access and/or link part of the data, since the company was not able to make this data available and provide clear identification numbers for all employees. However, every effort was made by the candidate to ensure that all available data was obtained and that the data from various sources (e.g. clinic, company HR department) was matched to the correct participants; in the case of ambiguity, the data was not included in the research.

A further limitation is linked to the missing data. There was a possibility that the datasets with missing variables could introduce a hidden bias which might have had a positive or negative effect on the outcomes of interest. To minimize this bias, missing values for both numeric and character variables were explicitly labelled as missing in tables and data listings. Cases with missing data were therefore excluded from bivariate and multivariate analyses.

An added limitation could have been employees that might have left during the two-year period (2015+2016). These employees were not included in the study sample and could have contributed to the “healthy worker” effect, meaning that the employees that were in the study sample were healthy and the employees who had left the organisation could have been the employees who developed MSDs, could not perform their job anymore and were forced to leave.

Moreover, although part of the data refers to a 2-year time period, the analysis in this study is cross-sectional, and it is therefore not possible to determine or make assumptions around causality. Even if an association is found between an independent and outcome variable, we cannot assume that it is a causal one or determine the direction of causality. In the future, specifically designed longitudinal research, possibly combined with qualitative enquiry, may be better suited to address the issue of causality.

An added limitation was the inability to include control for factors outside the workplace that may have been leading to MSD injuries/symptoms, since this data was not available. Very few injuries on duty cases were reported in this sample and it is likely that the majority of MSD-related injuries/symptoms were due to gradual symptoms of MSD injuries/symptoms that developed and were therefore reported while at work. This makes it challenging to confidently determine that the pain or injury was a direct result (only) of an employee’s working condition.

It should be noted however, that this is a limitation of many similar studies, since reliable data on both workplace factors and possible external predictors of MSD injury/symptom is often unavailable. This is another possible area where both companies and researchers should look into routinely collecting and analysing data.

Duration of employment was mentioned in the literature review as a potential risk factor. However, this data was available from the employer, but it was discovered that the dataset was invalid and included employees who had not worked at the company between the 2 years used in the study. If accurate data was given, this variable could have been useful in supporting the literature that duration of employment could indeed be a risk factor.



6. CONCLUSION and RECOMMENDATIONS

6.1 Conclusion

This study, conducted in a company distribution centre in Durban, KwaZulu-Natal, South Africa, highlights the importance of understanding the occurrence and factors associated with MSD injuries/symptoms in a workplace where heavy lifting is a key element of the job's function and tasks. Distribution centres work efficiently when the desired productivity is maintained. Productivity can be significantly affected if the workforce is prone to developing MSD injuries/symptoms because of heavy lifting while at work. Moreover, a high incidence and prevalence of injury and chronic musculoskeletal disorders represents an individual, workplace and public health problem. That is why it is essential to determine risk factors for MSD injuries/symptoms, and understand who is most affected, in order to develop effective data collection systems, policies and interventions to create a healthy workforce and workplace.

A high prevalence rate for MSD injuries/symptoms was found among participants of this research (57%), highlighting the need to understand why MSDs in this workplace are so common. One of the main objectives of the study was to determine which individual and workplace-related factors - such as employee demographic characteristics, contract related variables and productivity – could be related to MSD injuries/symptoms among employees in the distribution company. Although limited by the available data and sample size, findings of this study add to the little existing company-level analyses in South Africa investigating factors associated with MSD in a heavy lifting workplace.

This study found that participants performing below the measured productivity requirement were more likely to visit the clinic more often for MSD injuries/symptoms. This likely indicates that participants who already suffer from MSD injuries/symptoms have a lower level of productivity on tasks that involve lifting and moving. This result motivates the need for effective workplace management and intervention programs, so that both participants and companies can reduce the burden of MSD injuries/symptoms and increase company productivity. It may also suggest that companies should carefully consider and revise their incentive structure, to avoid placing the musculoskeletal health of employees at greater risk, as they strive to reach the employer-determined productivity targets. They should also avoid disadvantaging employees with existing MSD injuries/symptoms, who would be consistently

taking home a lower pay than their (healthier or stronger) counterparts. In the light of this study's findings, it can be concluded that further attention should be paid both to the routine collection of reliable and relevant employee data, and to strategies aimed at mitigating the risk factors associated with MSD injuries/symptoms in a heavy lifting workplace.

Information regarding the weight of the lifting loads and frequency of the lifts would be useful in determining the extent to which working in the heavy department may lead to increased MSD injuries/symptoms, and the maximum weights and lifts that should be allowed. The data necessary to draw these conclusions was unfortunately not available for this study and suggests that employers should make greater efforts to routinely collect this type of workplace-related data, so that future enquiry can attempt to shed further light on these dynamics.

6.2. Recommendations

Given the findings of this study and the broader literature on MSD injuries/symptoms in the workplace, the following recommendations should be considered, by this particular distribution company and more broadly, to prevent and reduce MSD injuries/symptoms among employees:

- **Ongoing company-level monitoring of employee MSD-related data:**

The distribution company studied needs to continue to record and monitor MSD-related indicators among their employees. It would be good for the company to strengthen its systems to better link HR and clinic employee data, to be able to more easily retrieve this data for any individual employee and to conduct these types of analyses in the future with a larger sample of employees. They should also consider expanding the type of indicators collected to better inform their workplace policies and protocols. These could include indicators of previous MSD history among employees and data that could assist the company in determining the extent to which workplace-related incidents and factors, versus external factors, may be affecting the musculoskeletal health of their employees. Stronger data collection and analysis would allow the company to determine, for example, who is most at risk and how these risk patterns may change over time. In the case of this specific company – and more broadly – it would also be useful to analyse the data collected longitudinally to achieve a better understanding of trends and possible causal relationships. For example, this could help determine whether the frequency and duration of MSD injuries/symptoms are increasing among population groups with certain characteristics in these industries (e.g. younger employees, female employees) and, if so, why, as well as assess the effects of higher

productivity and incentive structures on MSD rates over time and vice versa. This would be important for the company to determine in order to better manage and protect the health of its staff.

- **Strengthening workplace health management strategies:**

It would be important for companies to develop informed employee management strategies that seek to prevent and minimize employee health risks, particularly for physically demanding tasks. The researched distribution company, for example, needs to determine optimal time periods for participants to work in a heavy lifting department. Descriptive data presented from the distribution centre's HR department suggested that participants in the heavy department were more likely to develop MSD injuries/symptoms and subsequently be moved to the non-heavy department. However, if threshold time periods and some restriction on repetitive working conditions could be determined before MSD injuries/symptoms occur or worsen, the rate of MSD injuries/symptoms would likely decrease. It is important that these continuous and repetitive working conditions are rotated on a regular basis for each employee so that their risk of developing MSDs is reduced. Similarly, as previously mentioned, it is recommended that the frequency of lifting heavy items and the amount of bending, twisting and flexing be measured to determine when it would be appropriate to move pickers to other departments to prevent the development of MSDs.

Moreover, a review of the productivity incentive structure within the distribution company would be advisable. This research found that employees who were more likely to report the occurrence of MSD injuries/symptoms were also more likely to be employees performing below the productivity threshold. This indicates that there may need to be reform the incentive structures. Employees that have reported the occurrence of MSD injuries/symptoms should not be penalised for not meeting the productivity threshold or risk worsening their musculoskeletal health trying to reach these. A separate measuring system could possibly be developed to measure these employees, taking into account the occurrence of MSD injuries/symptoms and the impact that it has on their ability to perform the required job function. Re-evaluating the incentive structures could also lower the occurrence of MSD injuries/symptoms, considering the risks employees may be incurring by attempting to reach these. Employees may also be more willing to disclose their MSD injury/symptom without the fear of missing the incentives provided.

It would also be important to highlight the change that the distribution company is making in the contracts that are issued to their employees. They have been phasing out permanent contracts and moving employees on to the flexi-timer contracts. Although not confirmed, it is assumed that this is being done because of the busy and quiet seasons within the retail business. During quiet seasons fewer pickers are needed and in the busy season all pickers are needed, hence the use of flexi-timer contracts. If this is the case, there could be an under-lying risk factor around job security among the flexi-timer employees. This could result in them performing harder to reach the incentives offered in order to keep their job. This in turn can increase the risk of the development of MSDs amongst employees with that contract type. Despite no significant relations being observed in this study, it could be a potential risk factor for developing MSDs **Developing workplace programs that improve employee knowledge on health risks linked to MSD.**

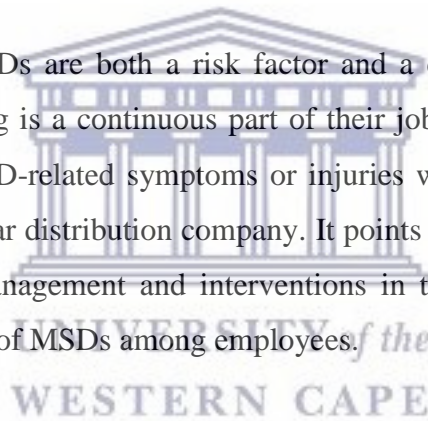
Effective intervention strategies should be implemented to educate and empower individuals in physically demanding jobs about the potential health risks of their tasks, how best to perform their jobs to ease the strain on their body's skeletal structure, and which indicators to watch out for in order to identify MSDs before they worsen or become chronic. For example, in the researched company effective ergonomic education programs should be introduced to highlight the importance of how best to lift, bend and twist heavy items and what knowledge pickers need to have to reduce their risk of developing MSDs. Pickers need to be made aware of the risk that their job involves and how MSDs can develop from being in one position for too long. They need to understand the effect that MSDs can have on their health and how best to prevent them, as well as understand what treatments can be used to treat MSDs. With such an intervention, pickers would be able to have greater control of their own health behaviour while working at the distribution company. It should be noted that the distribution company included in this research has started to develop a basic intervention that orientates perspective pickers to the job of picking and educates them around the different policies and procedures involved in picking. However, this intervention is still in its early stages. Also, effective ergonomic procedures, that aim to educate the picker, only represented a small portion of the introductory program, and only a small sample of pickers in the distribution company had been exposed to the

intervention. As a result, it was not possible to test the effectiveness of the intervention program within the scope of this study.

- **Improving workplace knowledge on the company's health policies and facilities:**

This specific distribution company, and companies more generally, should ensure that employees have a good understanding of their company's policies regarding health and employee wellbeing. For this particular distribution company, this should include ensuring that employees are well educated on the role of onsite clinics and other health facilities, the type of primary health care services offered, and the confidentiality around disclosing health related illnesses. This could be achieved through a number of channels such as: workplace health initiatives to increase the clinic's profile in the company; regular health talks on subjects applicable to the workplace; and media items such as posters, mobile phone messages and surveys about the functionality of the on-site clinic.

There is little doubt that MSDs are both a risk factor and a challenge for employees in a workplace where heavy lifting is a continuous part of their job. This research indicates that participants experiencing MSD-related symptoms or injuries were underperforming in their role as pickers in this particular distribution company. It points to the need for more effective data collection, employee management and interventions in the workplace, to prevent the development and progression of MSDs among employees.



APPENDIX 1 – Ethics approval form



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31 July 2017

Mr T Hilliar
School of Public Health
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Ethics Reference Number: BM16/5/35

Project Title: Promoting musculoskeletal health in the workplace: A descriptive study among employees exposed to heavy lifting.

Approval Period: 28 July 2017 – 28 July 2018

I hereby certify that the Biomedical Science Research Ethics Committee of the University of the Western Cape approved the scientific methodology and ethics of the above mentioned research project.

Any amendments, extension or other modifications to the protocol must be submitted to the Ethics Committee for approval.

Please remember to submit a progress report in good time for annual renewal.

The Committee must be informed of any serious adverse event and/or termination of the study.

Ms Patricia Josias
Research Ethics Committee Officer
University of the Western Cape
PROVISIONAL REC NUMBER -130416-050

REFERENCES

- Anderson, G. (1999). Epidemiological features of chronic low-back pain. *The Lancet*, 354(9178), 581-585.
- Bergquist – Ullman, M. and Larsson, U. (2014). Acute low back pain in industry: A controlled perspective study with special reference to therapy and confounding factors. *Acta orthopaedica Scandinava*. 48(170) .1-117.
- Brandt, M., Madeleine, P., Ajslev, J., Jakobsen, M., Samani, A., Sundstrup, E., Kines, P. and Andersen, L. (2015). Participatory intervention with objectively measured physical risk factors for musculoskeletal disorders in the construction industry study protocol for a cluster randomized controlled trial. *BMC Musculoskeletal Disorder* 16(302).1-9.
- Bureau of Labor Statistics. (2016). Employment tenure summary. Economic news release. *US Department of Labor*. USDL16-1867.
- Choobineh, A., Hamidreza-Tabatabae, S., Mokhtorzabeh, A. and Salehi, M. (2007). Musculoskeletal problems among factory workers of an Iranian rubber factory. *Journal of Occupational Health*. 49.418-423.
- CIPD. (2007). *What's happening with wellbeing at work*. Retrieved from CIPD Change agenda website <http://www.cipd.co.uk/NR/rdonlyres/DCCE94D7-781A-485A-A702-6DAAB5EA7B27/0/whthapwbwrk.pdf>.
- Egwuonwu, A., Mbaoma, C. and Addullahi, A. (2016). Prevalence and Associated Risk Factors of work-related musculoskeletal disorders among road construction workers in a Nigerian community. *Journal of the Ergonomics Society of South Africa*. 28(1).25-31.
- Urwin, M., Symmons, D., Allison, T., Brammah, T., Busby, N., Roxby, M., Simmons, A. and Williams, G. (1998). Estimating the burden of musculoskeletal disorders in the community: the comparative prevalence of symptoms at different anatomical sites, and the relation to social deprivation. *Annals of the rheumatic diseases*. 57(11).649-655.
- Gala, S., Ibrahim, M., El-Sayed Hommour, Z. and el-Belbasy, R. (2003). Musculoskeletal disorders in male and female patients and related factors. *British Journal of Medicine and Medical Research*. 8(9).748-757.
- Gcelu, A. and Kalla, A. (2015). Musculoskeletal disorders – disease burden and challenges in the developing world. *The South African Medical Journal*, 105(2), 1070-1071.

- Global Burden of Disease. (2015). *Lancet*. 388.1545-1602.
- Gunderson, M. and Hyatt, D. (2000). *Workers Compensation: Foundations to reform*. University of Toronto Press.
- Harter, T. (2001). Minimizing absenteeism in the workplace: Strategies for nurse managers. *Nursing Economics*, 19(2).53-55.
- Hisang, S., Brogmus, G. and Courtney, T. (1995). Lower Back Pain and Lifting technique – A review. *International Journal of Industrial Ergonomics*, 19.59-74.
- Holtermann, A., Jørgensen, M., Gram, B., Christensen, J., Faber, A., Overgaard, K., Ektor-Andersen, J., Mortensen, O., Sjøgaard, G. and Sjøgaard, K. (2010). Worksite interventions for preventing physical deterioration among employees in job-groups with high physical work demands: Background, design and conceptual model of finale. *BMC Public Health*, 10(120).
- London School of Hygiene and Tropical Medicine. (2009). *The use of epidemiological tools in conflict affected populations: open access educational resources for policy makers*. Retrieved from London School of Hygiene and Tropical Medicine website http://conflict.lshtm.ac.uk/page_37.htm.
- Louw, Q., Morris, L. and Grimmer-Somers, K. (2007). The prevalence of lower back pain in Africa: A systematic review. *BMC Musculoskeletal disorders*, 8(105).
- Meerding, W., Ijzelenberg, W., Koopmanschap, M., Severens, J. and Burdorf, A. (2005). Health problems lead to considerable productivity loss at work among workers with high physical load jobs. *Journal of Clinical Epidemiology*. 58(5).517-523.
- Meo, S., Alsaaran, Z., Alshehri, M., Khashougji, M., Almeterk, A., Almutairi, S. and Alsaeed, S. (2013). Work-related musculoskeletal symptoms among building construction workers in Riyadh Saudi Arabia. *Pakistan Journal of Medical Science*. 29(6).1394-1399.
- Middlesworth, M. (2016). *The cost of musculoskeletal disorders: Infographic*. Retrieved from Ergonomic plus website <http://ergo-plus.com/cost-of-musculoskeletal-disorders-infographic/>.
- Morken, T., Riise, T., Moen, B., Bergum, O., Vigeland Hauge, S., Holien, S., Langedrag, A., Olson, H., Pedersen, S., Liahjell Saue, I., Midttun Seljebø, G. and Thoppil, V. (2002). Frequent musculoskeletal disorder symptoms and reduced health-related quality of life amongst industrial workers. *Occupational Medicine*. 52(2). 91-98.

- Naidoo, S. (2011). Musculoskeletal pain amongst women working in a small-scale agriculture in South Africa. *Women's occupational health*. 4. 71-91.
- Picavet, H. and Hazes, J. (2003). Prevalence of self-reported musculoskeletal diseases are high. *Annals of the rheumatic diseases*. 62(7). 644-50.
- Punnett, L. and Wegman, D. (2004). Work-related musculoskeletal disorders: the epidemiologic evidence and the debate. *Journal of Electromyography and Kinesiology*. 14. 13-23.
- Vern Putz-Anderson, V., Bernard, B., Burt, S., Cole, LL., Fairfield-Estill, C., Fine, LJ., Grant, KA., Gjessing, C., Jenkins, L., Hurrell Jr, JJ., Nelson, N., Pfirman, D., Roberts, R., Stetson, Haring-Sweeney, D. and Tanaka, S. (1997). Musculoskeletal Disorders and Workplace Factors: A Critical Review of Epidemiologic Evidence for Work-Related Musculoskeletal Disorders of the Neck, Upper Extremity, and Low Back. *US Department of Health and Services*. National Institute for Occupational Safety and Health.
- Reddy, E. and Yasobant, S. (2015). Musculoskeletal disorders among municipal solid waste workers in India: A cross-sectional risk assessment. *Journal of Family Medicine and Primary Care*. 4. 519-524.
- Song, J., Lee, C., Lee, W., Bahn, S., Jung, C. and Yun, M. (2016). Development of a job rotation scheduling algorithm for minimizing accumulated work load per body parts. *Journal of work*, 53(3).511-521.
- Stats SA. (2016). *Quarterly labour force survey*. Retrieved from Statistical release P0211 website <http://www.statssa.gov.za/publications/P0211/P02111stQuarter2016.pdf>.
- Stewart, W., Ricci, J., Chee, E., Morganstein, D. and Lipton, R. (2003). Lost productive time and costs due to common pain conditions in the US workforce. *American Medical Association*. 290(18). 2443-2454.
- The Standard. (2012). *Health-Related Lost Productivity: The Full Cost Of Absence*. Retrieved from Productivity Insights #2 website https://www.ibiweb.org/?ACT=65&id=STShIBhgCqjvdLIU8zHkGWN0EkKIW_cyfWbH6qnLSI0Nj4uqNmzz5b2kIv6VYrl3clqB3wUm9qmo6sTN6w.
- Van Eerd, D., Munhall, C., Irvin, E., Rempel, D., Brewer, S., Van der Beek, A., Dennerlein, J., Tullar, J., Skivington, K., Pinion, C. and Amick, B. (2015). *Effectiveness of workplace*

interventions in the prevention of upper extremity musculoskeletal disorders and symptoms: an update of the evidence. Retrieved from the BMJ Occupational environmental medicine journal website <http://oem.bmj.com/content/73/1/62>.

Van Vuuren, B., Becker, P. and Van Heerden, N/ (2005). Lower back problems and occupational risk factors in a South African steel industry. *American Journal of industrial medicine.* 47(5). 451-457.

WHO, 2017. *Health topics. Disabilities.* Retrieved from the WHO website <http://www.who.int/topics/disabilities/en/>

Zungu, L and Ndaba, E. (2009). Self-reported musculoskeletal disorders among office workers in a private hospital in South Africa. *University of South Africa, Department of Health Studies.*

