The epidemiology of low back pain in construction workers in the eThekwini Municipality of KwaZulu-Natal

By Verushan Moodley

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I, Verushan Moodley, declare that this dissertation is representative of my own work in both conception and execution (except where acknowledgments indicate to the contrary).

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Verushan Moodley Date

Approved for Final Submission

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Supervisor: Professor Julian David Pillay Date

Research Chair and Full Professor: Global Health

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ABSTRACT

Background

Low back pain (LBP) is a significant musculoskeletal disorder and a major occupational health concern globally. In developing countries, occupational LBP remains a major public health crisis, with high levels of LBP reported, resulting in high levels of absenteeism, disability, and a loss of productivity. Construction workers are involved in one of the most physically demanding occupations, making them exceedingly susceptible to LBP. They are also exposed to a variety of demographic, lifestyle, and occupational risk factors that may further predispose them to LBP. In South Africa, research on LBP amongst construction workers is currently lacking. The aim of this study was, therefore, to determine the epidemiology of LBP in construction workers in the eThekwini Municipality of KwaZulu-Natal.

Methodology

This study adopted a cross-sectional survey design. Participants were recruited from the two largest construction companies in the eThekwini Municipality. A sample size of 256 construction workers was used and questionnaires were provided to the participants at their respective companies. The questionnaire was divided into four sections, namely demographic factors, lifestyle factors, occupational factors, and LBP history. IBM SPSS version 28 was used to analyse the data. Descriptive statistics, such as mean, standard deviation and range, were used to summarise continuous data. Frequency counts and percentages were used to summarise categorical data. Risk factors for LBP were assessed for those who reported LBP. Pearson's chi-square tests or Fisher's exact tests were deemed as appropriate and were used to assess categorical factors, while t-tests were used to assess mean differences for continuous variables. A p-value of <0.05 was used to indicate statistical significance.

Results

A total of 256 construction workers in the eThekwini Municipality were investigated in this study. The mean age of the male participants was 34.2 ± 9.2 years, while the female participants were 37.5 ± 8.1 years. The mean BMI of the men was calculated as 24.1 ± 3.9 kg/m^2 and for the women it was 32.0 ± 10.1 kg/m^2. The females had a mean weight of 78.7 ± 18.7kg and the men had a mean weight of 69.8 ± 9.9 kg. The males had a mean height of 1.7 ± 0.1kg and the females had a mean weight of 1.6 ± 0.1 kg. The point and period prevalences were 16.8% (*n*=43) and 26.2% (*n*=67) respectively. The study reported that 54.3% of the participants experienced LBP on both sides of the lumbar spine, 43.2% experienced it daily, and 48.1% had mild pain. Factors such as height (*p*=0.507), weight (*p*=0.657), and BMI (*p*=0.657) were not significantly associated with LBP. It was noted that age (*n*=81; *p*=0.124) was marginally non-significantly higher in those with LBP. No association between LBP and sex was noted (*p*=0.517) and LBP was equally likely in men and women (31% in men and 37.5% in women). A longer duration of smoking (*p*=0.015), a higher number of cigarettes smoked per day (*p*=0.047), the presence of work-related stress (*p*=<0.001), personal stress, or both, were significantly associated with LBP. The general workers (43.2%; *n*=16), followed by the erectors (33.3%; *n*=6), were most likely to have LBP. The most frequently used treatment was getting advice from a general practitioner, 56.7% (*n*=17), followed by self-medication, 30% (*n*=9).

Conclusion

LBP continues to be a major health burden on construction workers, impacting their daily activities and causing disability. The prevalence of LBP reported in the study was similar to some of the previous studies, whilst it varied from others. Notwithstanding this, LBP in construction workers is a concern requiring urgent attention. A joint intervention strategy between health professionals and the construction industry is required. This will reduce absenteeism, stress, decreased productivity, and activity limitations.

Key words: Construction workers, epidemiology, low back pain, musculoskeletal disorders, risk factors.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

Abbreviations

The following abbreviations appear in this study:

BMI: Body Mass Index

CLBP: Chronic low back pain

DALYs: Disability adjusted life years

DUT: Durban University of Technology

GBD: Global burden of disease

IREC: Institutional Research Ethics Committee

IVD: Intervertebral disk

IVF: Intervertebral foramen

Kg: Kilogram

Kg/m^2: Kilogram per square metre

KZN: Kwa-Zulu Natal

L: Lumbar

LBP: Low back pain

M: Metre

N: Number

P: Probability

S: Sacral

Std: Standard

USA: United States of America

CHAPTER ONE

INTRODUCTION

This chapter provides a background of low back pain (LBP) in construction workers. It outlines the aim and objectives of the study and provides the study's rationale. Moreover, it outlines the flow of the dissertation, describing each chapter throughout the dissertation.

1.1 BACKGROUND OF THE STUDY

The burden of LBP is a major public health crisis, globally, with a lifetime prevalence of approximately 70%–80% (Chen *et al.* 2022). Furthermore, it is currently the main cause of work absenteeism and disability, associated with an immense socio-economic burden and supply chain reduction (Kahere, Hlongwa, and Ginindza 2022). The study on the global LBP prevalence and years lived with disability from 1990 to 2017 by Wu *et al.* (2020) reported the global number of years lived with disability due to LBP to be 42.5 million in 1990. This increased by 52.7% to 64.9 million in 2017. One of the largest increases was observed in low to middle-income countries, such as those in Africa (Hartvigsen *et al.* 2018).

The health of Africans is a problem, as advances in health outcomes that have been experienced in developed countries have not been achieved in Africa (Wu *et al.* 2020). Africa makes up approximately 18.2% of the world's population and accounts for over 20% of the global burden of disease (GBD) (Niohuru 2023). Musculoskeletal disorders are prevalent in about 3.4% and 1.7% of the total GBD in low-and-middle-income-countries (Kahere and Ginindza 2022). The prevalence of LBP in Africa after one year continues to be high at a prevalence of 57% (Morris *et al.* 2018). Notwithstanding this, LBP remains understudied in literature and less prioritised in Africa, because most research funding and health interventions have been aimed at communicable diseases, such as HIV/AIDS, TB, and Covid-19. To add to the burden of these communicable diseases, medical and social systems, particularly in South Africa, are strained and not enough resources are available to manage the increasing burden of LBP, which is expected to rise under these circumstances (Kahere, Hlongwa and Ginindza 2022).

Lower back pain is defined as muscle tension, pain, and stiffness located between the lower border of the 12th ribs and the inferior gluteal folds (Mattiuzzi, Lippi and Bovo 2020). The pain can range from a dull ache to a sharp shooting sensation. This pain may be associated with or without pain referred to one or both lower limbs, that lasts for at least one day (Nicol *et al.* 2020). It is classified as acute when lasting for less than six weeks, subacute when lasting between six weeks and three months, and chronic when it is over three months (Hüllemann *et al.* 2018).

The pain may be specific or non-specific in nature, but most cases are non-specific. Non-specific LBP occurs when there is no underlying pathology and specific LBP occurs when there is an underlying pathology, such as trauma, infection, bone disease, or a tumour (Urits *et al.* 2019). A small amount of cases (10%) has a specific underlying cause. Most cases (90%) are non-specific, meaning their cause is idiopathic, and the diagnosis is determined by ruling out a specific pathology (Maher, Underwood and Buchbinder 2017). LBP that is non-specific and generally subsides within a couple of weeks with hardly any intervention, although there may be periods of recurring pain needing medical management (Urits *et al.* 2019).

The effects of LBP remain a major occupational health problem that adversely affects the well-being of a variety of construction workers (Inoue *et al.* 2019). It vastly affects the industrial workforce by reducing worker productivity, quality of life, and social responsibilities, and increasing absenteeism (Russo *et al.* 2021). LBP among blue-collar workers such as construction workers in developing countries currently lacks research (Lette *et al.* 2019).

The construction industry is one of the most hazardous workplace industries, with high rates of fatalities, injuries, and musculoskeletal disorders which increase occupational disability and absenteeism among construction workers (Gopalakrishnan and Kumar 2020). A reported 1,066 serious occupational injuries occurred among construction workers in the United States of America (USA). In addition, there were 81,000 cases of poor occupational health in the United Kingdom (UK), with 57% being associated with musculoskeletal conditions (Fajarudin, Erwandi and Kadir 2021).

Construction workers are manual labourers who engage in the building of structures, and they are subjected to highly physically demanding tasks, such as maintaining difficult postures for long periods, frequent bending, or twisting of trunks, repetitive motions, and lifting of heavy materials (Anagha 2020). As a result, construction workers are at risk of developing LBP. Unfortunately, construction workers who suffer from LBP are documented to not report this, for a number of personal and professional reasons, including fear of losing hours or being labelled unfit to work; given that most of them are sole providers in their households (Crawford *et al.* 2020). The 'non-reported' pain has significant effects on the worker's productivity and well-being, which may lead to increased safety-related risks but, most importantly, this decreases the amount of knowledge available to help find ways to resolve that situation (Russo *et al.* 2021).

Over the last few decades, the largest increase in disability has been observed in Africa (Kahere and Ginindza 2021). This should be of great concern, especially in South Africa, as this will result in restrictions on construction workers' usual activities and will influence the country reaching optimal economic growth (Fatoye *et al.* 2023). This has significant impacts on the South African economy, as the construction industry plays a vital role in it (Adeniran and Shakantu 2022). Construction workers in South Africa are of a lower socio-economic standard than those in developed countries. It was postulated, therefore, that the burden of LBP would be higher in low- and middle-income countries, like those in South Africa (Morris *et al.* 2018).

A study conducted by Himalowa and Frantz (2012) with a Cape Town-based construction company reported LBP occurred 25% more than in developed countries. The high rate of LBP reported in this company indicates the need for further studies to determine the magnitude of the problem in the country and feasible ways to lessen its effects. Understanding the epidemiology of LBP in construction workers can help health professionals such as chiropractors, with more effective approaches in the prevention, treatment and management of these individuals.

In addition, other stakeholders, such as the employers, would be able to make necessary changes within the work environment or incorporate employee assistant schemes to limit exposure to risk factors identified as possible contributors to LBP (Russo *et al.* 2021). If implemented, this will decrease the cost to the employer and relieve the growing burden of LBP. This study focuses on the epidemiology of LBP pain in construction workers in the eThekwini Municipality (a municipality in South Africa) which is currently unknown, thus emphasising the need for this study, to add to the knowledge gap and further provide vital-novel information for policy strengthening in the South African context.

1.2 AIMS AND OBJECTIVES OF THE STUDY:

The aim of this study was to determine the epidemiology of LBP in construction workers in the eThekwini Municipality of KwaZulu-Natal (KZN).

1.2.1 Objectives

- To determine the prevalence (point and period) of LBP in construction workers in the eThekwini Municipality.
- To determine the risk factors (occupational, demographic and lifestyle) of LBP in construction workers in the eThekwini Municipality.
- To determine the association, if any, between LBP and risk factors.

1.2.2 Rationale

The purpose of this study was to determine the epidemiology of LBP in construction workers in the eThekwini Municipality, using a questionnaire to collect the data. Knowledge of the epidemiology of LBP is important for decision-making in the public/private health sector of South Africa. For there to be proper implementation of policies, it is essential for decision-makers to know the magnitude of the condition in a population and the associated risk factors. According to the research currently available, there have been no local studies on the epidemiology of LBP in construction workers. The results of this study will, therefore, add to that knowledge gap and will provide important information for research prioritisation and planning in healthcare.

1.3 SUMMARY

Chapter One

Chapter One introduced the background and the rationale of LBP in construction workers. The chapter provided a broad overview of LBP in construction workers, as well as the premise of it. The aim and objectives of the study were also outlined in this chapter.

Chapter Two

This chapter reviews the literature currently available on the epidemiology of LBP in construction workers and provides in-depth analyses of the pertinent information associated with it.

Chapter Three

This chapter provides comprehensive detail on how the aims of the epidemiology of LBP in construction workers in the eThekwini Municipality have been accomplished via the study design, methodology applied, and research instruments used.

Chapter Four

This chapter presents the results of the epidemiology of LBP in construction workers in the eThekwini Municipality study. These results are presented in tables and figures which are followed by brief interpretations of the data.

Chapter Five

This chapter discusses the results of the epidemiology of LBP in construction workers in the eThekwini Municipality in relation to the current literature presented in the literature review, as well discussing the results in relation to the aim and objectives of the study.

Chapter Six

This chapter outlines the conclusions and limitations of the epidemiology of LBP in construction workers in the eThekwini Municipality. Additionally, it provides recommendations for future studies.

CHAPTER TWO

LITERATURE REVIEW

2.1 INTRODUCTION

The World Health Organisation define epidemiology as "the study of the distribution and determinants of health-related states or events and the application of this study to control disease and health problems" (Frérot *et al.* 2018). The epidemiology of LBP will be discussed below, as per the current literature. LBP is a major burden on individuals, healthcare systems, economies, and societies (Wu *et al.* 2020). In addition, it significantly affects people's quality of life and functional status, given that it is the leading cause of disability worldwide; higher than major depression, diabetes, and heart disease (Alonso-García and Sarría-Santamera 2020).

The global burden of disease study by Nieminen, Pyysalo and Kankaanpää (2021) reported that between 1990 and 2015, LBP resulted in 60.1 million years lived with disability. This was a 54% increase since 1990. A study among farmers in rural Nigeria, reported that over half of them had to reduce their tasks because of LBP (Buchbinder *et al.* 2020). Another study with residents in Zimbabwe, observed that LBP was among the top five reasons for restrictions on their activities. This is concerning for developing countries, as disabling LBP could perpetuate the cycle of poverty (Hartvigsen *et al.* 2018). The most common cause of sick leave and premature retirement in Europe, is LBP. In addition, it causes the greatest number of absenteeism cases, more than any other musculoskeletal condition (Buchbinder *et al.* 2020). Approximately 4% of construction workers are absent due to LBP, equating to about 90 million working days lost in the United Kingdom (Froud *et al.* 2015).

Globally, LBP has an immense effect socially and economically. This will increase substantially in developing countries as participation in work is affected. As a result, the workforce may be reduced, causing pressure on families and communities (Hartvigsen *et al.* 2018). The study of villagers in Botswana, by Hondras *et al.* (2016) reported that LBP results in economic consequences, loss of independence, and social identification. This is because villagers are unable to continue with traditional and social duties in a society with rough living conditions. LBP is associated with high healthcare utilisation and treatment costs. LBP is the sixth most common disorder seen by healthcare providers in South Africa (Hartvigsen *et al.* 2018). The expenditure on health care for LBP and neck pain in the (USA) was $134.5 billion (Dieleman *et al.* 2020). The costs associated with LBP in developing countries are unknown. The costs associated with LBP are probably going to be immense, given that the overall prevalence of chronic low back pain (CLBP) in developing countries is approximately 52% (Fatoye, Gebrye and Odeyemi 2019).

2.2 GLOBAL BURDEN OF LBP

Low back pain is one of the most common musculoskeletal disorders found globally. It is the main cause of activity restriction and absenteeism from work. In addition, it has an immense economic impact on individuals, societies, governments, and industries (Fatoye *et al.* 2023).

The systematic review by Chen *et al.* (2022) of the global burden of LBP highlights that there were 568.4 million people affected with LBP, having an age-standardised point prevalence of 6972.5. The prevalence increased with age and reached the highest between 80–84 years old. The USA (12 706), Denmark (11 082.3), and Switzerland (10 621.2) had the highest age-standardised rates of prevalence.

According to the study by Ferreira *et al.* (2023) on the global burden of LBP, it was reported that 619 million people suffer from LBP, and the age-standardised rate of prevalence was 7460. That study investigated data from the 2020 GBD study, whereas the study by Chen *et al.* (2022) investigated data from the 2019 GBD study. It showed that the number of prevalent cases in southern Sub-Saharan Africa was higher at 4 520 000, than in the study by Chen *et al.* (2022) at 3 974 668. The prevalence increased with age and the rate peaked at 85 years.

The countries with the biggest age-standardised rates of prevalence were Hungary (14 000) and Czechia (13 100). The age-standardised rate of prevalence was greater in women (9330) as opposed to men (5520). The risk of LBP due to smoking was highest among middle-aged men and lowest among women in the 15–49 year age group. The risk of LBP due to a high body mass index (BMI) was highest among women aged 50–69 years, and lowest among younger men aged 15-49 years old.

A systematic review of the global prevalence of LBP by Hoy *et al.* (2012) reports the lifetime, one-month, and annual prevalence to be 38.9%, 30.8%, and 38%, respectively, and that prevalence increases with age. The study focused on adults only and included 54 countries, which is far less than the study by Chen *et al.* (2022) and Ferreira *et al.* (2023), which included 204 countries. The definition of LBP also varied in the studies that were included, and this would have affected prevalence percentages. The studies by Chen *et al.* (2022), Mattiuzzi, Lippi and Bovo (2020), and Ferreira *et al.* (2023) include the same definition of LBP.

A study on the current epidemiology of LBP by Mattiuzzi, Lippi and Bovo (2020) reported that 577 million cases were prevalent, globally. This study analysed data from a large worldwide database of health-related data, which included data from 195 countries. The prevalence of LBP in women was 8.57% whilst in men it was 7.09%. According to a systematic review, the real-world prevalence of LBP was reported to range between 1.4%-15.6%. It was found in these two studies the prevalence was lower in men as opposed to women. The researchers of these studies used varying definitions of LBP; this would have affected the reporting of LBP.

The highest prevalence rates of LBP were seen in construction workers in the American aerospace and defence industry, whilst Canadian residents had the lowest prevalence rates. This suggests that working in industry could be one of the major risk factors for LBP (Fatoye, Gebrye and Odeyemi 2019). This study excluded paediatric participants, whereas the studies by Chen *et al.* (2022), Ferreira *et al.* (2023), Mattiuzzi, Lippi and Bovo (2020), and Hoy *et al.* (2012) did not. In addition, that study only included studies from developed countries, such as Belgium, Canada, Finland, the Netherlands, Sweden, USA and Israel. None of the studies were from developing countries, such as South Africa, which might explain the low prevalence. It was noted by Chen *et al*. (2022) that developing countries are one of the significant contributing factors to the burden of LBP, globally.

2.3 BURDEN OF LBP IN AFRICA

Low back pain remains a major public health problem among countries in Africa. Notwithstanding this, LBP remains less prioritised in contrast to other communicable diseases, such as HIV/AIDS and TB. In addition, the public healthcare sector in

Africa does not have the resources to deal with the treatment of LBP, which may justify the high prevalence of LBP in Africa. The burden of LBP among African countries remains understudied in literature (Kahere, Hlongwa and Ginindza 2022).

According to a study on the prevalence of LBP in Africa by Morris *et al.* (2018), prevalence was reported to be 47% (lifetime), 57% (annual), and 39% (point). The annual, lifetime, and point prevalence of LBP was higher among adults, in contrast to children/adolescents. These results show that the prevalence of LBP among Africans increases with age. In addition, there was a variation in point and annual prevalence of LBP of 20% between sexes, with men having a higher prevalence. This study has a contrasting sex pattern to global observations, which show that women experience a higher prevalence. This study was conducted on adults and children/adolescents, with most of the studies conducted in Nigeria (31.47%) and South Africa (16.25%). These are affluent African countries and factors such as urbanisation and economic progression may have influenced trends of LBP occurrence and reporting. Most of the studies used in this review did not define LBP. According to Dionne *et al.* (2008) epidemiological studies should include the definition used in determining the prevalence of LBP. Half of the studies in industry included only men, while construction workers included in the professional subgroup, consisted of a higher number of women. As industrial occupations comprise more physical labour, an over-representation of men could have occurred.

A cross-sectional study on LBP based at an orthopaedic clinic in Nigeria, reported a point prevalence of 10%, with pain radiating into the lower extremities in 57.1% of the patients. The most common risk factor for LBP was lifting heavy objects, which was seen in 13.8% of patients. The low prevalence reported might be because most of the patients in this study were referred from primary and secondary levels of care, where they may have received treatment. A large sample size of 2914 patients was used, and paediatric patients were included (Omoke and Amaraegbulam 2016).

The systematic review of LBP in Africa, which comprised 27 studies by Louw, Morris and Grimmer-Somers (2007) reported a point prevalence that varied between 10% to 14% in adolescents and 16% to 59% in adults. A study highlighted that smoking was significantly associated with LBP. The health care professionals most commonly engaged were general practitioners and physiotherapists, whilst the most common management strategies applied, related to analgesics and rest. It was noted that a “history of LBP” as reported in numerous (many) Western societies as the cause of LBP, could be a significant predictor of LBP among Africans. The population comprised mainly of construction workers (48%) and scholars (15%). Most of the studies (67%) were conducted in urban populations and 10 studies (37%) defined LBP. The high prevalence reported might have been because there is insufficient legislation in Africa to assist construction workers with LBP. The questionnaire used to collect data lacked detail, reliability, and validity. For example, if a questionnaire is not culturally suited to an African population, it would mean that unsuitable or incomplete questions would be asked about potential risk factors. The overall prevalence of CLBP in Western Africa was 35.49%, with rural areas having a much higher prevalence rate (40.17%) than urban areas (30.68%). The prevalence of regular physical activity associated with CLBP was 43.63%, whilst the prevalence of obesity associated with CLBP was 43.27%. A total of 4320 participants were engaged and paediatric participants were excluded. Working in the agricultural sector is the most common occupation in rural areas, with many of the farmers using informal farming methods, which will contribute to their LBP (Kossi *et al.* 2022).

A study at a health clinic in KZN, by Khumalo and Haffejee (2022), reported a lifetime prevalence of 79.3% and a point prevalence of 32.5% in LBP. Low back pain was more prevalent with a higher BMI and age. This study was done at a hospital, which meant that these participants had a medical condition that may have increased the prevalence and risk factors of LBP.

According to a study conducted in Cameroon, by Doualla *et al.* (2019), a prevalence of 41% in non-specific CLBP was reported, with more than 80% of the patients suffering from significant disability. On average, patients reported six days leave of absence from work. A sample size of 136 patients was used and CLBP was investigated. In a study of LBP amongst schoolchildren in Cameroon, by Kemta Lekpa *et al*. (2021) there was a period prevalence of 12.3% in CLBP. The main pain-relieving factors were physiotherapy (39.4%), supine position (27.3%), and painkillers (18.2%). The sample size included 1137 children. Most of them visited a physiotherapist instead of a doctor, due to the pain being mild to moderate. Since the children were interviewed without their parents present, they were not influenced by their parents helping them answer the questions.

A study in Ghana among the elderly population by Nakua *et al.* (2015), reported a prevalence of 28.2% in CLBP. Participants who were aged 50 years and older were included, and the sample size comprised 1925 residents from rural areas, and 2799 residents from urban areas. A high prevalence of CLBP was found among women from urban and rural areas. It was noted that older women are prone to medical conditions such as stress and increased blood pressure, all of which contribute to LBP. In addition, most older women may carry their grandchildren and engage in strenuous work at the same time, which causes CLBP. A study done at a health facility based in South Africa by Helsloot *et al.* (2015) reported a lifetime prevalence of 73.2% in LBP. This study also reported that 90% of patients used pain medication, whilst only 15% used physiotherapy.

According to a study among adults in KZN by Kahere and Ginindza (2021), there was an overall prevalence of 18.1% in CLBP. The prevalence was highest among heavy smokers at 54%. It has been found that smoking decreases bone density, which increases the risk of osteoporosis and fractures. In addition, smoking causes coughing, which will increase intradiscal pressures resulting in disc herniation. The study was conducted in one region of South Africa; and thus the findings cannot be generalised. Moreover, a study was conducted in a hospital setting and focussed on people visiting the hospital for medical care. Findings from this study will, therefore, not reflect the whole population.

In a study by Wang *et al.* (2018) the prevalence of chronic back pain among older Populations in South Africa and Uganda was 27,4% and 64.7%, respectively. The prevalence of mild/moderate and severe generalised pain was 34.5% and 15.7% respectively. The reference to back pain in this study and throughout the dissertation means that LBP was one of the types of back pain that were investigated.

A cross-sectional hospital-based study in patients with CLBP in KZN by Kahere and Ginindza (2022) reported a prevalence of 22.2%. The prevalence of CLBP with mild pain was 54.7% and with sciatica it was 19.1%. The study only investigated CLBP, with a sample size of 554 participants and was conducted with hospital patients who were accessing services for specific medical conditions, which could have inflated findings.

A study on LBP among adult patients at a Nigerian hospital by Ogunbode, Adebusoye and Alonge (2013) reported a point prevalence of 46.8%. The prevalence of LBP increased with age in 44.9% of the adults who were younger than 30 years and up to 55.6% in adults aged between 51–60 years. The prevalence of LBP was significantly higher in smokers (91.7%) than non-smokers (45.7%). The study included 485 participants and older participants experienced more constant and severe forms of LBP.

2.4 CAUSES OF LBP

2.4.1 Muscle Strain / Ligament Sprain

This is the most common cause of LBP. A strain is caused by the muscle/ tendon being abnormally stretched or torn. The symptoms experienced include muscular spasms, weakness, swelling, inflammation, and cramping (Beatty and Wyss 2017). A sprain is due to the stretching or tearing of ligaments from their attachments (Patel, Atalay and Lekshminarayanan 2023).

Sprains are classified as:

Grade 1 sprain: Slight stretching and little trauma to the ligament.

Grade 2 sprain: Slight tearing of the ligament with laxity in the joint.

Grade 3 sprain: Complete tear of the ligament resulting in severe instability.

The symptoms experienced by a sprain are pain, bruising, swelling, and inflammation (Lee and Kim 2023).

2.4.2 Disc Degeneration

Discs usually degenerate from 30 years of age (Boyer 2018). The cells in the disc produce less aggrecan and collagen, which causes a decrease in proteoglycan and water content. As a result, the nucleus pulposus gets dehydrated, disc height diminishes, and the annulus fibrosis develops fissures (Kirnaz *et al.* 2021). The disc is now more rigid and the nucleus pulpous loses its pressure protector function, making the disc prone to a prolapse, which usually occurs at the L4/L5 and L5/S1 levels of the lumbar spine (Sénégas *et al.* 2019). Disc degeneration results in altered biomechanics and increased loading on the facet joints. This will cause osteoarthritis of the joints and hypertrophy of the ligamentum flavum. Disc degeneration is caused due to diabetes mellitus, vascular disease, genetics, and smoking (Lacroix *et al.* 2022).

2.4.3 Lumbar Disk Herniation

The highest incidence of lumbar disk herniation occurs between 40-50 years of age, with men being more prone to developing it (Boyer 2018). Degenerative changes cause the annulus to bulge into the spinal canal or impinge on the nerve root (Goel, Wang, and Bicket 2019).

There are three types of herniation:

- Protrusion occurs when there is eccentric bulging through a normal annulus fibrosus.
- Extrusion occurs when parts of the disk cross the annulus fibrosus, while it is continuous within the disk space.
- Sequestration is not continuous within the disk space (Bellitti *et al.* 2021).
- Those affected might present with motor, sensory, and reflex changes. Risk factors include smoking, excessive lifting and driving (Earls and Kiefer 2019).

2.4.4 Sciatica

The sciatic nerve starts in the lumbar region of the spine and extends down the gluteal region into the lower limbs. A herniated disc may put pressure on the sciatic nerve thereby irritating it. This pressure results in radiating pain down the leg. The common causes of sciatica are herniated discs, spondylolisthesis, degenerative disc disease, spinal stenosis, spinal tumours, infections and trauma (Nakkella *et al.* 2021).

2.4.5 Spinal Stenosis

Spinal stenosis could be congenital, acquired or coupled together. If it is acquired, it is usually due to degeneration but may also occur as a result of tumours, trauma, infections and spondylolisthesis. Degenerative stenosis causes osteophyte formation in the facet joints and hypertrophy of ligamentum flavum. Moreover, the disc degenerates faster, which leads to herniation into the spinal canal (Sobański *et al.* 2023). This leads to the narrowing of the spinal canal, which may cause compression of the spinal cord, blood vessels and nerve roots. The symptoms experienced include pain, aching, heaviness, weakness, and numbness (Robinson 2021). Spinal stenosis may be classified as central, lateral or foraminal. Central spinal stenosis occurs in the area between the facet joints. Lateral stenosis occurs on the lateral border of the dura to the medial border of the pedicle. Foraminal stenosis occurs laterally in the pars and facet joints (Lee *et al.* 2020).

2.4.6 Spondylolisthesis

There are various types of spondylolistheses such as:

1. Dysplastic
2. Isthmic
3. Degenerative traumatic
4. Traumatic
5. Pathologic
6. Iatrogenic

Spondylolisthesis occurs when a vertebra slips forward onto the vertebra below. This results in entrapment of the spinal nerves, which usually occurs at L4-L5/L5-S1. A typical vertebra has a locking mechanism that stops each vertebra from going forward onto the one inferiorly. Slippage takes place when this mechanism has failed (Blom *et al.* 2017). Degenerative spondylolisthesis is the most common type of spondylolisthesis with an incidence of 25% (Lan *et al.* 2023). This occurs when there are changes in the disc and facet joint, which will cause forward slippage. This generally occurs in middle-aged women and usually occurs above a sacralised L5 vertebra. Those affected will present with a Phalen-Dickson gait, hamstring contracture, palpable step-off and higher-grade steps (Yoshihara 2020).

2.4.7 Osteoarthritis

Osteoarthritis is the most common type of musculoskeletal disorder that destroys articular cartilage of joints in the spine (Blom *et al.* 2017).

The outer bridge classification system is used to illustrate the changes that happen in the articular cartilage:

Grade 1: Weakening and swelling of the cartilage.

Grade 2: Breaking and fissuring of the cartilage of a space <1.27cm in diameter.

Grade 3: Breaking and fissuring of the cartilage of a space >1.27cm in diameter.

Grade 4: Exposure of underlying bone.

It causes inflammation, swelling, crepitus, decreased range of motion, joint abnormalities and tenderness (Linka *et al.* 2021).

2.4.8 Lumbar Facet Arthropathy

This is due to degenerative changes in the zygapophyseal joint, which is mainly prevalent in older people. In addition, it may also be caused by constant hyperextension, which stretches the joint capsule resulting in a tear. This in turn causes inflammation of the joints with the absence of any neurological clinical features (Van den Wyngaert 2023).

2.4.9 Spondylolysis

This occurs when there is a unilateral/bilateral stress fracture of the pars interarticularis. It occurs due to two different processes. The ‘nutcracker’ mechanism where the inferior articular process of the superior vertebra collides with the pars interarticularis of the inferior vertebra (Chung and Shimer 2021). The ‘bony pincers’ mechanism whereby there is trauma to the pars interarticularis causing a stress fracture (Blom *et al*. 2017). The most affected area occurs at L5-S1. Those affected will have a ‘stiff-legged’ gait, and pain on extension (Lu, Le and Lebwohl 2023).

2.4.10 Inflammatory Arthritis

Inflammatory arthritis occurs when there is inflammation of the bone, connective tissue, and joint capsule. Ankylosing spondylitis is a chronic, inflammatory arthritis that is idiopathic and usually begins at 30 years of age. The disease is caused due to the binding of HLA-B27 in the joints, that triggers a pathological reaction. It causes inflammation of the entheses of the ligaments and tendons (Boyer 2018). This results in bony erosions, reactive bone formation and ankylosis. Inflammation of the annulus fibrosus causes the development of syndesmophytes. Those affected with inflammatory arthritis will develop CLBP in the gluteal and sacroiliac regions (Blom *et al.* 2017).

2.5.1 Anatomy of the Low Back

The lower back consists of the lumbar spine, which comprises five lumbar vertebrae (L) and intervertebral discs (IVDs) (Moore and Agur 2018). A lumbar vertebra is made up of a vertebral body, seven vertebral processes and a vertebral arch. The vertebral body is a large, cylindrical bone, that provides weight distribution throughout the vertebral column. It is made up of trabeculae bone and is surrounded by the epiphyseal rim. The vertebral body has a superior and inferior aspect that is covered with hyaline cartilage known as vertebral endplates (Drake, Vogl and Mitchell 2020).

2.5.2 Lumbar Vertebrae

Posteriorly to the vertebral body is a vertebral arch, which is made up of two pedicles and laminae. These pedicles are small, round parts, that extend posteriorly from the vertebral body to join two bones known as laminae. The vertebral arch forms up to seven vertebral processes known as a spinous process (one), transverse processes (two) and articular processes (four). The spinous process extends posteriorly at the union of the laminae and the two transverse processes extend posterior laterally, from the union of the pedicles and laminae. Lastly, there are four articular processes with an articular facet (two superior and two inferior) at the union of the pedicles and laminae (Moore and Agur 2018). The boundaries of the vertebral foramen are formed by the vertebral arch and the vertebral body. The series of vertebral foramina gives rise to the vertebral canal. This canal contains the spinal cord and spinal nerve roots. On the lateral aspect of the vertebrae there are superior and inferior indentations known as vertebral notches, which form the intervertebral foramen (IVF) (Drake, Vogl and Mitchell 2020).

2.5.3 The Sacrum and Coccyx

The sacrum is composed of five fused vertebrae, which are located at the base of the vertebral column. The fifth sacral vertebral body articulates with the coccyx through the sacrococcygeal IVDs. The coccyx is described as a little triangular bone that is formed by four rudimentary coccygeal vertebrae (Moore and Agur 2018).

2.5.4 Articulations and Ligaments

2.5.4.1 Lumbar Vertebral Joints

The IVDs allow for strong articulations between the vertebral bodies, forming a semirigid column. The discs make up 20–25% of the length of the vertebral column. The discs allow movement between the adjacent vertebrae and aid in shock absorption. The IVDs is made up of an outer annulus fibrosus and a gelatinous core, known as the nucleus pulposus. Annulus fibrosis is a bulging fibrous ring, comprising concentric layers of fibrocartilage. The annulus receives little vascularisation, and a small part of the annulus receives sensory innervation. The nucleus pulposus comprises a gelatinous semifluid mass of mucoid material. As no blood is supplied to the nucleus pulposus, it receives nutrients through diffusion (Drake, Vogl and Mitchell 2020).

The sacro-iliac joints are powerful compound, weight-bearing joints, comprising an anterior synovial joint and a posterior syndesmosis. The sacroiliac joints are unique in that there is decreased mobility. The lumbosacral joints are formed by L5 and first sacral vertebrae (S) that articulate with the L5/S1 IVDs, and at two facet joints between the articular processes of these vertebrae. The facet joints are articulations between the superior and inferior articular processes of the vertebrae. Both joints have joint capsules, and these joints allow flexion and extension. The medial branches of the posterior rami of spinal nerves supply these joints (Moore and Agur 2018).

2.5.4.2 Lumbar Ligaments

The anterior longitudinal ligament is a broad, fibrous band, that surrounds the anterolateral parts of the vertebral bodies and IVDs. It projects longitudinally, from the sacrum to the anterior tubercle of the first cervical vertebrae and the occipital bone. The ligament is thickest on the anterior part of the vertebral body. It prevents hyperextension of the vertebral column, assisting in the stability of the joints between the vertebral bodies (Drake, Vogl and Mitchell 2020). The posterior longitudinal ligament is very narrow and runs within the vertebral canal. It attaches to the IVDs and vertebral bodies. This ligament prevents hyperflexion of the vertebral column and disk herniation.

The ligament flava are broad, pale yellow bands of elastic tissue, that extend from adjacent vertebral arches to connect lamina. These ligaments prevent the separation of the vertebral lamina. The iliolumbar ligaments are made up of five parts and connect the transverse process of the L5 vertebra to the ilium bilaterally. The ligament restricts the anterior translation of the L5 vertebral body on the sacrum. The interspinous ligaments run from the root of the spinous process to the apex. The supraspinous ligament connects the tips of the spinous processes from the seventh cervical vertebrae to the sacrum. The intertransverse ligaments connect adjacent transverse processes (Moore and Agur 2018).

2.5.5 Vasculature of Low Back

2.5.5.1 Arterial Supply

The abdominal aorta has four pairs of lumbar arteries emanating from it, with each pair passing around the L1 to L4 vertebrae. The lumbar arteries then divide into anterior and posterior branches. The anterior branches supply the anterolateral walls of the inferior abdomen and pelvis. The posterior branches supply the spinal cord, cauda equina, spinal meninges, erector spinal musculature and the skin. The posterior branch gives off spinal arteries which enter the IVF where they split into anterior and posterior radicular arteries. The radicular arteries are responsible for supplying the vertebrae, meninges and nerve roots. The median sacral artery arises from the aorta and this artery gives off a pair of lumbar arteries to the L5 vertebra (Drake, Vogl and Mitchell 2020).

2.5.5.2 Venous Drainage

The lumbar veins drain into the inferior vena cava. These veins meet with the ascending lumbar vein. On both sides, the ascending lumbar vein meets the common iliac vein. The right ascending lumbar vein becomes the azygous vein, and the left ascending lumbar vein becomes the hemi-azygous vein. On the anterolateral part of the lumbar spine, the vessels form the anterior external venous plexus. Within the vertebral canal, the anterior internal vertebral venous plexus extends superiorly to the thoracic levels. And inferiorly it extends to the sacral levels at each IVF, where the two internal vertebral venous plexuses meet the ascending lumbar veins. A posterior external plexus meets with the posterior internal plexus through the interspinous spaces. The anterior external plexus communicates with the anterior internal plexus via the basi-vertebral veins, which drain the vertebral bodies (Drake, Vogl and Mitchell 2020).

2.5.5.3 Innervation of Low Back

There are five pairs of mixed spinal nerves originating from the lumbar spine. These nerves branch into the ventral and dorsal rami. The dorsal rami provide motor innervation to the erector spinal muscles and sensation to the dermatomes. The ventral rami supply motor and sensory fibres to the rest of the prevertebral muscles and legs. The T12 (12^{th} thoracic vertebrae) - L4 ventral rami form the lumbar plexus. The L4 and L5 nerve roots form the lumbosacral trunk, which joins the sacral plexus.

This plexus then forms the sciatic nerve, which divides into the common peroneal and tibial nerves (Sassack and Carrier 2022).

2.5.5.4 Musculature of the Low Back

There are various muscles in the lumbar region and these muscles allow for smooth and controlled movement. The extensor group is made up of the erector spinae and the multifid. The erector spinae consist of the longissimus thoracic and iliocostalis lumborum. The extensors are found posterior to the lumbar spine. The contraction of these muscles causes the extension of the lumbar spine. The flexor group consists of the psoas major, iliacus and abdominal musculature, which lie anterior to the lumbar spine. The abdominal musculature is comprised of the internal/external oblique and rectus abdominis muscles which provide a vital role in trunk flexion (Sassack and Carrier 2022).

The various muscles are described according to their origin, insertion, innervation and action in the Table 2.1.

Table 2.1: Anatomy of muscles (Developed by Drake, Vogl and Mitchell 2020)

Muscle	Origin	Insertion	Innervation	Action
Longissimus thoracic	Merges with the transverse processes iliocostalis lumborum	Transverse processes of thoracic vertebrae	Thoracic and lumbar spinal nerves	Lateral flexion Extension to maintain an upright posture
Iliocostalis lumborum	Sacrum, spinous processes of the lumbar and lower two thoracic vertebrae	Angles of the lower six or seven ribs	Lumbar spinal nerves	Lateral flexion and extension
Multifidus	Sacrum, erector spinae, posterior superior iliac spine, mammillary processes of lumbar vertebrae, transverse processes of thoracic vertebrae, and articular processes of lower four cervical vertebrae	The spinous processes of all vertebrae from L5 to cervical vertebrae 2	Posterior rami of spinal nerves	Balances vertebrae during movements
External oblique	Outer surface of the inferior eight ribs	Lateral lip of iliac crest; aponeurosis	Anterior rami of lower six thoracic spinal nerves	Compress abdomen
Internal oblique	Thoracolumbar fascia; iliac crest; lateral two-thirds of the inguinal ligament	Aponeurosis, pubic crest and pectineal line	Anterior rami of lower six thoracic spinal nerves and L1	Compress abdominal contents
Rectus abdominis	Pubic crest, pubic tubercle, and pubic symphysis	Costal cartilages of ribs 5-7; xiphoid process	Anterior rami of lower seven thoracic spinal nerves	Compress abdominal contents; flexes vertebral column
Psoas major	thoracic vertebrae 7 and LI-L5 vertebrae, transverse processes of the lumbar vertebrae	Lesser trochanter of the femur	Anterior rami of L1 to L3	Flexion of thigh
Iliacus	Posterior abdominal wall	Lesser trochanter of femur	Femoral nerve	Flexes the thigh

2.6 INTRODUCTION TO OCCUPATIONAL LBP

Low back pain is a major occupational health burden with many construction workers likely to suffer from the symptoms of LBP. Occupational LBP is the main cause of work absenteeism and incapacity (disability) of construction workers less than 45 years of age (Dave *et al.* 2019). A systematic review by Wynne-Jones *et al.* (2013) reported that approximately 15% of construction workers with back pain are absent from work. The study included all types of back pain which meant that LBP was one of them. Low back pain has a significant impact on individual construction workers, families, industries and governments (Mengistu, Demmu and Alemu 2021). It is also important to note that LBP may significantly affect a person's ability to perform work activities. As a result of LBP between 6% and 10% of construction workers had to cease working, change jobs or make significant changes in their work routine (Iker and Luckhaupt 2019). Occupational LBP affects the economy due to high healthcare expenditure, absenteeism and a loss of productivity. The total medical costs and loss of work productivity in the USA due to LBP, was approximately $635 billion annually (Yang *et al.* 2016).

It was reported by the National Institute of Occupational Health and Safety that over 26% of working adults will develop LBP in the USA (Luckhaupt *et al*. 2019), whilst about 46% of European construction workers will experience back pain (Vendramin and Valenduc 2012). Certain occupational groups are more prone to LBP than other occupational groups, such as construction workers, manufacturing, transportation, healthcare and office workers. Various occupational risk factors are significant in the development of occupational LBP. These include heavy lifting, awkward postures, whole-body vibration and prolonged sitting (Yang *et al.* 2022).

2.7 GLOBAL BURDEN OF OCCUPATIONAL LBP

It was reported by the Department of Labor Statistics in the USA, that the back comprised 38.5% of all occupational musculoskeletal conditions (Taori and Lim 2023). A study on the global burden of occupationally related LBP by Driscoll *et al.* (2014) reported that in 2014 there were 21.8 million DALYs (disability-adjusted life years) of LBP, due to occupational exposures. The highest number of DALYs occurred in Asia East, Asia South, Asia Southeast and North Africa/Middle East. The risk was more than double in occupations such as agriculture, husbandry, forestry, fishing and hunting, compared to other occupational groups. The prevalence of LBP amongst construction workers in the USA was 25.7%. The prevalence for older construction workers was 27.7%, whilst for younger construction workers it was 23.8%. This study highlighted that among all of the occupational groups, construction, and extraction, construction workers had the highest prevalence of LBP. The sample size was 13924 and there were 22 occupations included in this study (Yang *et al.* 2016).

According to a study by Tomioka, Shima and Saeki (2021), LBP makes up 62.2% of occupational illnesses in Japan. This makes it the most common occupational disorder. The period prevalence of LBP was 13.0%. A high prevalence of 12.2% was observed in the agricultural/forestry/fishery industries and 17% in the construction/mining industry. The sample size comprised 67313 participants and there were 12 occupational groups studied. This study highlighted that women are also at high risk of LBP in the agricultural/forestry/fishery industries. The prevalence of LBP was much higher for unemployed individuals than for working individuals. This is because some unemployed people are not able to work due to LBP. The definition of LBP used in this study was over the past few days. As this definition includes a shorter period than previous studies, this led to a lower prevalence of LBP. In addition, this study had mild cases of LBP, so it may have resulted in a higher prevalence of LBP.

In a study by Jia *et al.* (2022) the annual incidence of LBP among Chinese construction workers was 16.4%. The incidence of LBP in the different industries was as follows: vegetable farming (32.5%), toy production (27.3%), animal farming (26.0%), medical professionals (25.3%), biopharmaceutical production (21.8%), flight crew (20.3%), maritime and related equipment manufacturing (18.9%), coal mining and washing industries (17.3%), car dealers (16.9%), car manufacturing (16.0%), electronic equipment manufacturing (13.9%), shoe manufacturing (13.3%), construction (12.0%), furniture production (10.3%) and fuel industry (6.7%). Occupational factors such as frequently standing, lifting heavy objects and working with constant postures at fast speeds, were associated with LBP. The sample size was 64 052 in 15 of the occupational groups, and vital industries related to LBP were not included. That study observed that the highest incidence of LBP was in vegetable farmers. This is because they are exposed to confined spaces, abnormal postures, repetitive movements and heavy physical activities.

2.8 BURDEN OF OCCUPATIONAL LBP IN AFRICA

A study on LBP among teachers in Ethiopia by Mengestu (2013) reported an annual prevalence of 53.8%. The prevalence was higher among women (75.9%) than men (48.9%). It was also noted that it was higher among teachers who smoked (79.1%). A total of 662 teachers were included in that study, which comprised primary, secondary school and tertiary teachers. The higher prevalence of the women might be because they were obese. Women generally report more types of pain as opposed to men, as they have a lower threshold of pain. Smoking causes inflammation in the arteries which will decrease the blood supply to the lumbar spine. This will cause degeneration of the discs and tissue damage.

The study of LBP among nurses at a regional hospital in KZN reported a period prevalence of 59%. The prevalence of LBP was high in those who were aged between 21 and 30 years (56%) and those who were overweight (58%). The sample size was small and included 300 nurses. The high prevalence of LBP among nurses was due to the manual handling of patients and the physical loads they have to carry. African women usually do more household tasks than men, and thus LBP may reflect a cumulative effect of various exposures at work and home (Dlungwane, Voce and Knight 2018).

Commercial motor drivers and private automobile drivers in Nigeria reported prevalence of 96% and 88% in LBP, with sitting for long periods being the main cause of LBP (Odebiyi, Ogwezi and Adegoke 2009). The annual prevalence of LBP among underground gold miners in Ghana was 67.2%, with a regular sickness absence record of 2-7 days and strenuous work being identified as the major cause of LBP (Bio *et al.* 2007). A study by van Vuuren *et al.* (2007) reported that Manganese construction workers in South Africa had a one-month (55%) and point prevalence of 37.6% in LBP. Forward bending, bulk manual handling, carrying 5–15 kg objects, carrying objects more than 15 kg and lifting, were strongly associated with LBP. According to a study of LBP among automotive workers in Ethiopia, by Hailu *et al.* (2020), there was a point and an annual prevalence of 15.3% and 35.9%, respectively. This study reported that 11.2% of the workers received treatment, of which 3.4% had traditional remedies, 3.6% medications, 1.5% physical exercise, and 1% physiotherapy. The study also reported the prevalence of job stress associated with LBP to be 55.3%, and work service of 6-10 years associated with LBP to be 59.29%. Most of the participants had a mean age ranging between 25 to 35 years. Since there were middle-aged adult participants, this may have resulted in a higher prevalence of LBP. The systematic review by Jegnie and Afework (2021) reported the annual prevalence of occupational LBP in Ethiopia to range from 3.21% to 82.93%. The lowest prevalence was reported in office workers, while the highest was reported in nurses.

This study showed that abnormal postures, frequent bending and twisting, are significant risk factors for LBP. The review included 32 articles and most of the studies comprised participants between the ages of 25 and 35 years. Many of the important occupational factors of LBP in these studies were only found in two studies, and thus they were not included in the review. Various methodological differences, such as variations in sample size and the LBP case definition were found in the studies.

According to a study of LBP among primary school teachers in Kenya, by Elias *et al.* (2019) there was an annual prevalence of 64.98%. Absenteeism for less than a week was seen in 45.9% of teachers with LBP, and 62.4% of teachers with LBP engaged in physical exercise. In a study by Aleku *et al.* (2021) there was a prevalence rate of 39.6% in LBP among health workers in Uganda. The prevalence was 50.5% among workers who worked more than eight hours per day. A significant association with age was observed, with the highest prevalence rate being observed among workers aged 40–49 (62.9%) years. The prevalence observed in this age group is believed to be due to decreased bone densities and comorbidities.

A study of LBP among nurses in Ethiopia by Belay *et al.* (2016) reported a point and annual prevalence of 45.3% and 45.8%, respectively. A high prevalence of LBP among nurses who did not exercise was found (61.3%) and those who had mental stress (45.1%). Another study on LBP among university teaching staff in Kenya, by Doualla *et al.* (2019) reported an annual prevalence of 64%. This study highlighted a strong association between occupational stress levels and LBP.

2.9 LBP IN CONSTRUCTION WORKERS

Occupational LBP is more common among construction workers as opposed to other occupational groups (Alghadir and Anwer 2015). This is due to the physical demands of the occupation, as construction workers are required to constantly engage in repetitive trunk bending or twisting, repetitive motions, maintaining abnormal postures and lifting and carrying heavy materials. This places high pressure on the anatomical structures, such as tendons, ligaments, muscles and joints involved in LBP. A 2018 USA Health Survey reported that construction workers and military workers have a significant risk of developing occupational LBP (Kesiena *et al.* 2021). In contrast to other occupations, back pain is more serious for construction workers and causes the highest compensation costs and disability. A study on chronic back pain among elderly construction workers in the USA by Dong *et al.* (2012) reports that when the incidence of back pain was probed, over 39% of the construction workers reported "yes," in contrast to 34% or less other construction workers. That study had a large nationally representative longitudinal sample size of USA residents over the age of 50 and less than 10% of the construction workers were women.

A study on migrant construction workers in Argentina, reported the period prevalence of LBP to be 61.5%. The prevalence of LBP was higher in the age group 20 to 29 years, as opposed to older and younger construction workers. Working over 44 hours per week as opposed to working fewer hours was also associated with a higher prevalence of LBP. The sample size consisted mainly of construction workers younger than 30 years (62%) and most of them worked more than 44 hours a week (71%). The migrant construction workers were more apprehensive than the local construction workers to report LBP, because they feared legal consequences. Moreover, the working conditions were far worse for the migrant construction workers as opposed to the normal construction workers. These conditions included lengthy working hours and a poor psycho-social working environment, which contribute to LBP. In addition, socio-demographic factors varied greatly, as migrant construction workers were younger than local construction workers, and many were educated (Susseret, Briceno-Ayala and Radon 2019).

According to an epidemiological study of LBP among semi-skilled Danish construction workers, there was a prevalence of 68%. A relationship was found between the length of work experience and the severity of LBP, in that there was severe LBP in those with more than 29 years of work experience, versus those with less experience (Latza *et al.* 2000).

A study on scaffolders by Elders and Burdorf (2004) reported an annual prevalence of 60% in LBP. The incidence of those with LBP aged less than 35 years was 48%, and the incidence in those with a high BMI associated with LBP was 37%. This study only concentrated on scaffolders; these construction workers engage with heavy workloads. As a result, this may restrict generalisation of other occupational groups. In a study of LBP amongst construction workers in Nepal, the point prevalence was 22.9%. The prevalence of LBP was far lower among painters and electricians compared to other types of construction workers. This is because the type of work and working posture differed. Other types of construction workers such as bricklayers, adopt postures such as bending excessively with the abdomen and bending and twisting of the abdomen for long periods (Adhikari *et al.* 2021).

A study on musculoskeletal pain among construction workers in Saudi Arabia, by Alghadir and Anwer (2015) reported that 50% of construction workers had LBP. The musculoskeletal pain was mostly associated with standing (65%) and sitting (37%) postures. Over 70% of construction workers who reported musculoskeletal pain were between the ages of 30–50 years. The study included 165 male construction workers. The reference to musculoskeletal pain in this study and throughout the dissertation means that LBP was one of the types of musculoskeletal pains that were investigated.

A study on the epidemiology of LBP amongst construction workers in Japan, reported an incidence of 29.3%. Of those, 73,4% reported moderate pain and 5,4% reported severe pain. The number of construction workers that were absent or visited the doctor was high at 50.2% and 67.5%, respectively. The construction workers in this study adopted abnormal postures for long periods. These postures are mainly attributed to the cause of LBP. Most of the construction workers in Japan work on a daily or temporary basis and thus their work environment is constantly changing. Due to this, that study restricted (limited) the reporting of LBP (Kaneda, Shirai and Miyamoto 2001).

According to a study on musculoskeletal disorders among construction workers by Boschman *et al.* (2012), there was a period prevalence of 42% in back pain, with age causing a higher prevalence. It was noted, that working with a bent back was the most common cause and aggravator of LBP. The study included 750 bricklayers and no women responded. It was also noted that the season affected the prevalence, as musculoskeletal complaints are more prevalent in winter than in summer, with larger differences for bricklayers.

In a systematic review of 35 articles on musculoskeletal symptoms in the construction industry by Umer *et al.* (2017), it was reported that the highest overall one-year prevalence of 51.1% was in the low back region. The point prevalence of LBP ranged between 33% to 39% in the USA, whereas the point prevalence of LBP ranged from 47.8% to 60.3% in Germany. It was also reported that among Indian construction workers, the two most prevalent recurring musculoskeletal symptoms were seen in the lumbar region with a one-week prevalence rate of 34%. The review included studies made up of 303 384 construction workers in 19 different types of construction from 15 countries, with most conducted in the USA. The studies reported different types of period prevalence for occupational related musculoskeletal symptoms and the case definitions were also different. There are only two studies that reported on the musculoskeletal prevalence of both sexes in the construction industry. Both studies reported that female construction workers are more prone to musculoskeletal symptoms. This could be due to anatomical differences (e.g. lower muscle strength in women) and genetic pain coping. The reference to musculoskeletal symptoms in this study and throughout the dissertation means that LBP was one of the types of musculoskeletal symptoms that were investigated.

According to Chung *et al.* (2019), there was a point prevalence of 10.6% in musculoskeletal pain among construction workers. The most severe pain regions were the left knee (6.1%) and lower central back (5.8%). The study showed that 41.3% of the construction workers with musculoskeletal pain were obese, and 21% of them with musculoskeletal pain chose to ignore it. A total of 2021 construction workers were included in the study, with 17.6% women being female and 82.4% men. Over 20 construction disciplines were included. Given that that study was on point prevalence, most construction workers reported mild pain, as those with moderate/severe pain would not be present at work. The study observed that men were able to cope with pain more than women. This led to a lower pain intensity being reported in the male construction workers. Most of the construction workers in that study were employed daily, which meant that they were not willing to give up their salaries to address their pain. Thus, they would continue working until the pain was unbearable.

A study on LBP and the level of disability amongst construction workers by Araújo, Carvalho and Martins (2016) reported a prevalence of 71.4%. This study highlighted that the average construction worker's time of service that experienced LBP was 60 months versus those who did not experience LBP and had been working for 2 months. The study included 84 construction workers. LBP was more common during physical labour which resulted in most of the construction workers (91.7%) reporting physical exertion. It was noted that physical exertion was one of the significant causes of LBP in construction workers. A study on musculoskeletal pain among construction workers reported a period prevalence of 60%. A significant number of the construction workers reported moderate pain in their lower back (30%) and 26% of the construction workers with musculoskeletal pain had their pain diagnosed by a physician. The 23 construction workers who took part in the study were mainly Caucasian men. The participants were from a specific geographic region, which meant that there were similar demographic characteristics and working practices among the construction workers (Arias, Koenig and Choi 2022). According to a study on the severance and prevalence of LBP amongst construction workers by Vasiwala *et al.* (2021), the prevalence of less than three months was 19.1%, and 26.3% in those who experienced it for more than three months. Low back pain was more prevalent among construction workers in the age group 31-40 years old (58.0%) than those in the age group 41-50 years old (55.0%). This could be due to degeneration in the bones and muscles of older construction workers.

The study comprised 194 male construction workers who were from Bangladesh, Nepal, Indonesia, India, Pakistan and Malaysia. The study reported that the type of work construction workers engage in has a profound impact on the disability experienced. Most of those with LBP participated in 10–12 and 1–3 types of construction work. Many of the construction workers who participated in 10–12 types of work, had hardly any disability. The same trend was seen in construction workers who did 1–3 types of work, although the number of construction workers with moderate disabilities was higher in this group. The explanation for this pattern is that there is less strain on their lower back when they alternate between the different types of work. A lower workload thus increases the chance of them injuring their lower back cumulatively, which will result in high levels of pain and disability.

A study by Lette *et al.* (2019) on construction workers reported an annual overall prevalence of 43.9% in LBP. The most common types of musculoskeletal pain were dull aches (42.8%) followed by cramping (35.6%). The total study sample size counted 422 construction workers. The majority (55.4%) of construction workers had less than five years of experience and 70% of the construction workers worked over eight hours per day. Approximately 51.7% of the construction workers took more than 15 days of sick leave due to LBP. A Hamburg construction study by Latza *et al.* (2000) reported a one-year prevalence of 50.1% in LBP among construction workers. House painters had the highest prevalence of LBP (56%), whereas carpenters (41%) had the lowest prevalence. In a study of apprentice construction workers by Merlino *et al.* (2003) there were 54.4% construction workers with low back injuries, of those 16.8% visited a doctor and 73% missed workdays.

According to the systematic review of 63 articles by Antwi-Afari *et al.* (2023), the prevalence of LBP was reported to be 66% among cement/concrete construction workers and 65% among mason tenders. They highlighted that bending or twisting of the back, working in a static position and heavy lifting were the main causes of LBP. These studies were conducted in the USA, Hong Kong, Canada, China and the UK. The annual prevalence of injury among construction workers in Ethiopia was 41.4%, with the leading injury being injury by object (36.9%) and LBP (35.6%). The low back (26.2%) was the most affected part. Among the injured 22.2% of the construction workers were severely injured, 42.3% received medical treatment and most lost three working days. Developing countries are more prone to severe types of LBP due to poor safety regulations This study also reported that working longer than eight hours a day doubled the risk of occupational-related injury compared to construction workers who work eight hours a day or less. This is because fatigue increases the risk of work-related injuries (Lette *et al.* 2018).

A study by Shaukat and Fatmi (2022) reported the point and period prevalence of LBP to be 8.1% and 14.3%, respectively. The most common ergonomic risk factor reported, was enduring excessive forces. Only men were included in the study, and a small number of older participants. A study on musculoskeletal disorders among

Indian construction workers by Chakraborty *et al.* (2017) reported that the annual prevalence was 40.64% and the period prevalence was 33.87% in LBP. The highest number of absenteeism days (1447 days/year) was observed in participants with LBP. A significant association was found between musculoskeletal disorders and occupational stress. This is because construction workers participate in physically demanding tasks under tight deadlines and receive poor wages. The study was limited to a male population.

According to Attaullah *et al.* (2019), the prevalence of construction workers with symptoms in the lower back was 32.83%. The significant risk factors were lifting loads (24.34%), working in the same position for extended periods (21.56%) and abnormal positions (19.36%). The study showed a significant association between age and the prevalence of occupational-related musculoskeletal disorders.

2.10 RISK FACTORS OF LBP IN CONSTRUCTION WORKERS

2.10.1 Occupational

There are various risk factors associated with LBP among construction workers. A study by Wami *et al.* (2019) highlighted that occupational factors such as maintaining abnormal postures for long periods may cause LBP. These postures result in constant strain on muscles and ligaments, which prevents it from supporting the spine. Due to constant strain, ligaments, capsules, and intervertebral discs, the lumbar spine may creep and be prone to injury from sudden forces (Chowdhury *et al.* 2012).

Himalowa and Frantz (2012) reported that LBP was mainly attributed to bending activities among construction workers. Excessive bending of long periods causes increased pressure on the annulus fibrosis and endplates of the disk. This may tear the annular part of the disk and result in trauma to the internal part of the disc (Schilling *et al.* 2021). It was noted that construction workers get injured when participating in tasks that were not anticipated e.g. the straining of back muscles by improper lifting. A British study reported that a task could be dangerous if the load is greater than an individual’s strength capacity (Chaffin and Andersson 1991). It was noted by Fathallah, Marras and Parnianpour (1998) that the risk of LBP is mostly determined by the load lifted. The frequent carrying of heavy loads causes spinal loading which damages tissues. This will cause atrophy in muscle, bone and cartilage (Dave *et al.* 2021).

A study by Branham (2016) highlighted that excessively turning/twisting of the spine might cause a lumbar strain or sprain. A lumbar strain is caused when muscle fibres are abnormally stretched, and a sprain is caused when ligaments are torn from their attachments. It has been reported that bricklayers bear a high risk of developing LBP and low back injuries. In addition, a Hamburg construction worker study reported an increased risk for bricklayers, as most of their tasks are done in a standing position (94.2%). The increased risk for bricklayers is believed to be due to the inclined work postures and by frequent carrying of bricks with a weight of approximately 5–24 kg (Latza 2000). According to a longitudinal analysis study by Reddy *et al.* (2016), laying large lime sandstones was a risk factor for LBP in construction workers, as bricklayers must move over one ton per hour.

2.10.2 Lifestyle

The lifestyle factors will be discussed below.

2.10.2.1 Stress

Adhikari *et al.* (2021) reported that construction workers' psychological distress was associated with LBP. A study in the construction industry by Abbe *et al.* (2011) highlighted that stress is associated with the occurrence of injury and loss of workdays. Moreover, it’s associated with physical and mental illnesses, such as cardiovascular disease, depression and anxiety (Burman and Goswami 2018). Elevated stress levels cause the sympathetic nervous system to release stress hormones, which may strain the musculoskeletal system resulting in LBP (Doualla *et al.* 2019).

Studies on construction workers and different occupational groups have observed that physiological distress is significantly associated with musculoskeletal pain and occupational injuries (Demyttenaere *et al.* 2006). Jacobsen *et al.* (2013) reported that 22% of construction workers with LBP had a lot of mental stress. Another study on the role of psychological factors in occupational LBP, by Feyer *et al.* (2000) reported that psychological distress was associated with a higher risk of new episodes of LBP. According to a study on chronic back pain among elderly construction workers by Dong *et al.* (2012) there was high job stress which significantly increased the chance of back disorders by 36%. The systematic review of construction workers by Anwer *et al.* (2021) reported a significant association between stress and LBP. Stress may decrease a person's pain tolerance, which will result in an increased perception of LBP (Anwer *et al.* 2021). Mental stress causes a person to perform their activities differently, this will result in more microtrauma to the lumbar spine (Anwer *et al.* 2021).

2.10.2.2 Exercise

According to a study by Lee *et al.* (2023), there was a significant association between exercise and LBP. The study also reported that 59% of the construction workers who exercised were less likely to develop LBP. It has been found that regular exercise strengthens the lower back muscles and allows proper alignment. In addition, there is increased circulation to the spinal muscles, joints and intervertebral discs to prevent injuries. The study by Alnaami *et al.* (2019) and Al-Otaibi, Al-Salameen and Abugad (2019), showed a positive association between LBP and exercise. These studies were not, however conducted on construction workers.

Exercise aids in muscle strength, increased cardiovascular function, and optimal absorption of nutrients by bone and muscle tissue, which prevents LBP from occurring (Tesfaye *et al.* 2023). In contrast, a study by Saragiotto *et al.* (2016) reported that exercise was not associated with LBP. The study was conducted on adult participants with acute, subacute, or chronic nonspecific LBP. Given the strenuous labour that is involved in this occupation, construction workers might be fatigued when they reach home and may not have the energy to exercise (Aryal *et al.* 2017).

2.10.2.3 Alcohol

Construction workers have higher rates of alcohol consumption as opposed to other occupations. As a result, this may also contribute to higher rates of musculoskeletal symptoms such as LBP (Ompad *et al.* 2019). It was noted by Kovalic, Cholankeril and Satapathy (2019) that excessive and regular consumption of alcohol may increase the risk of osteoporosis and myopathies. Alcohol is a substance with analgesic properties and therefore a decrease in pain after consumption, could change and increase the main effect of alcohol on pain (Thompson *et al.* 2017). It has been observed in animal studies that alcohol can block nociceptors receptors, which was also found in humans (Karimi *et al.* 2022).

According to a study by Barnes and Zimmerman (2013) there was a strong association between construction workers in physically demanding occupations and alcohol consumption, as these construction workers drank more often and excessively. A study on the prevalence and perception of risky health behaviours among construction workers by Strickland *et al.* (2017) reported that 20% drank almost daily, and 13.2% drank 20 or more drinks weekly. In addition, 29.5% of them were binge drinking five or more times a month. According to Yi and Chan (2016) the average musculoskeletal pain of construction workers not consuming alcohol was 42.1% lower than regular alcohol consumers. That study also highlighted that the occurrence of occupational injury was associated with alcohol consumption. The studies by Adhikari *et al.* (2021) and Ganesan *et al.* (2017) reported no significant association between LBP and alcohol in construction workers. The prevalence reported in these studies was 54.5% and 11.5%, respectively.

2.10.2.4 Smoking

The construction industry has a very high rate of smoking consumption, with the rates of construction workers twice as high as that of white-collar construction workers (Chin *et al.* 2012). Smoking causes degeneration of the intervertebral discs by preventing disc metabolism, collagen and proteoglycan synthesis, which leads to LBP (Oichi *et al.* 2020). A study on musculoskeletal pain in construction workers by Alghadir and Anwer (2015) reported that 45% of construction workers with musculoskeletal pain had a history of smoking.

According to Strickland *et al.* (2017) there was a high prevalence of smoking (34.3%) among construction workers. UENO *et al.* (1999) reported that construction workers who smoked more than 20 cigarettes per day had a significantly higher risk for LBP. The studies on construction workers by Lette *et al.* (2019) and Arias, Koenig and Choi (2022) reported that there was no significant association between musculoskeletal pain and smoking. In contrast, the studies by Lv *et al.* (2022) and Kahere and Ginindza (2021) showed a positive association between LBP and smoking. A study by Lv *et al.* (2022) obtained data from the European genome-wide association studies, whereas a study by Kahere and Ginindza (2021) on hospital patients with CLBP in KZN. Smoking causes coughing, which increases the pressure in the disc and abdomen, which in turn may lead to disc herniation (Lv *et al.* 2022). Smoking also decreases blood flow to the intervertebral discs, causing metabolic imbalances in the discs (Lv *et al.* 2022).

2.10.3 Demographic

The demographic factors are discussed as follows.

2.10.3.1 Sex

A study by Adhikari *et al.* (2021) reported that sex was significantly associated with LBP. The annual prevalence of LBP was higher among women (72%) as opposed to male (48%) construction workers. The risk of LBP is higher in women because of hormonal changes, gynaecological conditions and childbirth (Sencan *et al.* 2018). In a study by Merlino *et al.* (2003) the prevalence of LBP was higher amongst female construction workers (45%) as opposed to male construction workers (39%). Another study by Lee *et al.* (2023) on construction workers found that women had a significantly higher annual prevalence of musculoskeletal symptoms, as compared to men. The study on work-related pain prevalence of construction workers in Hong Kong by Chung *et al.* (2019) reported a prevalence of 16.7% in musculoskeletal pain among women.

2.10.3.2 Age

A study by Adhikari *et al.* (2021) highlighted that the age of construction workers with LBP was significantly higher than those who did not have LBP. According to the study on the pain and severity amongst construction workers by Vasiwala *et al.* (2021) LBP was highly prevalent in the age group 31 - 40 years (58.0%) followed by those in the age group of 41- 50 years old (55.0%). The prevalence in these age groups was double that of those aged between 20-30 years old (30.2%). In a study by Holmström and Engholm (2003) the LBP prevalence rate among construction workers increased by age from 18% in those aged 24 years, to 35.7% for those aged 55–59 years.

A study on the prevalence and associated factors of work-related musculoskeletal disorders symptoms by Lee *et al.* (2023) reported that there was a significant association between age and the prevalence of work-related musculoskeletal disorders among construction workers. The prevalence increased with age from 18–26 years, 27–37 years and 38–48 years. According to Alghadir and Anwer (2015) it was reported that over 70% of construction workers with musculoskeletal pain were in the age group 30–50 years. The studies by Marvimilan *et al.* (2022) reported that there was a significant relationship between age and LBP in construction workers. In contrast, studies on construction workers by Chung *et al. (*2019) and Lette *et al.* (2019) reported that musculoskeletal pain and age were not associated.

2.10.3.3 Body Mass Index

Obesity increases the load bearing on the nearby anatomical structures which results in microtrauma over time (Dario *et al.* 2015). The study by Yi and Chan (2016) reported that the prevalence of being overweight (36%) and obesity in construction workers (20.8%) in Hong Kong was higher than the general population (6.5%). In another study on musculoskeletal pain among construction workers by Kovalic, Cholankeril and Satapathy (2019) it was reported that 43.7% of the construction workers who were overweight, had musculoskeletal pain. According to the study it was reported that 50.8% were obese and 59.6% were overweight with LBP.

A study on LBP in construction workers in Nepal, by Adhikari *et al.* (2021) reported that 41.3% of construction workers who were obese had LBP. According to Attaullah *et al.* (2019) there was a significant association between BMI and the prevalence of occupational-related musculoskeletal disorders among construction workers. In contrast, the studies of construction workers by Bodhare, Bele and Valsangkar (2011) and Lette *et al.* (2019) reported no significant associations between LBP and BMI. The study by Alghadir and Anwer (2015) reported that 21.2% of the construction workers that were obese, had musculoskeletal pain. A study on the health assessment of construction workers by Umar *et al.* (2020) reported that 73,3% were overweight or obese.

2.11 SUMMARY

Numerous studies have reported on the problem of LBP, which is a multi-factorial musculoskeletal condition with different causes. The impact of LBP on the general population validates that this condition is the most common musculoskeletal symptom and a significant disabling ailment. The significance of LBP within an occupational environment is apparent from the numerous studies aiming to isolate occupational risk factors. However, due to the aetiology of LBP being a multi-factorial lifestyle demographic, occupational risk factors need to also be considered.

A multitude of epidemiological studies have been conducted in various countries around the world, which suggests that LBP represents a global burden. However, a gap in the literature regarding the epidemiology of LBP in construction workers in South Africa exists, which suggests the need for this study to determine the epidemiology of LBP in construction workers. Chiropractors also have an important role to play in decreasing the burden of LBP experienced by the construction worker population. This study identifies the risk factors common in construction workers in the eThekwini Municipality, so that chiropractors can understand the best management approaches to use, to minimise and prevent LBP in the industry.

The next chapter outlines the methods used in our study.

CHAPTER THREE

METHODOLOGY

3.1 BACKGROUND

In this chapter, the methods and instruments used to conduct the study on the epidemiology of LBP of construction workers in the eThekwini Municipality, as well as the statistical methodology used, will be discussed. The topics to be addressed include the study design, setting, population, permission to conduct research, inclusion and exclusion criteria, sampling design, data analysis, measurement tool, study procedure and ethical considerations of the epidemiology of LBP of construction workers in the eThekwini Municipality.

3.2 STUDY DESIGN

This research study used a quantitative paradigm with a descriptive, cross-sectional survey data collection tool. Quantitative research is a method type that incorporates numbers derived from observations, to explain the events that the observations may reflect on them. One of the main goals is to create accurate and reliable measurements that allow proper statistical analysis. In addition, it can highlight trends across a study group, as it focuses on data that is measured and it is very useful in determining the ‘what’ or ‘how’ of a situation (Taherdoost 2022). A descriptive design is employed to describe the distribution of one or more variables, without regard of any causation. The purpose is to identify issues within a population or look at differences in characteristics within a population (Aggarwal and Ranganathan 2019).

In health-related research, cross sectional studies are observational studies that evaluate data from a population at a specific period. They are generally used to measure the prevalence of health outcomes, understand determinants of health and describe features of a population (Wang and Cheng 2020). A research survey is defined as “the collection of information from a sample of individuals through their responses to a question” (Ponto 2015). This was the best design to evaluate precise answers to specific questions, which in this context included the risk factors and prevalence of LBP in construction workers in the eThekwini Municipality.

3.3 SETTING

The research was conducted at two of the largest commercial construction companies which are based at construction sites located within the eThekwini Municipality and focus on the building of commercial buildings. The eThekwini Metropolitan area is found on the east coast of KZN and is the third biggest metropolitan municipality in the country. It covers an area of approximately 2555km^2 and has 3.9 million people (Nyawo and Mubangizi 2021).

3.4 POPULATION

The study population included male and female construction workers from two of the largest commercial construction companies in the eThekwini Municipality. From this area, a target population was obtained which included 590 construction workers within the eThekwini Municipality. This population group was selected to determine the risk factors and prevalence of LBP in construction workers. Both sexes and all race groups were included if participants qualified as per the inclusion and exclusion criteria.

3.5 PERMISSION TO CONDUCT RESEARCH

Ethical approval was granted (Appendix A) to conduct the research by the Institutional Research Ethics Committee (IREC) at the Durban University of Technology (DUT), based on the results of the focus group and the pilot study. The ethical approval number was 303/22. In order to grant full ethical approval, the IREC also required gate keeper permissions. These permissions were obtained, as permission was granted by the management of the construction companies. Full ethical approval indicates that the research study obeys the principles of the Declarations of Helsinki of 1964 and Nuremburg and Belmont of 1947.

3.6 INCLUSION AND EXCLUSION CRITERIA

The following inclusion/exclusion criteria were ensured:

Inclusion criteria:

- All construction workers had to meet the definition of a construction worker. These include manual labourers, such as bricklayers, carpenters, excavators and scaffolders involved in the building of structures on construction sites.

- Employees were required to read and sign the Letter of Information and Informed Consent form (appendices A and G).
- Only individuals that are 16 years and older were allowed to participate in the study.

Exclusion criteria:

- Any employee that was not willing to participate in the study (those that are not prepared to read and sign the Letter of Information and Informed Consent form).
- Participants who participated in the pilot study.
- Those who do not meet the inclusion criteria.

3.7 SAMPLING STRATEGY

3.7.1 Participant Recruitment

Once permission was granted (Appendix A) from Institutional Research and Ethics Committee (IREC) and the management (appendices N and O) of the two largest commercial construction companies located within the eThekwini Municipality, participants were recruited. Each company counted 450 and 140 construction workers, respectively. The researcher then contacted the manager at each construction company and set up a suitable time and date for the researcher and interpreter to visit the manager at the construction site. The manager communicated with all the team leaders to invite the construction workers to participate in the study. The researcher gave the construction workers a letter of information form (Appendix B) which was supplemented with an explanation by the manager regarding the purpose of the study as per the letter of information form (Appendix B). Those who were willing to participate received a letter of informed consent form (Appendix H) from the manager. Upon completion of the informed consent form (Appendix H) they placed it in a box with the manager and received a questionnaire (Appendix P) from the manager. Finally, once the questionnaire was completed, they placed it in another box with the manager.

3.7.2 Sample Size

The sample size was calculated around the primary objective of estimating the prevalence of LBP in this population. Two of the largest commercial construction companies located in the eThekwini Municipality were used to calculate the sample size. We ascertained that there are 450 construction workers at one company and 140 construction workers at another company equating a total population of 590 construction workers. We required at least a precision of 4% around the estimate from the sample, when the actual proportion is near 0.25 with 95% confidence. A sample size of 256 construction workers was thus required.

This was generated by PASS 2021 Power Analysis and Sample Size Software (2021) NCSS, LLC. Kaysville, Utah, USA, ncss.com/software/pass. In order to ensure proportional representation from both companies, a larger sample was obtained from the larger company (195/256 participants), whilst 61/256 participants came from the other company. This is called probability proportional to size sampling.

3.8 DATA ANALYSIS

The raw data for the quantitative component were coded and exported into a Microsoft Excel spreadsheet. Thereafter, it was statistically analysed by a biostatistician, Tonya Esterhuizen, using IBM SPSS version 28 (Nie, Bent and Hull 2021). Descriptive statistics such as mean, standard deviation and range were used to summarise continuous data. Frequency counts and percentages were used to summarise categorical data. Risk factors for LBP were assessed for those who had ever reported LBP. Pearson's chi-square tests or Fisher's exact tests, as deemed appropriate, were used to assess categorical factors, while t-tests were used to assess mean differences for continuous variables. A p value <0.05 was used to indicate statistical significance.

3.9 VALIDITY AND RELIABILITY

The validity of a study is described as how well the findings of a study represent proper findings among similar people not in the study. This idea relates to different clinical studies, such as those about prevalence, associations, treatments and diagnosis (Patino and Ferreira 2018). Reliability is described as the consistency of a method in its measurement. The measurement is reliable if the same result can be achieved consistently using the same methodology, under a similar environment (Ahmed and Ishtiaq 2021). The questionnaire was adapted from two validated questionnaires. Reliability and validity were ensured in the study through a focus and pilot study.

3.9.1 Measurement Tool

Permission was sought and subsequently obtained (appendices K and L) from Adhikari *et al.* (2021) and Dlungwane, Voce and Knight (2018) to adapt the questionnaire that they used in their studies. The questionnaire by Adhikari *et al.* (2021) and Dlungwane, Voce and Knight (2018) were both validated. The questionnaire was then modified by the focus group discussion and pilot study, respectively, to obtain a final questionnaire. The questionnaire was divided into four sections in order to obtain the required data for this study. The sections included demographics, lifestyle, occupational risk factors and LBP history. The research tool for this study was an in-person questionnaire used to collect data from the study population.

3.9.2 Focus Group

A focus group is an interview in which the study participants are encouraged to share ideas and thoughts in relation to the topic of the questionnaire. The aim is to ensure that the questions are appropriate for the population in which the study is to be conducted in. This ensures reliability of the research tool and further aids in content validity (Nyumba *et al.* 2018). This ensured that the questionnaire was critically evaluated. This further ensured that there was a consistent and thorough format, correlating with the aims and objectives of the study. Construction workers who participated in the focus group did not participate in the main study.

The focus group consisted of the following six members:

1. The researcher.
2. The research supervisor.
3. Two construction workers.
4. A student studying for their master's degree who has either completed or is currently conducting questionnaire research.
5. One individual who has experience in quantitative research.

These individuals needed to read and sign the Letter of Information and Consent (appendices E and F). Once all members of the focus group agreed to the procedure, they received a copy of the questionnaire (Appendix P). Thereafter all questions in the questionnaire (Appendix P) were discussed in an online Microsoft Teams meeting, and all necessary changes or suggestions were made. The changes/ suggestions included moving questions from one section to another section and including more options for multiple choice questions. This then formed a pilot questionnaire.

3.9.3 Pilot Study

A pilot study is a pre-run testing trial that will help to identify if there are any discrepancies in the questionnaire, and to ascertain whether the participants understand the instructions and questions being asked. This was done to determine if there are any weak points in the questionnaire (In 2017). The primary function of the pilot study is not to answer certain research questions, but to not allow researchers to begin a large study whilst not having enough knowledge of the methods proposed (Malmqvist *et al.* 2019). Construction workers who participated in the pilot study did not participate in the main study. Three construction workers were chosen to participate in the pilot study. These participants needed to read and sign the Letter of information and consent (appendices D and H) as well as complete the questionnaire (Appendix P). The participants provided feedback and all necessary changes were made. Once all changes were made, the questionnaire (Appendix P) was approved by IREC (Appendix A), finalised and used in the research study.

The styles of questioning varied in the final questionnaire. The types of questions that were used, varied from open-ended questions, multiple choice questions, dichotomous (yes/no options) and questions that required answers. This allowed for structured and open-ended questions, which increased the reliability of the questionnaire. The questionnaire was divided into three sections so that the desired data could be obtained. The sections included demographics, risk factors and the history of LBP.

3.10 STUDY PROCEDURE

- Once permission (Appendix A) was received from the IREC and the management of the construction companies (appendices N and O), a suitable time and date was arranged by the manager for the researcher and the interpreter to visit the construction workers at the construction site.

- The manager communicated with the team leaders to invite the construction workers to participate in the study.
- The researcher then provided the construction workers with a letter of information form (Appendix B) which was supplemented with an explanation by the manager regarding the purpose of the study, as per the letter of information form (Appendix B).
- Those willing to participate put their hands up and received a letter of informed consent form (Appendix H) from the manager.
- One company had 195 questionnaires left with the manager, whilst the other company had 61 questionnaires left with the manager.
- Upon completion of the informed consent form (Appendix H) the construction workers placed it into a box that was with the manager and then received a questionnaire (Appendix P) from the manager.
- The manager received participants until the minimum number of 195 and 61, respectively, were received. Once the questionnaires (Appendix P) were completed, they were placed into another box with the manager. A number that was issued to the participant's questionnaire (Appendix P) was used on the data sheet to maintain confidentiality.
- The boxes were guarded by the manager and sealed by the researcher to ensure that the questionnaires (Appendix P) were not linked to the participants. This serves to maintain confidentiality and anonymity in the study. The researcher was available for the day if the participants required any assistance.
- The questionnaire box has been stored in the DUT Chiropractic Department for five years before the data will be shredded.
- All completed questionnaires were only analysed by the researcher and the statistician.

3.11 ETHICAL CONSIDERATIONS

3.11.1 Ethical Aspects

There are four principles of ethics that should always be maintained within research, these include autonomy, non-maleficence, justice and beneficence (Varkey 2020). Our study upheld these principles as follows:

3.11.2 Autonomy

- Participation was completely voluntary, and the participants were free to leave the study at any time. This was communicated to the participant verbally and was included in the informed consent form.
- None of the construction workers were coerced into participating in the study.
- The participants had to read and sign the Letter of Information and Informed Consent (appendices B and H) to provide autonomy.
- The names of companies and participants were not placed on the questionnaires in order to provide confidentiality and anonymity.

3.11.3 Justice

- All construction workers were treated fairly and without prejudice.
- Ethical approval (Appendix A) to conduct this study was obtained from IREC at DUT.

3.11.4 Non-maleficence

- Participants were assured that they would not jeopardise their job by participating in this study. This was communicated to the participants verbally. This study was extremely low risk for the participants, as there were no invasive investigative procedures, nor any form of treatment. It was thus highly unlikely that harm could befall a participant as a result of this study.
- The completed questionnaires and signed consent forms were collected in separate sealed ballot boxes to protect the participants in the form of nonmaleficence, by imposing the least amount of harm to reach an advantageous outcome.
- Only the researcher, statistician and supervisor had access to the data obtained from the questionnaire.
- Data collected was safely stored and will be kept for five years in the DUT Chiropractic Department, thereafter, it will be destroyed by shredding.
- The researcher objectively coded and always reported on the data.

3.11.5 Beneficence

- This was accounted for as results provided valuable information with regards to epidemiology in construction workers.

3.12 SUMMARY

A quantitative, descriptive cross-sectional study was conducted, involving the sampling of construction workers based at commercial construction companies within the eThekwini Municipality. In order to conduct the research study, ethics approval (Appendix A) was obtained from the IREC at the DUT.

All participants were administered the questionnaire in person. The study used a survey as a research tool, that included various questions relating to the epidemiology of LBP in construction workers, as per the study objectives. The research tool content was assessed, evaluated, and modified by a focus group, and a pilot study performed before the distribution of the questionnaires, in order to ensure reliability and validity. The data attained during the research study was kept confidential and stored at the DUT Chiropractic Department.

The next chapter presents the results of the study with tables and figures.

CHAPTER FOUR

RESULTS

4.1 BACKGROUND

This chapter presents the results obtained from the questionnaire (Appendix E) administered to our study, on the epidemiology of LBP in construction workers in the eThekwini Municipality. The results present descriptive statistics in the form of graphs and tables and the interpretation thereof.

4.2 Questionnaire Completion/Return Rate

Of the 256 questionnaires distributed to consenting participants, all questionnaires were completed and returned, yielding a 100% completion rate. Of the total number of questionnaires issued, there were 195 and 61 questionnaires left with the manager at the two companies, respectively. The manager received questionnaires from participants until the minimum number of 195 and 61, respectively, were received at each company.

4.3 DEMOGRAPHIC CHARACTERISTICS OF PARTICIPANTS

Table 4.1 Indicates demographic characteristics by sex of the participants in terms of age, height, weight and BMI**.**

Table 4.1: Demographic characteristics (N=256)

	Male (*n*=232)		Female (*n*=24)	
	Mean	Standard Deviation	Mean	Standard Deviation
Age	34.2	9.2	37.5	8.1
Height (m)	1.7	0.1	1.6	0.1
Weight (kg)	69.8	9.9	78.7	18.7
BMI (kg/m^2)	24.1	3.9	32.0	10.1

The study included 256 participants, where the study population comprised more men 90.6% (*n*=232) than women 9.4% (*n*=24). The women tended to be slightly older than the men. The mean age of the male participants was 34.2 ± 9.2 years, while the female participants were 37.5 ± 8.1 years. The mean BMI of the men was calculated as 24.1 ± 3.9 kg/m^2 and for the women it was 32.0 ± 10.1 kg/m^2. The women tended to be slightly heavier than the men with a mean weight of 78.7 ± 18.7kg as opposed to the men with a mean weight of 69.8 ± 9.9 kg.

4.4 PREVALENCE OF LOW BACK PAIN IN THE PARTICIPANTS

Figure 4.1 reports on the point and period prevalence.

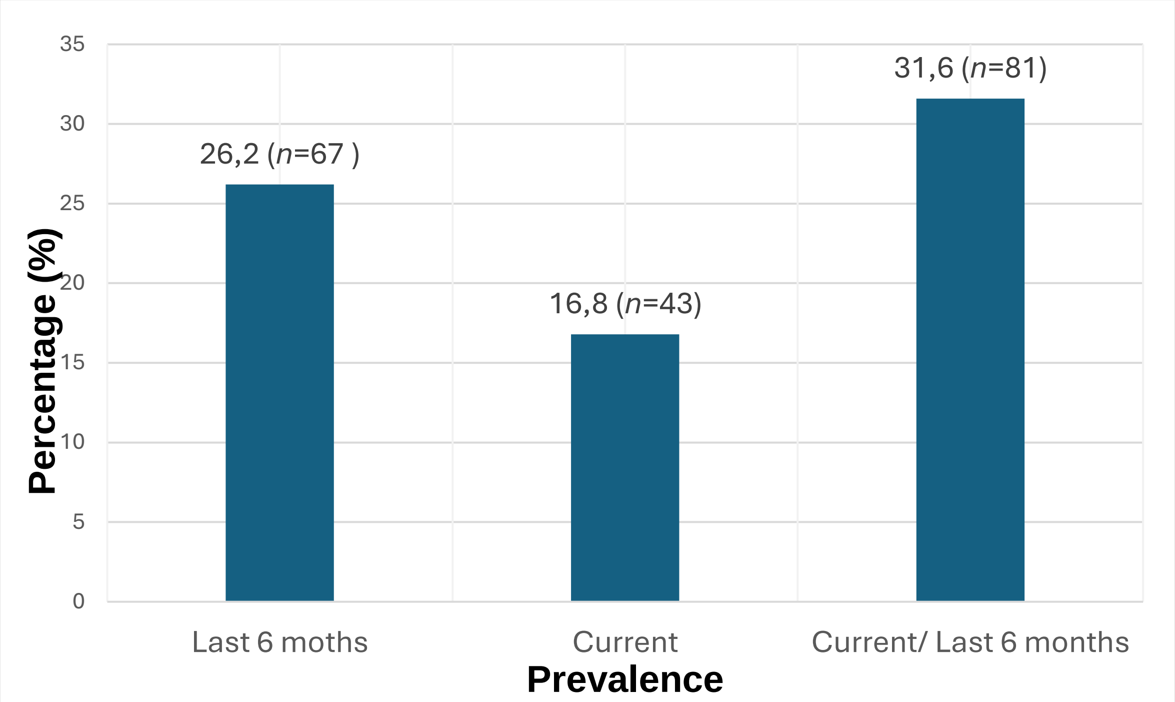

Figure 4.1 The prevalence of low back pain amongst the participants.

Of the study participants, 16.8% (*n*=43) reported currently experiencing LBP (point prevalence) and 26.2% (*n*=67) who experienced LBP in the last six months (period prevalence). It was found that 31.6% (*n*=81) had experienced LBP either currently, or for the last six months. The *n*=81 was obtained because there was an overlap of 29 participants who experienced it currently, and in the last 6 months; 14 participants experienced LBP in the last six months but not currently; 38 participants experienced it currently but not in the last six months. Thus 29+14+38=81 or it can be explained

as 175 people had neither current LBP nor LBP over the recent 6 months. Consequently a total of 81 participants experienced LBP currently or over the past 6 months (i.e. 256 – 175 = 81)

Table 4.2 depicts the binned age of the LBP that participants experienced.

Table 4.2: Describes the binned age of the LBP that participants experienced

Of those aged ≤27 years old, 34.8% had LBP, while of those 41+ years old, 45.6% had LBP. There was a slight increase in risk of the older people compared with the younger people.

			No	Yes	Total
Age (Binned)	≤27 years	Number (*n*)	45	24	69
		Percentage (%)	65.2%	34.8%	100.0%
	28 – 33 years	Number (*n*)	49	12	61
		Percentage (%)	80.3%	19.7%	100.0%
	34 – 40 years	Number (*n*)	48	19	67
		Percentage (%)	71.6%	28.4%	100.0%
	41+ years	Number (*n*)	31	26	57
		Percentage (%)	54.4%	45.6%	100.0%
Total		Number (*n*)	173	81	254
		Percentage (%)	68.1%	31.9%	100.0%

4.5 CHARACTERISTICS OF LBP

Table 4.3 describes the characteristics of the LBP that participants experienced.

Table 4.3: Characteristics of LBP

		Number (*n*)	Percentage (%)
Location of pain	Right side	24	29.6%
	Left side	13	16%
	Both sides	44	54.3%
Frequency of low back pain	Daily	35	43.2%
	Weekly	22	27.2%
	Monthly	20	24.7%
	Permanently	4	4.9%
Description of pain	Mild	39	48.1%
	Moderate	31	38.3%
	Severe	11	13.6%
Pain pattern	No	58	71.6%
	Yes	23	28.4%
Impact on job performance	No	50	62.5%
	Yes	30	37.5%
Absence from work due to LBP	No	57	70.4%
	Yes	24	29.6%
Days of work missed in the last six months	1-3	20	83.3%
	4-7	2	8.3%
	More than 7	1	4.2%
	More than 1 month	1	4.2%
Treatment received for LBP	No	51	63%
	Yes	30	37%

It was found that 54.3% (*n*=44) of the participants experienced LBP on both sides of the lumbar spine, 43.2% (*n*=35) experienced it daily and 48.1% (*n*=39) stated that the pain was mild. Most of the participants reported that the pain did not extend into the limbs 71.6% (*n*=58) and it did not affect their ability to perform their job 62.5% (*n*=50). In addition, 63% (*n*=51) did not receive any form of treatment and 83.3% (*n*=20) took one to three days off from work.

4.6 TREATMENT

4.6.1 Choice of Treatment

The participants were asked to report on their choice of treatment for their LBP, with only 30 participants with LBP receiving treatment **(Table 4.3).**

Table 4.4: Choice of treatment for LBP (N=30)

		Number (*n*)	Percentage (%)
GP	No	13	43.3%
	Yes	17	56.7%
Physiotherapist	No	28	93.3%
	Yes	2	6.7%
Chiropractor	No	30	100%
	Yes	0	0%
Traditional healer	No	29	96.7%
	Yes	1	3.3%
Self-medication	No	21	70%
	Yes	9	30%
Neurologist	No	30	100%
	Yes	0	0%
Orthopaedic surgeon	No	30	100%
	Yes	0	0%
Other(specify)	No	29	96.7%
	Yes	1	3.3%

The most frequently used treatment was a general practitioner 56.7% (*n*=17) followed by self-medication 30% (*n*=9).

4.7 RISK FACTORS

Table 4.5 represents demographic factors associated with LBP.

Table 4.5: Demographic factors associated with low back pain

	Last 6 months/ current	n	Mean	Std. Deviation	Std. Error Mean	*p*-value
Age	No	173	33.9	8.4	0.6	0.124
	Yes	81	35.9	10.4	1.2	
Height (m)	No	172	1.7	0.1	0	0.507
	Yes	80	1.7	0.1	0	
Weight (kg)	No	172	70.9	11.5	0.9	0.657
	Yes	79	70.2	10.7	1.2	
BMI (kg/m^2)	No	170	25.1	5.7	0.4	0.657
	Yes	78	24.4	4.4	0.5	

A p-value <0.05 was used to indicate statistical significance

Factors such as height (p=0.507), weight (p=0.657) and BMI (p=0.657) were not significantly associated with LBP. Age (n=81; p=0.124), although it was borderline non-significantly higher in those with LBP.

Table 4.6 shows sex associated with LBP.

Table 4.6: Sex associated with LBP

			Last 6 months/current		
			No	Yes	Total
Sex	Male	Number (n)	160	72	232
		Percentage (%)	69%	31%	100%
	Female	Number (*n*)	15	9	24
		Percentage (%)	62.5%	37.5%	100%
Total		Number (*n*)	175	81	256
		Percentage (%)	68.4%	31.6%	100%

No association was found between LBP and sex (p=0.517). LBP was equally likely in men and women (31% in men and 37.5% in women). **Table 4.7** indicates lifestyle factors associated with LBP.

Table 4.7: Lifestyle factors associated with LBP.

		Last six months/current				
		No		Yes		
		Number (n)	Percentage (%)	Number (*n*)	Percentage (%)	*p*-value
Smoking status	Current smoker	52	63.4%	30	36.6%	0.289
	Ex-smoker	10	58.8%	7	41.2%	
	Non-smoker	112	71.8%	44	28.2%	
	Total	174	68.2%	81	31.8%	
Years smoked	Less than 1year	11	73.3%	4	26.7%	0.015*
	1-5years	28	75.7%	9	24.3%	
	6-10years	13	56.5%	10	43.5%	
	11-15years	7	70%	3	30%	
	More than 15years	4	26.7%	11	73.3%	
	Total	63	63%	37	37%	
Cigarettes per day	1-5	39	68.4%	18	31.6%	0.047*
	6-10	14	50%	14	50%	
	11-15	5	100%	0	0%	
	16-20	1	20%	4	80%	
	More than 20	1	50%	1	50%	
	Total	60	61.9%	37	38.1%	
Alcohol	No	91	68.9%	41	31.1%	00.837
	Yes	84	67.7%	40	32.3%	
	Total	175	68.4%	81	31.6%	
Years of alcohol	Less than 1year	9	69.2%	4	30.8%	0.069
	1-5	43	78.2%	12	21.8%	
	6-10	17	54.8%	14	45.2%	
	11-15	5	45.5%	6	54.5%	
	More than 15	9	81.8%	2	18.2%	
	Total	83	68.6%	38	31.4%	0.783
Frequency alcohol	Everyday	2	50%	2	50%	
	Once a week	26	66.7%	13	33.3%	
	Twice a week	12	63.2%	7	36.8%	
	Occasionally	44	71%	8	29%	
Tots per week	Less than 1	28	80%	7	20%	0.310
	1-6	40	65.6%	21	34.4%	
	7-12	12	54.5%	10	45.5%	
	13-18	2	66.7%	1	33.3%	
	More than 18	1	100%	0	0%	
Exercise regularly	No	85	74.6%	29	25.4%	0.056
	Yes	90	63.4%	52	36.6%	
Running	No	146	69.5%	64	30.5%	0.392
	Yes	29	63%	17	37%	
Walking	No	152	68.8%	69	31.2%	0.717
	Yes	23	65.7%	12	34.3%	
Cycling	No	173	68.7%	79	31.3%	0.426
	Yes	2	50%	2	50%	
Gym	No	164	69.8%	71	30.2%	0.100
	Yes	11	52.4%	10	47.6%	
Swimming	No	174	68.5%	80	31.5%	0.575
	Yes	1	50%	1	50%	
Soccer	No	142	69.3%	63	30.7%	0.531
	Yes	33	64.7%	18	35.3%	
Basketball	No	173	68.1%	81	31.9%	0.334
	Yes	2	100%	0	0%	
Other	No	173	68.7%	79	31.3%	0.426
	Yes	2	50%	2	50%	
Exercise sessions per week	3-4	58	60.4%	38	39.6%	0.158
	5	20	80%	5	20%	
	Greater than 5	9	56.3%	7	43.8%	
Length of exercise (In mins)	Less than 30	7	38.9%	11	61.1%	0.076
	30	19	67.9%	9	32.1%	
	Between 30 and 60	43	71.7%	17	28.3%	
	60 or more	21	60%	14	40%	
Vigorous exercise	Light	32	66.7%	16	33.3%	0.880
	Moderate	22	61.1%	14	38.9%	
	Fast	29	63%	17	37%	
	Very Fast	6	54.5%	5	45.5%	
Stress	No Stress	149	77.2%	44	22.8%	<0.001*
	Work	14	45.2%	17	54.8%	
	Personal	7	31.8%	15	68.2%	

Both personal and work	4	44.4%	5	55.6%	

A p-value <0.05 was used to indicate statistical significance

A longer duration of smoking (p=0.015); a higher number of cigarettes smoked per day (p=0.047); the presence of work-related stress, personal stress or both (p<0.001) were significantly associated with LBP.

Table 4.8 depicts occupational factors associated with LBP.

Table 4.8: Occupational factors associated with LBP

		Last 6 months/current				
		No		Yes		
		Number (n)	Percentage (%)	Number (n)	Percentage (%)	*p*-value
Booked off work in the last six months	No	152	70%	65	30%	0.138
	Yes	22	57.9%	16	42.1%	
Days absent in the six last months	0-1	16	69.6%	7	30.4%	0.325
	2-3	5	45.5%	6	54.5%	
	4-5	2	50%	2	50%	
	More than 5	0	0%	1	100%	
Years working in construction	Less than 1	35	62.5%	21	37.5%	0.656
	1-5 years	57	68.7%	26	31.3%	
	Between 5-10	33	67.3%	16	32.7%	
	10 years or more	49	73.1%	18	26.9%	
Days worked per week	3-5	31	67.4%	15	32.6%	0.876
	6-7	144	68.6%	66	31.4%	
Hours worked per day	Less than 8	5	5-0%	5	50%	0.608
	8-11	156	68.7%	71	31.3%	
	12	8	72.7%	3	27.3%	
	More than 12	6	75%	2	25%	
Job performed	Bricklayer	41	69.5%	18	30.5%	0.084
	Scaffolder	9	50%	9	50%	
	Erector	12	66.7%	6	33.3%	
	Excavation	13	76.5%	4	23.5%	
	Form work	16	72.7%	6	27.3%	
	Concrete mixer	15	75%	5	25%	
	Carpenter	32	65.3%	17	34.7%	
	General worker	21	56.8%	16	43.2%	
	Other	16	100%	0	0%	
Performing the same task over and over	No	117	71.8%	46	28.2%	0.119
	Yes	58	62.4%	35	37.6%	
Sitting/standing for long periods	No	113	70.2%	48	29.8%	0.413
	Yes	62	65.3%	33	34.7%	
Bending or twisting movements	No	99	71.7%	39	28.3%	0.209
	Yes	76	64.4%	42	35.6%	
Working in awkward positions	No	129	69.7%	56	30.3%	0.447
	Yes	46	64.8%	25	35.2%	
Carrying or lifting heavy material or equipment	No	106	70.2%	45	29.8%	0.448
	Yes	69	65.7%	36	34.3%	
Other	No	166	67.5%	80	32.5%	0.133
	Yes	9	90%	1	10%	

A p-value <0.05 was used to indicate statistical significance

None of the factors were significantly associated with LBP. It was not possible to statistically compare the job functions and prevalence of LBP, due to the numerous categories present, but the trends showed that general workers (43.2%; *n*=16), followed by erectors (33.3%; *n*=6) were most likely to have LBP. All 14 of the participants who selected “other” for the job function were steel fixers.

4.8 SUMMARY

This chapter has outlined the results from the data collected from participants in this study. This study investigated the period and point prevalence and risk factors of LBP in construction workers in the eThekwini Municipality. The study included a total of 256 participants. The point and period prevalence were 16.8% and 26.2%, respectively. None of the demographic and occupational factors were associated with LBP. However, age was borderline non-significantly higher in those with LBP and the prevalence of LBP was higher in women. The trends showed that general workers followed by erectors, were most likely to have LBP. Longer duration of smoking, a higher number of cigarettes smoked per day, and the presence of work-related, personal stress, or both, were significantly associated with LBP. None of the other lifestyle factors were associated with LBP.

The following chapter elaborates on the significance of these results in the context of the literature. This will allow an accurate comparison regarding the epidemiology of LBP between the literature and this study.

CHAPTER FIVE

DISCUSSION

5.1 BACKGROUND

This chapter discusses the results of our study as presented in Chapter four. The discussion relates to the available literature concerning the epidemiology of LBP in construction workers. This chapter draws a comparison between the results of this study and the findings of other similar studies, in order to better understand the epidemiology of LBP in construction workers.

5.2 DEMOGRAPHIC CHARACTERISTICS

The mean age of the male construction workers was 34.2 (± 9.2 years), and female construction workers was 37.5 (± 8.1 years) in the current study. This may be due to construction workers around this age being able to perform the activities of a construction worker optimally, as these activities are physically demanding. The present study was similar to a study by Araújo, Carvalho and Martins (2016) on male construction workers in Brazil, who were between the ages of 18-63 years. The reported mean age of the participants was 32.5 years.

The mean ages in the present study were higher than the studies by Shaukat and Fatmi (2022), Chakraborty *et al.* (2017), Lette *et al.* (2019) and Adhikari *et al.* (2021). In the study by Shaukat and Fatmi (2022), the mean age of the participants was 29.6 ± 10.6 years. This study was conducted on male construction workers in Pakistan. Only construction workers aged between 18–59 years were included in the study. The study by Chakraborty *et al.* (2017) reported the mean age of the construction workers to be 28.17 years. This study was conducted in India and no inclusion/exclusion criteria were specified.

The study by Lette *et al.* (2019) reported that the mean age of the construction workers was 31.32 years. The construction workers included in the study were between 21−58 years old, conducted in Southeastern Ethiopia. A study of construction workers in Nepal by Adhikari *et al.* (2021) reported that the mean age of the participants was 31.78 ± 9.49 years. The participants were construction workers aged between 18 to 64 years. These studies were similar to the current study, as they were conducted with construction workers in a developing country. In addition, the sample size had construction workers of a similar age to our study.

The present study consisted of far more male (90.6%) than female (9.38%) construction workers. This was similar to the studies by Adhikari *et al.* (2021), Chung (2019), Mustapha, Akomah and Baiden (2022) and Yi and Chan (2016). In the study by Adhikari *et al.* (2021) there were (83.8%) male and (16.2%) female construction workers in Nepal. The study by Chung (2019) reported that there were (17.6%) female and (82.4%) male construction workers in Hong Kong. A study Mustapha Akomah and Baiden (2022) reported that there were (92 %) men and (8%) women. This study was conducted on construction workers in Ghana.

In a study by Yi and Chan (2016) there were more male (86.8%) as opposed to female (13.2%) participants. This study was conducted on construction workers in Nepal. These studies were the same as the present study, as they had more men than women in the sample size. The higher prevalence of male as opposed to female construction workers is because the construction industry is male dominated. This is due to the fact that the job is more mechanical in nature (Akinlolu and Haupt 2019). The mean BMI in the present study was calculated as 24.1 ± 3.9 kg/m^2 in men and for women it was 32.0 ± 10.1 kg/m^2. This was similar to studies by Yi and Chan (2016) and Umar *et al.* (2020). The BMI of the participants in the study by Yi and Chan (2016) was 24.3 ± 3.7 kg/m^2. This study was conducted with construction workers in Hong Kong. Majority of construction workers were male. The average height of these construction workers was 168.6cm and their average weight was 68.5kg.

In the study by Umar *et al.* (2020), conducted on male construction workers in Oman, the BMI was 27.32 ± 3.17 kg/m^2. The heights and weights were not specified in the study. That studies were different to the current study. This may be due to the study by Yi and Chan (2016) calculating both the BMI of the men and women. Moreover, the current study had more women than the study by Yi and Chan (2016). The study by Umar *et al.* (2020) had construction workers of different heights and weights, as opposed to the present study.

5.3 RISK FACTORS

The selected risk factors are discussed according to the following: demographics, lifestyle, and occupational.

5.3.1 Demographic risk factors

The demographic factors are discussed as follows.

5.3.1.1 Age

The results of the present study showed that age was not significantly associated with LBP. Our findings concurred with the studies by Chung *et al.* (2019), Himalowa and Frantz (2012), Lette *et al* (2019), Telaprolu, Lal and Chekuri (2013), Alghadir and Anwer (2015) and Eaves, Gyi and Gibb (2016). These studies were conducted on construction workers in developing countries besides the study by Eaves, Gyi and Gibb (2016).

The study by Eaves, Gyi and Gibb (2016) was conducted on construction workers in the UK. This study reported that construction workers conducted their activities poorly, for example, strenuous physical exertion and an unwillingness to use personal protective equipment, resulted in a higher prevalence of LBP in younger construction workers. The mean ages in the studies were similar to the present study.

The studies by Chung *et al.* (2019), Lette *et al.* (2019), Telaprolu, Lal and Chekuri (2013) Alghadir and Anwer (2015) were the same as the present study, as they investigated LBP and were conducted with construction workers. The sample sizes in the studies by Chung *et al.* (2019) (*n*=2021) and Lette *et al.* (2019) (*n*=422) were larger than the present study. The studies by Telaprolu, Lal and Chekuri (2013) (*n*=125), Himalowa and Frantz (2012) (*n*=212), Alghadir and Anwer (2015) (*n*=165) and Eaves, Gyi and Gibb (2016) (*n*=90) had smaller sample sizes than the current study.

The types of physical activities present in these studies were similar to the present study. The present study's findings on age and LBP may be due to the construction workers having more awareness of injury prevention, dangerous loads and management strategies for LBP (El-Soud *et al.* 2014). It may be due to the culture that is seen in construction workers, whereby they are unwilling to report health issues because they fear judgment from their co-workers (Eaves, Gyi and Gibb 2016). These findings are due to the construction workers having more work experience and survivor bias. Survivor bias is when construction workers avoid certain activities that have a high risk of musculoskeletal injuries which will lead to LBP (Ekpenyong and Inyang 2014).

A study by Wong, Karppinen Samartzis (2017) reported that aging is associated with changes in central pain processing, pain perception, and neuroplastic changes to pain responses. These changes in pain processing may increase a person's awareness and tolerance of pain. In contrast to our findings, the studies by Adhikari *et al.* (2021), Vasiwala *et al.* (2021) and Lee *et al.* (2023) found a significant association between age and LBP. The study by Adhikari *et al.* (2021) was conducted on construction workers in Nepal. A study by Vasiwala *et al.* (2021) of construction workers in Malaysia, showed that a high number (n=194) of construction workers had participated in the study. However, language issues with the questionnaire's questions were evident. This might have led to inaccurate data.

A study by Lee *et al.* (2023) was conducted with construction workers in South China. The construction workers were aged between 20-57 years. The construction workers aged 40 years or older, were more likely to develop LBP than those aged 25 years or younger. The studies were conducted on construction workers and the ages of the construction workers varied. These studies sample sizes (164/385/419) were different from the present study. The workloads were more strenuous and the type of construction workers was also different from the present study.

The association between LBP and age is due to the degeneration of the lumbar intervertebral discs that occurs due to repetitive microtrauma. This occurs when the balance between synthesis and degradation of the matrix is altered, which causes a loss of water, glycoproteins and increased levels of proteolytic enzymes. The disc now becomes dehydrated and the annulus fibrosis develops fissures which makes it prone to prolapse (Mohd Isa *et al.* 2022).

5.3.1.2 Sex

No significant association between LBP and sex exists in the current study. Our study had the same findings as the studies by Lette *et al*. (2018), Bodhare, Bele and Valsangkar (2011) and Chung *et al.* (2019). The study by Lette *et al.* (2018) was conducted with construction workers in Southwestern Ethiopia and investigated work-related injuries with LBP having a prevalence of 35.6%; consisting of *n*=266 men and *n*=89 women participants in the study.

A study on construction workers in Hong Kong by Chung *et al.* (2019) had a large sample size (*n*=2021) in which there were more male construction workers (*n*=1665) than female construction workers (*n*=356). In a study by Bodhare, Bele and Valsangkar (2011) with construction workers in Andra Pradesh, India, more male construction workers (*n*=179) than female construction workers (*n*=32) were sampled. The sample size was small (*n*=154) and their pain had occurred during the past year, lasting at least one week or more. Many more male than female participants were included in the sample size of those studies, similar to the current study, and the types of construction workers were also similar to the present study.

The sample size in our study consisted of many more male (90.6%) than female (9.38%) construction workers and an overrepresentation of males might have resulted because of this. The men may have had more work experience and, thus, they were more knowledgeable on how to prevent themselves from getting LBP. It was noted that men reported less pain severity, pain interference, and total pain (Chung *et al.* 2019). Most of the tasks involved in our study were strenuous and the women tended to be less involved in the strenuous tasks which could have caused LBP.

The prevalence of LBP in the present study was 31% in men and 37.5% in women. The studies by Kahere and Ginindza (2021) and Palacios-Ceña *et al.* (2020) also report a higher prevalence of LBP in women. In the study by Lee *et al.* (2023), a higher prevalence of LBP was also found in women. The study by Kahere and Ginindza (2021) was conducted in KZN on hospital patients and only looked at CLBP. Since the study was conducted on hospital patients (*n*=394) women and (*n*=284) men in the study. These participants might have had an ailment which may have increased the risk factors of CLBP. In the study by Palacios-Ceña *et al.* (2020), the participants were drawn from the Spanish general population. Only CLBP was investigated on a large number of participants (*n*=22 511). The sample size comprised more women (54%) than men (46%).

The study by Lee *et al.* (2023) was conducted with construction workers and there were (*n*=337) men and (*n*=47) women.

The findings of our study may be because most of the participants were men and an over-representation of males may have resulted. This difference in the prevalence may be due to hormones such as testosterone and oestradiol, which control sensitivity to and pain (Adhikari *et al.* 2021). In most African cultures, men usually underreport health problems as they believe it may decrease their masculinity and a higher prevalence is reported by African women (Morris *et al.* 2018). Another explanation could be due to the differences in the anatomical structures of the lower back, as men tend to have more musculoskeletal strength as opposed to women (Jones, Koehoorn and McLeod 2020).

5.3.1.3 Body Mass Index

No significant associations between LBP and BMI (p=0.657) were found in the present study. This was also found in the studies on construction workers by Lette *et al*. (2019) and Adhikari *et al.* (2021). The studies by Lette *et al.* (2019) and Adhikari *et al.* (2021) had a greater sample size (n=422/419) than the present study. The study by Bodhare, Bele and Valsangkar (2011), however, had a smaller sample size (n=154) than the present study. The studies were conducted on construction workers and had more men in their sample size, like the present study. The current study did not use a properly calibrated instrument to measure BMI. This was also the case in the studies by Bodhare, Bele and Valsangkar (2011) and Lette *et al.* (2019). A study by Adhikari *et al.* (2021), however, used a properly calibrated instrument.

In the current study, there was an overrepresentation of men (90.6%) as opposed to women (9.4%). In a study by Shiri *et al.* (2008) it was reported that the association between BMI and the prevalence of LBP was more prevalent in women than men. These differences between BMI and LBP relating to sex, may be due to hormone-induced obesity and changes in pain sensitivity (Siddiqui *et al.* 2022). This may also be due to the construction workers exercising and having a healthy diet.

5.3.2 Lifestyle

The lifestyle factors are discussed as follows.

5.3.2.1 Alcohol

No significant associations between LBP and alcohol were found in the current study. These findings concurred with the studies by Adhikari *et al.* (2021), Bodhare, Bele and Valsangkar (2011), Shmagel *et al.* (2016), Ganesan *et al.* (2017), Iizuka *et* *al.* (2017), Nazeer *et al.* (2015), Lv *et al.* (2022). The studies by Adhikari *et al.* (2021) and Bodhare, Bele and Valsangkar (2011) were conducted with construction workers in Nepal and India. In these studies, only current alcohol consumption was investigated. A study on adults with CLBP from the USA, by Shmagel *et al.* (2016) only looked at CLBP and did not state the correct definition of LBP. That study used a large national representative sample (*n*=5103) and a private computerised drug use questionnaire, that was not vulnerable to reporting bias. The data collected was restricted to participants between the age groups of 20 and 69 years. In addition, a non-institutionalised population was included and under sampling of illicit drug use could have resulted.

In a study on adults in India, by Ganesan *et al.* (2017) a large sample size (*n*=1532) included young adults of the age group 18-35 years, from the coaching institution of the Indian Administrative Service aspirants and medical aspirants. A regular alcohol consumer was defined as those who consumed five drinks (men) and four drinks (women). The alcohol had to be drunk at least once in two weeks. The participants were students and were required to provide information regarding alcoholism.

A study by Iizuka *et al.* (2017) consisted of 213 participants aged 50 years and over and looked at CLBP. The study took place in Katashina Village, Japan where the main economic sectors are agriculture and tourism. Most of the participants engaged in these sectors. This may have influenced the prevalence of CLBP and its associated factors. In addition, this study did not indicate the region for CLBP.

A study in South India, by Nazeer *et al.* (2015) provided details regarding alcohol consumption and looked at participants who were in hospital, in the age group 31-70 years. In a study by Lv *et al.* (2022), it was reported that the Mendelian randomisation method was used, which is a reliable method. This study used a large sample size (*n*=1378), but the participants were exclusively European.

These previously mentioned studies concurred with our study findings, although there were some differences among the studies. Some of those studies were conducted on construction workers, whilst some were conducted on the general population. The sample sizes varied and some of them were conducted in developed countries.

Studies by Adhikari *et al.* (2021), Ganesan *et al.* (2017) and Bodhare, Bele and Valsangkar (2011) probed alcohol in a similar way to the present study, but the definition of LBP was different from the current study. In a study by Shmagel *et al.* (2016) alcohol was measured differently to the current study. In addition, that study focused on CLBP and the participants were from the general population. A study by Iizuka *et al.* (2017) had a similar sample size (*n*=213) to the current study, although only CLBP was investigated. Moreover, the definition of an alcohol consumer was different from the present study.

There may also have been cases of underreported alcohol consumption in our study, which may have been done consciously or subconsciously (Gilligan *et al.* 2019). Alcohol consumption is of significant concern in the African culture, as its values favour a 'clean' lifestyle (Idang 2018). Alcohol is a substance with analgesic properties and therefore a decrease in pain after consumption, could change and increase the main effect of alcohol on pain (Thompson *et al.* 2017). It has been observed in animal studies that alcohol can block nociceptors receptors, which was also found in humans (Karimi *et al.* 2022). Another research study reported that alcohol consumption causes a dose-related excretion of opioid ligands, which decreases the transmission of pain to the central nervous system (Palm and Nylander 2016).

The current study reported the prevalence of LBP in alcohol to be 32.3%. This was higher than a study by Iizuka *et al.* (2017) which reported a prevalence of 27.2%. In contrast, the studies by Adhikari *et al.* (2021), Shmagel *et al.* (2016) and Ganesan *et al.* (2018) reported a lower prevalence. The studies by Iizuka *et al.* (2017) and Shmagel *et al.* (2016) were conducted on the general population. These two studies only looked at CLBP and the measurement of alcohol varied in these studies.

The studies by Adhikari *et al.* (2021) and Ganesan *et al.* (2018) were the only studies that reported on construction workers. It found that consuming alcohol every day had the highest prevalence of LBP at 50%. This was similar to a study in Sri Lanka by Karunanayake *et al.* (2013) who reported that consuming alcohol daily, doubled the risk of developing LBP. That study investigated CLBP in men, and differed from the present study in that it was conducted on patients in a hospital and CLBP was investigated. The frequency of alcohol measured was similar to the present study and it was also conducted in a developing country.

The present study reported the highest prevalence of LBP associated with the quantity of alcohol to be 45.5% (7-12 tots per week). In contrast, Strine and Hootman (2007) reported that LBP was associated with heavy drinking. The findings of the present study were higher than the study by Bezerra *et al.* (2018) but lower than the study by Kirsch Micheletti *et al.* (2019).

A study by Strine and Hootman (2007) was conducted on adults in the USA. Heavy drinkers were defined as men who drank more than two drinks per day and women who drank more than one drink per day. This study differed from the current study in that the sample size was greater than the present study. The volume of alcohol in our study was measured according to tots and this study did not specify what one drink was equivalent to.

A study by Bezerra *et al.* (2018) reported that consuming alcohol moderately had the highest prevalence of LBP at 20.5%. This study examined data from Brazil's National Health Survey and chronic musculoskeletal disorders were investigated. Alcohol consumption was measured per month. These findings differed from the present study. This was due to the measurement of the volume of alcohol and the questions were split according to sex. This study was also conducted in a developing country.

A study by Kirsch Micheletti *et al.* (2019) reported the highest prevalence of units of alcohol in LBP to be 53.6% (0-7 units). A large sample size of working adults from Denmark was used. This study differed from the present study, as it was conducted on the general working population and a larger sample size (*n*=20000) was used. The volume of alcohol in this study differed to the present study. In this study, the equivalence of one unit of alcohol was greater than the present study. No association between the quantity of alcohol and LBP was found. These findings were same as the study by Leboeuf-Yde (2000). That study was a systematic review with articles from the general and working populations. The systematic review contained studies from developed and developing countries. The measurement of the volume of alcohol differed in these studies as compared to the present study. The population was from the general and working class which differed from the current study.

5.3.2.2 Smoking

No significant associations between LBP and smoking were found in the present study. This was also the same in studies by Lette *et al*. (2019), Adhikari *et al.* (2021), Ekpenyong and Inyang (2014), Arias, Koenig and Choi (2022), Bodhare, Bele and Valsangkar (2011), Ganesan *et al.* (2017). Lette *et al.* (2019) reported that there was no description of smoking, and a small sample size (*n*=422) was used. This study was conducted on construction workers in Southeastern Ethiopia. In a study of construction workers in Nepal by Adhikari *et al.* (2021) the current smokers were defined as anyone who reported smoking any type of tobacco product within the last month. In addition, participants who reported smoking a minimum of 100 cigarettes in their lifetime and who at the time of data collection were not smokers, were defined as past smokers.

A study by Ekpenyong and Inyang (2014) was an observational study which meant that there was a restriction in physical assessment and it can, therefore, not be used to approximate past exposures. These limited observations may lead to misclassifications. This study was conducted on male construction workers in Nigeria. A study by Arias, Koenig and Choi (2022) focussed only on male construction workers, and it was conducted in a first-world country.

A study by Bodhare, Bele and Valsangkar (2011) had a small sample size (*n*=154) of construction workers in India. The degree of musculoskeletal disorders was not quantified by investigation due to the study being community-based. According to Ganesan *et al.* (2017), regular smoking was defined as anyone who smoked 100 cigarettes in their lifetime and currently smoked cigarettes daily, or seldomly. The study was conducted on young adults who were getting ready for their entrance exams. These adults usually studied for extended hours; which may have been a significant factor contributing to the LBP. They would have experienced lots of stress, which could have exacerbated LBP. The studies were different from the present study, in the way smoking was probed with a Yes/No response to current smoking only. The present study, however, looked at current and ex-smokers. All of the studies were conducted on construction workers, although the study by Ganesan *et al.* (2017) did not. In addition, the studies were conducted in developing countries, like the current study.

Smoking was underreported in our study due to fear of repercussions from the employer, making it difficult to detect the association between smoking and LBP (Bert *et al.* 2020). The prevalence of LBP in current smokers and ex-smokers in the current study was 36.6% and 41.2%, respectively. In the studies by Adhikari *et al.* (2021) and Ekpenyong and Inyang (2014) there was a higher prevalence of 52.4% and 53.1%, respectively. In studies by Arias, Koenig and Choi (2022), and Ganesan *et al.* (2017), the prevalence was lower at 32%, and 10.6%, respectively. The prevalence differed in these studies compared to the current study.

The status of smoking prevalence reported in these studies was different from the current study, in that the other studies reported only on current smokers. The present study reported a significant association between a longer duration of smoking and LBP, with the highest prevalence found in 15 years and over (73.3%). This finding was similar to the study by Pirouzi *et al.* (2011), who reported that the prevalence of LBP associated with duration of smoking to be highest at 9-13 years (52.9%). This study was conducted on male medical students with musculoskeletal pain in Iran. The students had to smoke five or more cigarettes per day, for at least two years, to be included in the study. The findings from that study were the same as the present study.

A study by Pirouzi *et al.* (2011) was similar to the present study, in that it was conducted in a developing country. The present study revealed a significant association between a higher number of cigarettes smoked per day and LBP. The findings of the studies by Kahere and Ginindza (2021), Pirouzi *et al.* (2011) and Green *et al.* (2016) also reported a significant association between a higher number of cigarettes smoked per day and LBP. It is believed that smoking may have a quantity-response relationship with LBP. The excitatory effects of nicotine alter the threshold and perception of pain. This increases the reporting of pain (Smuck *et al.* 2019). Smoking increases the levels of cytokines, which stimulate the central nervous system leading to higher amounts of pain (Green *et al.* 2016). In the study on USA adults by Green *et al.* (2016) back pain was investigated and defined as pain for the whole day or longer, in the previous three months.

A study by Kahere and Ginindza (2021) examined at hospital patients with CLBP, which was similar to the present study, in that it was conducted in KZN. This study, however, looked only at CLBP. In addition, it was done on hospital patients. In a study by Green *et al.* (2016) the definition of current and ex-smokers was different to the present study. Current smokers/former smokers were defined as those smoking a minimum of 100 cigarettes in their lifetime. This study also differed to the present study, in that it was conducted on the general population and back pain was investigated. A study by Pirouzi *et al.* (2011) was similar to the present study, as it was conducted in a developing country. The studies by Lv *et al.* (2022), Shmagel *et al.* (2016), and Kahere and Ginindza (2021) were different from the current study, as they showed a positive association between LBP and smoking. A study by Lv *et al.* (2022) reported that the Mendelian randomisation method was used, which is a reliable method. The data was obtained from European genome-wide association studies. A study by Shmagel *et al.* (2016) was conducted on young USA adults with CLBP. A study by Kahere and Ginindza (2021) was conducted on 678 hospital patients with CLBP in KZN. The findings were not the same as the current study. These studies differed from the current study, in that they were not conducted on construction workers and the sample sizes varied. Smoking causes coughing, which increases the pressure in the disc and abdomen, which in turn may lead to disc herniation. Smoking also decreases blood flow to the intervertebral discs, causing metabolic imbalances in the discs (Lv *et al.* 2022). Smoking decreases the concentration of minerals in bones which will increase the risk for osteoporosis, fractures, and degeneration (Kahere and Ginindza 2021).

5.3.2.3 Stress

The presence of work-related, personal stress or both, was significantly associated with LBP in the present study. These findings were the same as the studies by Adhikari *et al.* (2021), Vinstrup, Jakobsen and Andersen (2020), Takegami *et al.* (2023), Anwer *et al.* (2021) and Jacobsen *et al.* (2013). A study on construction workers in Nepal by Adhikari *et al.* (2021) did not describe stress and a small sample size was used. A depression anxiety and stress scale (DASS-21) was used to measure the stress. A study by Vinstrup, Jakobsen and Andersen (2020) was conducted on healthcare workers, who work in a highly stressful environment and this might have exaggerated the findings. The Cohen's perceived stress scale is an accurate indicator to measure stress and used in that study.

A study by Takegami *et al.* (2023) had a small sample size (*n*=300) and participants over 50 years of age were recruited from people living in a mountain village, in

Japan. In a study by Jacobsen *et al.* (2013), there was a small sample size (*n*=178) used, and it was reported that construction workers are a low-income class with a high prevalence of temporary work status. This is independently associated with a higher risk of mental distress. Being weak psychologically may cause more perceived pain or disability.

The systematic review of construction workers by Anwer *et al.* (2021) included studies from developing and developed countries. The studies included more male than female participants. The studies were conducted on construction workers; but one was conducted on healthcare workers. In a study by Adhikari *et al.* (2021) from Nepal, a Depression Anxiety and Stress Scale (DASS-21) was used. A study by Vinstrup, Jakobsen and Andersen (2020) used the Cohen's perceived stress scale. These tools, used to measure stress, were reliable and comprehensive, while in the present study no reliable tool was used. A study by Anwer *et al.* (2021) and Takegami *et al.* (2013) was similar to the present study, in that no reliable tool was used to assess stress and it was assessed at a very basic level with Yes/No responses. Moreover, these studies were similar to our study, as they investigated LBP. The present study specified the type of stress, whereas the studies did not specify this. Work stress could be caused by sudden events, loss of control over situations and time. Stressful events reported in our study may be present in a worker's personal life, which may influence the stress experienced at work (Lazarus 2020). Stress results in cortisol dysfunction and generalises inflammation. This can lead to oxidative, nitrative stress, free radical damage, cellular injury and systemic tissue degeneration. This in turn, causes muscle tension, increased sensitivity to pain, poor posture and decreased vascular supply to the soft tissue structures (Hannibal and Bishop 2014). Stress may decrease a person's pain tolerance, which will result in an increased perception of LBP. Mental stress causes a person to perform their activities differently, this will result in more microtrauma to the lumbar spine (Anwer *et al.* 2021).

The prevalence of stress, be it work, personal or both, in the current study, was 54.8%, 68.2% and 55.6%, respectively. These findings are similar to the studies on construction workers by Adhikari *et al.* (2021) and Jacobsen *et al.* (2013) which reported a prevalence of 56.1% and 52.98%, respectively. In a study by Jacobsen *et al.* (2013) the Hopkins Symptoms Checklist was used, which is a reliable indicator for stress. The type of stress, however, was not specified in the present study. The study was similar in that it focussed on construction workers who were mostly men. A study by Adhikari *et al.* (2021) was similar in that men and women were included in the sample size.

5.3.2.4 Exercise

No significant associations between LBP and exercise were found in the present study. This was also reported on in a study by Saragiotto *et al.* (2016), with adult participants with acute, subacute, or chronic nonspecific LBP. This concurred with the current study's findings and was similar in that it included all types of LBP. The study had different types of exercises investigated, which were different from the current study. The lack of exercise and LBP in our study might be due to the fact that construction workers have long working hours, with no time for exercise Zhang *et al.* (2015). Given the strenuous labour that is involved in this occupation, construction workers might be fatigued when they reach home and may not have the energy to exercise (Aryal *et al.* 2017). There might also be a lack of knowledge of exercise and its benefits.

In studies by Kahere and Ginindza (2021), Alnaami *et al.* (2019), Shieh *et al.* (2016), and Al-Otaibi, Al-Salameen and Abugad (2019), a positive association between LBP and exercise existed. These findings did not concur with the present study. This may be due to the studies being conducted on different participants and the fact that the sample sizes (*n*=650/589/992/150) were larger. Not participating in regular exercise, causes a weakness in the myofascial parts of the lower back region and abnormal biomechanics (Kahere and Ginindza 2021). Exercise strengthens the spinal muscles, reduces the subsequent occurrence of LBP by approximately 30% and decreases the intensity of pain and associated disability (Alwardat 2018). Exercise aids in muscle strength, increased cardiovascular function and optimal absorption of nutrients by bone and muscle tissue, which prevents LBP from occurring (Tesfaye *et al.* 2023). In the current study, cycling and swimming had the highest prevalence of LBP at 50%, followed by exercising more than five times per week at 43.8%. In contrast, a study by Alwardat (2018) reported that the prevalence of LBP in strengthening and stretching exercises was 45%, whereas it was 33% for strengthening and aerobic exercises. In addition, LBP in daily exercise was 69% and 1% for exercising two to three times per week. These findings were not the same as our findings and this may be due to exercise being probed differently. The findings in our study might be due to the repetitive movements involved in cycling and swimming (Teferi 2020).

5.3.3 Occupational factors

The findings of the present study reveal that the prevalence of performing the same task over and over (37.6%) e.g., sitting/ standing for long periods (34.7%), bending and twisting movements (35.6%), working in awkward postures (35.2%) and carrying/lifting heavy materials (34.3%) is associated with LBP. These findings were higher than studies by Kashif *et al.* (2022) and Sany, Tanjim and Hossain (2022) but lower than a study by Dlungwane, Voce and Knight (2018).

A study by Boschman *et al.* (2012) had higher findings than our study. A study on construction by Kashif *et al.* (2022) reported that the prevalence of lifting loads (24.34%), working in the same position for extended periods (21.56%) and working in awkward positions (19.36%) is associated with LBP. In this study, different types of construction workers were used, including plumbers and steel binders and different types of musculoskeletal disorders were investigated. A study in KZN by Dlungwane, Voce and Knight (2018) reported that LBP prevalence in the following activities: working in awkward positions (6%), bending/twisting (80%), lifting (74%), extended positions (77%), repetitive tasks (24%) and working in awkward positions (9%). This study was conducted on nurses whose activities vary to those of construction workers. These findings were not the same as those in the present study. A study by Kashif *et al.* (2022) was similar to the present study, in that it was conducted on construction workers in a developing country. Different types of construction workers were used in this study, which resulted in a difference in prevalence between the two studies. Given that musculoskeletal disorders were investigated, this meant that LBP was not the only type of disorder. In a study by Dlungwane, Voce and Knight (2018) there was a similarity with this study, in that it was conducted in KZN, and the sample size (*n*=300) was similar. The study, however, was conducted on nurses and these workers are exposed to activities that are different from construction workers.

A study involving medical students by Sany, Tanjim and Hossain (2022) found that the following activities aggravated LBP: bending/twisting (18.8%), lifting objects (8.4%), sudden movements (5.2%) and repetitive tasks (3.2%). A study by Sany, Tanjim and Hossain (2022) only included students from one medical college and thus the results might not be representative of all medical students in Bangladesh. In addition, the researchers did not use any diagnostic medical tests to confirm they had LBP. A study on construction by Boschman *et al.* (2012) reported that working with a bent back (72%), carrying, and lifting (64%) and kneeling and stooping (55%) were associated with LBP. The sample size consisted of bricklayers and supervisors, which meant that there was a difference in the number of physical tasks and different types of musculoskeletal disorders were investigated. These studies did not concur with the present findings.

In a study by Sany, Tanjim and Hossain (2022) the sample size was similar to the present study; it was conducted on medical students. These students are involved in different tasks as compared to the construction workers which would affect the prevalence and type of activities reported. A study by Boschman *et al.* (2012) differed from the present study, in that only bricklayers and supervisors were included in the sample size. The study also investigated different types of musculoskeletal disorders. The present study did not find any of the risk factors to be significantly associated with LBP. These findings did not concur with the studies by Ekpenyong and Inyang (2014), Khumalo and Haffejee (2022), Yosef *et al.* (2019), Alnaami *et al.* (2019), Shiri *et al.* (2019), Anwer *et al.* (2021) and Bodhare, Bele and Valsangkar (2011), Kebede *et al.* (2019), Liu *et al.* (2023), Dlungwane, Voce and Knight (2018) and Kahere and Ginindza (2021). In a study by (Ekpenyong and Inyang 2014) it was reported that awkward posture (55.5%) was associated with LBP. This study was conducted on male construction workers in Nigeria. The sample size consisted of mainly bricklayers, and it was noted that workers in some trades are more vulnerable than others. Studies reported that LBP was associated with lifting heavy objects (Khumalo and Haffejee 2022; Yosef *et al*. 2019; Alnaami *et al*. 2019). Shiri *et al.* (2019) reported that manual handling of loads greater than 20 kg was associated with LBP. A study by Khumalo and Haffejee (2022) was conducted on patients presenting at a clinic in a rural area in KZN. The participants were required to carry large quantities of water over a far distance. Many carried a heavy bucket of water (20 litres) with their hand or on their head. This affects the biomechanics of the lumbar spine resulting in degeneration.

A study by Ekpenyong and Inyang (2014) was similar to the current study, in that it was conducted on construction workers in Africa, and there were more men than women in the sample size. Which was investigated for LBP. The types of construction workers differed from the present study, and different types of musculoskeletal disorders were measured. The results of the studies by Khumalo and Haffejee (2022), Yosef *et al.* (2019), and Alnaami *et al.* (2019) differed from the current study. This is because it was performed on a different population to the present study.

A study by Alnaami *et al.* (2019) was conducted on nurses, in which it was reported that manual handling of loads greater than 20 kg is associated with LBP. In studies by Anwer *et al.* (2021) and Bodhare *et al.* (2011) on construction workers, awkward postures were associated with LBP. A study by Anwer *et al.* (2021) reported that many of the studies included (38%) did not define and quantify specifications of the physical risk factors properly. This did not allow for comparisons of results across studies, and most of the studies that were included used poorly defined physical risk factors in their odds ratio calculations. The findings presented are different from this study. The systematic review by Anwer *et al.* (2021) differed from the present study, in that it was conducted on different types of construction workers in developing and developed countries. In the studies by Alnaami *et al.* (2019) and Shiri *et al.* (2019) a different population was used to this study. A study by Bodhare, Bele and Valsangkar (2011) was conducted on a different type of construction workers compared to this study.

It was reported by Kebede *et al.* (2019), Shiri *et al.* (2019) and Liu *et al.* (2023) that prolonged standing was associated with LBP. A study by Shiri *et al.* (2019) was conducted with a large sample size and participants were from different construction occupations. In a study on teachers by Kebede *et al.* (2019), it was reported that LBP may be due to the physical activities experienced during teaching. This includes prolonged standing in an awkward position for several hours, resulting in excessive strain on the lumbar spine. It was also noted that prolonged standing may not be the only risk factor for LBP. Other activities such as twisting, prolonged sitting to mark exams and lifting loads, were also risk factors for LBP. A study by Liu *et al.* (2023) was conducted on nurses and a large sample size (*n*=396) was used. The findings differed from this study. The studies were similar to this study, in that they were conducted in developing countries. A study by Shiri *et al.* (2019) was the only study conducted on construction workers, the others were conducted on different occupations. These occupations involved different types of activities.

A study in KZN by Dlungwane, Voce and Knight (2018) reported that bending and twisting were strongly associated with LBP in nurses. A study among the general adult population attending public hospitals in KZN reported that the stooped sitting posture was identified as a risk factor (Kahere and Ginindza 2021), but identified no formal education as a significant predictor of CLBP.

Individuals with no formal education have a higher chance of engaging in manual occupations characterised by a notable frequency of bending, twisting and lifting of heavy objects, all of which have been reported to be highly associated with CLBP. These results differed from the current study as they were conducted on nurses. These workers are involved in different activities that cause LBP. The findings are that these activities lead to musculoskeletal dysfunction and microtrauma to the soft tissue structures, joints, intervertebral discs and bones (Mosabbir 2022). The present study revealed that scaffolders and general workers had the highest prevalence of LBP at 50% and 43.2%, respectively. These findings are similar to a study by Chung *et al.* (2019). The studies by Susseret, Briceno-Ayala and Radon (2019), Adhikari *et al.* (2021), Lee *et al.* (2023), Attaullah *et al.* (2019) and Arias, Koenig and Choi (2022) differed from our study findings. In a study by Chung *et al.* (2019) the highest prevalence of LBP was among general workers (37.5%). This study was conducted on construction workers in Hong Kong, with over 20 different types of construction trades. The findings of this study are similar to the current study. This may be due to the study being conducted in a developing country and the types of construction workers included. Far more men than women were in the sample size, which is similar to the current study. A study on migrant workers in Argentina, by Susseret, Briceno-Ayala and Radon (2019) reported the highest prevalence of LBP to be in carpenters (71.6%). It must be noted that the migrant workers were more apprehensive than local workers to report poor working conditions or health conditions, because they feared legal consequences. The findings of this study differed from the current study. The study was different from the current study, in that no general workers and scaffolders were included in the sample size. Moreover, there were migrant construction workers included in the study's sample size. The sample size (*n*=275) was similar to the current study.

A study by Adhikari *et al.* (2021) reported the highest prevalence of LBP to be in painters and electricians (87.5%). It was reported that the difference in prevalence among construction workers might be due to the differences in their working postures, which did not concur with the current study. This study was similar to the current study, in that it was conducted on construction workers, although scaffolders were not included. A study with construction workers in China, by Lee *et al.* (2023) reported the highest prevalence of LBP to be found in interior decorators (78.9%). It was reported that interior decorators have to cope with a higher body load than general workers. In addition, interior decorators engage in more activities on floors than general workers. The study findings are different from the current study. The types of construction workers selected for this study were similar to the current study, but scaffolders were left out. In the study on construction workers in Pakistan by Attaullah *et al.* (2019) the highest prevalence of LBP was in steel binders (41%). This study reported that manual labourers and masonry workers are more susceptible to musculoskeletal disorders as opposed to machine operators. This study's findings did not concur with the current study. This study did, however, have a similar sample size (*n*=300) and was conducted in a developing country, like the current study. The construction trades were similar to the current study, but the group 'other' did not specify what types of construction workers these were.

The study by Arias, Koenig and Choi (2022) reported the prevalence of LBP to be highest in framers (39%). Certain construction trades, such as carpenters, labourers and framers, were lacking. This study was conducted on construction workers in Wisconsin, USA. The findings of the current study were different from this study, as the musculoskeletal pain was measured over seven days. This study differed from the current study, as it was conducted in a developed country and a smaller sample size (*n*=23) of construction workers was used. The study was like the current study, in that it also investigated LBP. The scaffolders are a unique occupational group due to the heavy physical labour involved. They are required to assemble the scaffold, dismantle it and transport the components. These activities involve manual lifting, lowering and carrying of heavy materials; all of which make them highly susceptible to LBP (Yin and Caldas 2020). The general workers are also involved in highly strenuous tasks, making them exceedingly susceptible to LBP (Anwer *et al.* 2021).

The highest prevalence of LBP was in construction workers working less than one year and for less than eight hours per day. These findings are similar to a study by Adhikari *et al.* (2021). Studies by Alghadir and Anwer (2015) and Lee *et al.* (2023) had higher findings than the current study. This may be due to the construction workers being less experienced and thus they don't have vast knowledge on prevention strategies of LBP. The studies by Alghadir and Answer (2015) and Lee *et al.* (2023) do not concur with the current study. This may be due to different periods being used to measure this.

The findings in a study by Adhikari *et al.* (2021) are similar to the current study. This may be due to the companies having a similar policy on the specified working hours, as well as that it was also conducted in a developing country. The current study did not find any association between LBP and the number of years and the number of hours per day, worked in construction. In the studies by Telaprolu, Lal and Chekuri (2013) and Shaukat and Fatmi (2022) LBP was not significantly associated with the number of years of construction work and the number of hours worked per day. This may be due to construction being more experienced and having more knowledge of injury prevention and harmful loads. In addition, they have better coping strategies for musculoskeletal pain than the less experienced construction workers (Telaprolu, Lal and Chekuri 2013). These studies had the same findings as the current study. This may be due to the studies being conducted in developing countries. A study by Lette *et al.* (2019), however, reported that years in construction were significantly associated with musculoskeletal pain. The study did not concur with the current study that this may be due to the study including more construction workers who are experienced.

5.4 LBP HISTORY

The history of LBP is discussed according to the following: prevalence, treatment and characteristics.

5.4.1 History of LBP

The history of low back pain will be discussed below.

The present study reported a period prevalence of 26.2% in LBP. The studies by Chakraborty *et al.* (2017), Adhikari *et al.* (2021), Vasiwala *et al.* (2021), Attaullah *et al.* (2019) and Susseret, Briceno-Ayala and Radon (2019), however, reported a higher prevalence. A study of Indian construction workers by Chakraborty *et al.* (2017) reported the period prevalence to 33.87%. This period prevalence was measured over a different period, as opposed to the current study. In addition, most of the construction workers worked overtime, and the sample size (*n*=268) was bigger than the present study. A study of LBP on construction workers in Nepal, by Adhikari *et al.* (2021) reported a period prevalence of 28.6%. The period of prevalence was measured over one week and the sample size was *n*=402 of construction workers.

In a study by Vasiwala *et al.* (2021) the period prevalence was 26.3%. Only male manual construction workers, 20-50 years of age, in Malaysia participated. The period prevalence in this study was more than three months and participants with previous low back injuries were included in the study. The studies were conducted in developing countries, similar to the current study. The measurement of period prevalence differed in those studies, from the current study.

A study by Attaullah *et al.* (2019) reported prevalence to be at 32.83%. This study was conducted on male construction workers only, in Hayatabad Peshawar, India. This study did not specify the type of prevalence investigated. The study only included construction workers who were working at least 40 hours per week, for the last six months. That study was similar to the current study in sample size (*n*=300) and the types of construction workers.

In a study of construction workers in Argentina, by Susseret, Briceno-Ayala and Radon (2019) the period prevalence was 62%. Most of the construction workers involved in the study were migrant workers (99.5%), which included many types of work that are routinely done by construction workers. The prevalence of LBP was taken over seven days. In these studies, the types of construction workers were different from the current study, as they were engaged in more physically demanding tasks. The number of participants was also greater (*n*=275) and construction workers had a lack of knowledge of prevention strategies for LBP. This study was similar to this study by being conducted in a developing country. The measurement of the period prevalence, was, however, different from the current study. The low prevalence reported in our study could be due to the healthy worker effect'; this occurs when the construction workers who participate in the study were not significantly affected by LBP, making them not fit to work. This implies that the prevalence of LBP may be higher amongst the construction workers. This effect has been observed in other mechanical industries, where workers with severe musculoskeletal symptoms were not fit to be on-site (Eaves, Gyi and Gibb 2016). This may also be due to the prevalence being measured over six months.

In the studies by Shaukat and Fatmi (2022) and Kemta Lekpa *et al.* (2021), the prevalence was lower than our current study findings. A study by Shaukat and Fatmi (2022) and Kemta Lekpa *et al.* (2021) had a prevalence of 14.3% and 12.3%, respectively. Shaukat and Fatmi (2022) reported that over half of the construction workers had weak levels of occupational health and safety prevention knowledge, and the majority had poor practices. The prevalence reported was lower than the current study. This study was different from the current study in that there were not many different types of construction workers. A study by Kemta Lekpa *et al.* (2021) was conducted on school children in Cameroon, these children were not engaged in any strenuous activities that might have led to LBP. This study was different from the current study, in that it was conducted with school children and a larger sample size (*n*=1137) was used. The point prevalence of LBP in this study was 16.8%. In contrast, Adhikari *et al.* (2021) and Umer *et al.* (2017) reported a higher point prevalence, whilst Shaukat and Fatmi (2022) reported a lower point prevalence, which was higher than the current study.

A study of construction workers in Nepal, by Adhikari *et al.* (2021) reported prevalence to be at 22.9%. Different types of construction workers took part in this study and a greater sample size (*n*=419) was used. This study was similar to the current study, as it was conducted in a developing county, although also different due to the type of construction workers who participated in the study. The systematic review of construction workers by Umer *et al.* (2017) reported the point prevalence to range between 33% to 39% in the USA and 47.8% to 60.3% in Germany. These studies were different from the current study, as they were conducted with larger sample sizes (*n*=312/4958) and different types of construction workers. These studies were also conducted in developed and different countries. A study by Shaukat and Fatmi (2022) reported the point prevalence to be 8.1%. This study was conducted with construction workers in Karachi, Pakistan. The researchers could not supplement the measurements with clinical examination for specific disorders that may have impacted the overall prevalence. This study differed from the current study, as there were not many types of construction workers included in the study. The low prevalence reported in the current study may be due to it being a point prevalence.

5.4.2 Treatment

The current study revealed that only 25% received treatment. The majority of the construction workers accessed a General Practitioner (GP) (56.7%) followed by self-medication (30%), physiotherapists (6.7%) and traditional healers (3%). This concurred with the findings by Lette *et al.* (2019), Arias, Koenig and Choi (2022), Alghadir and Anwer (2015) and Nazri *et al.* (2018) in their studies. A study by Lette *et al.* (2019) reported that most of the participants received treatment from a GP. The study was conducted with construction workers in Southeastern Ethiopia. This study was similar to the current study, as it was also conducted in Africa and LBP was investigated. Differences were found, however, as not many treatment options were available. In addition, other forms of musculoskeletal pain were included. A study of construction workers by Arias, Koenig and Choi (2022) in Wisconsin, reported that most of the construction workers visited a GP. This study was different from the current study, as it was conducted in a developed country where construction workers would have had the means to access a variety of treatments. In addition, the study looked at acute and chronic LBP. It was similar to the current study as there were many options for treatment and LBP was included. The sample size was small (*n*=23) and participants were from a specific geographic region. A study by Alghadir and Anwer (2015) reported that most of the participants received medical treatment (62.5%). This study comprised only male construction workers. This study was also conducted in a developing country and investigated LBP. There were, however, not many treatment options available.

A study by Nazri *et al.* (2018) reported that most of the participants chose medical treatment. The study was conducted with 226 construction workers in Malaysia. This study was similar to the current study, in that there were similar types of construction workers and LBP was investigated. There were, however, not many treatment options available. The reason for a doctor being the most sought-after treatment in our study, might be because the types of treatment provided by the company. The construction workers tend to use medicine because it is provided and accessible at the workplace. The participants did not have the financial means and were of low socio-economic status. A medical doctor provided the most accessible form of treatment at a clinic or public hospital.

The prevalence of construction workers who received physiotherapy in our study was 6.7%. The studies by Adhikari *et al.* (2021) and Kemta Lekpa *et al.* (2021) reported a higher prevalence, whilst a study by Alghadir and Answer (2015) reported a lower prevalence.

A study on construction workers in Nepal by Adhikari *et al.* (2021) reported that the prevalence of construction workers who received physiotherapy treatment was 41.1%. That study was similar to the current study in that men and women were included and there were many treatment options probed in the questionnaire.

A study on LBP in school children in Cameroon by Kemta Lekpa *et al.* (2021) reported that most of the construction workers received physiotherapy treatment (34%), which differed from the current study as it was conducted with school children and few treatment options were available.

In a study on construction workers in Saudi Arabia, by Alghadir and Answer (2015) it was reported that the prevalence of physiotherapy treatment was 1%. The findings of the current study differed from this study, in that there were not many treatment options available. The current study reported that the prevalence of self-medication was 30%. This was higher than the studies by Vasiwala *et al.* (2021) and Chung *et al.* (2019) but lower than a study by Khumalo and Haffejee (2022).

It was reported in a study on LBP by Vasiwala *et al.* (2021) that the prevalence of consumption of medication was 26.8%. This study was conducted on construction workers in Malaysia. This study was different from the current study, as the only treatment probed was medication. A study on hospital patients with LBP in a rural village in KZN by Khumalo and Haffejee (2022) reported that the prevalence of medication consumption was 66.9%. This study was different from the current study as it dealt with hospital patients and thus the types of treatment are restricted to the medical system. A study on construction workers in Hong Kong, by Chung *et al.* (2019) reported that the prevalence of medication consumption was 18.8%. This type of treatment allowed the construction workers to administer it themselves and it was cheap. This study was similar to the current study with regards to the different forms of treatment probed, although some of the more common treatments like medical doctors/physiotherapy were excluded.

The studies on construction by Adhikari *et al.* (2021), Chung *et al.* (2019) and Abas *et al.* (2018) reported that 36% of the respondents chose to rest. These findings were different from the current study, as the option of rest was not included in the current study. These studies were conducted in a developing country and the participants may not have had the financial means to access other treatments. The studies were similar to the current study, as they investigated LBP. In the studies on LBP by Jegnie and Afework (2021) and Khumalo and Haffejee (2022) it was reported that 3.4% and 19.2% used traditional healers, respectively. A study by Jegnie and Afework (2021) was also conducted in Africa, where this type of treatment is available. In a study by Khumalo and Haffejee (2022) the sample size used was greater than the current study and these were hospital patients. None of the participants chose a chiropractor in the current study. Most of the participants were unaware of complementary alternate treatments such as chiropractic treatment, as this type of treatment is not offered in clinics and hospitals and was therefore not sought by any of the participants.

5.4.3 Characteristics of LBP

Most of the participants in this study experienced LBP daily at 43.2%, 48.1% of them had mild pain and 83.1% took one to three days off from work. Moreover, 70.4% of them did not take time off work. In contrast, the studies by Lette *et al.* (2019), Alghadir and Anwer (2015) and Lin *et al.* (2012) had different findings. A study on construction workers in Southeastern Ethiopia, by Lette *et al.* (2019) reported that 42.8% of the participants experienced dull aches followed by cramping pain at 35.6%. The average duration of pain was between one to two weeks in 35.6% of the construction workers. Approximately 51.7% of the construction workers took sick leave for more than 15 days. This study looked at all different types of musculoskeletal pain and the definition of LBP was not specified. This study did not concur with the findings of the current study. This may be due to different types of questions being probed around the character of pain. The difference in sick leave may be due to the different policies that exist in the companies. This study was similar to the current study as LBP was also included.

A study with construction workers in Saudi Arabia, by Alghadir and Anwer (2015) reported that the average intensity of pain during activity and rest was 6.65 and 3.59, respectively. The majority of the construction workers had periodic pain (50%) followed by regular pain (28.8%). The duration of pain lasted between two to four days in most of the construction workers (47.5%). Of the construction workers who took part in the study, 42.5%, experienced dull aching pain followed by 30% of cramping pain. In addition, 47.5% of the construction workers who reported pain took sick leave for 15 days. There were, however, 45% of the respondents who reported pain that did not result in taking any sick leave. This study looked at all different types of musculoskeletal pain and the definition of LBP was not specified. This study did not concur with the findings of the current study. This may be a result of the manner in which the character of pain was probed in the studies. Different types of construction workers were also present in the study. This study was similar to the current study as LBP was included.

A study by Lin *et al.* (2012) reported that most of the LBP (68.54%) lasted less than seven days. The average pain score on the visual analogue scale was 41.67. About (73.21%) of the respondents reported that LBP was distressing. In addition, 68.79% of participants reported that the pain disrupted their work. This study was conducted with hospital nurses in Taiwan. This study had different findings from the current study, as different terminologies on pain were used. In addition, a more accurate tool to measure pain was employed. The construction workers in our current study are working, thus it was expected that the pain would be acute and mild in nature. Most of the construction workers are sole providers for their families, and would not to be booked off from work for a long period, as they would have to forgo their daily wages.

5.5 RECOMMENDATIONS FOR REDUCING LBP PREVALENCE AND THE MANAGEMENT IN CONSTRUCTION WORKERS

Pre-stretching programmes should be incorporated into construction worker's daily routines. This will prevent injuries to their lower back region that might result in LBP. In addition, stretching may also provide relief to those suffering from LBP. Stretching will increase the temperatures in the muscles, which will increase muscle reaction time and activate the nervous system. Stretching is significant for older construction workers as their flexibility levels decrease due to aging (Gasibat, Simbak and Aziz 2017). They should also participate in exercise programmes after their designated working hours. This will improve their muscle endurance, strength and aerobic capacity, which will prevent them from suffering from LBP (Lee *et al.* 2019).

Training of the ‘core’ for example, will strengthen the lumbopelvic muscles which will assist in controlling unwanted movements, while the muscles of the hips and thighs will enable mobility and strength (Malanga *et al.* 2016). Exercise has a dual function as it can be used to treat LBP and prevent it (Lizier, Vaz Perez and Sakata 2012). These exercises are significant for female construction workers as they have more musculoskeletal strength than males (Jones, Koehoorn and McLeod 2020). More construction workers should take some days off to rest and relax their muscles and attend to their pain, early. There should be health education and promotion on sleep enhancement to help them cope with their pain (Chung *et al.* 2019).

The “Goldilocks Principle” should be applied this is the allocation of work where it is “just right” in relation to the construction worker's health and physical characteristics. This principle will decrease the gap in socioeconomic health disparities, by protecting and promoting their health (Arias, Koenig and Choi 2022). Construction workers need to reduce the number of heavy objects that they lift and refrain from lifting below their knee height. It was reported, that if one reduces their lifting weight by 50%, the peak loads in the muscles of their lower back decrease by 22%. The use of team lifting, and mechanical lifting devices should be used to assist with the lifting (Antwi-Afari *et al.* 2023). Education on proper lifting techniques will improve the awareness of LBP and create good occupational behaviour. The correct technique for lifting is the ‘bend the knees and keep the back straight’ technique (McGill 2010). To reduce the amount of repetitive lifting amongst the construction workers there should be alternating of tasks, so that it becomes balanced. This will reduce the amount of cumulative microtrauma to the muscles and lumbar spine (Antwi-Afari *et al.* 2017). The construction workers should be educated on certain positions that may cause LBP. These positions include excessive bending and twisting and atypical positions. In addition, they need to be made more aware of end-range spinal positions that may result in LBP. Managers should base work schedules on the individual's physical capability to mitigate the risks due to LBP. For example, they could have frequent breaks to decrease the fatigue of the muscles in their lower back region (Luger *et al.* 2019). Employers need to train and educate their construction workers on ergonomics, on how to avoid certain activities that may pose a risk to them in developing LBP.

Education on adopting correct postures should be given to the construction workers. Devices such as adjustable lift tables and a lumbar support brace could improve the worker's posture (Antwi-Afari *et al.* 2023). A national surveillance system should be instituted to record the LBP of construction workers. This surveillance system will record aspects such as injury, employer injury reports and character of LBP (Lee *et al.* 2023). This will ensure there is protection of their health and rights. Construction workers should be advised on how to manage their back if they suffer from LBP. Construction workers must be advised to report symptoms such as pins/needles, tenderness, weakness, swelling, changes in bowel habits, urinary incontinence, fever, sharp shooting pain into the limbs and pain at night (DePalma 2020). Systems need to be put in place to ensure that in the acute phase of LBP, there is proper management. This will prevent the LBP from becoming CLBP (Lichtenstein and Miles 2018).

Construction workers should have their lower back region screened daily, to identify risk factors to prevent LBP. This screening will identify optimal flexibility, range of motion, muscle endurance levels, abnormal postures, and optimal muscle, biomechanical and neurological function (Karran *et al.* 2017). Construction workers need to try to reduce their consumption of cigarettes/alcohol with the end goal of eventually stopping smoking/alcohol. Chiropractors could assist with coping mechanisms on how to stop smoking/alcohol consumption and provide psychotherapy to them (Gliedt *et al.* 2017). In addition, chiropractors may be able to provide breathing exercises to strengthen their intercostal muscles and treat some of the symptoms associated with smoking with chiropractic adjustments and soft tissue therapy (Globe *et al.* 2016). Chiropractic care can be used in the treatment of stress by addressing the physical and mental components of it. The physical aspects include adjustments of the spine to restore normal functioning of the nerves, which assists in the relief of stress (Brockman 2007).

In addition, chiropractic adjustments could be used to treat symptoms of stress such as headaches (Plaza-Manzano *et al.* 2014). Chiropractors could also provide breathing exercises to help cope with the stress (Liang *et al.* 2023). Soft tissue therapy may also be used to reduce muscle activity and muscle tension (Piper *et al.* 2016). The mental aspects include psychotherapy on stress and providing coping mechanisms/strategies for stress management Gliedt *et al.* 2017). Cognitive behavioural therapy could also be used, this is the modification of unwanted thoughts and behaviours, improvement of mood and a reduction in pain-related avoidance (Gliedt *et al.* 2017). Chiropractors need to educate construction workers on maintaining a healthy BMI. This will be achieved through lifestyle and dietary modifications. Lifestyle modifications include reducing their smoking, alcohol consumption, and stress levels and engaging in more exercise daily (Leung *et al.* 2017). Dietary modifications include eating a healthy balanced diet that is rich in fruit, vegetables and lean protein. In addition, their sugar and cholesterol levels, and weight, would need to be checked regularly, to ensure that their BMI is normal (Herforth *et al.* 2019). Construction workers need to be educated on the different types of treatments available, as most are using a GP. Hardly any construction workers visited a chiropractor for treatment and construction workers need to be educated more on complementary medicine such as chiropractic medicine. Chiropractors need to approach the construction industry and offer seminars to educate them on chiropractic care. Health providers, such as chiropractors, should address the prevention of LBP at a primary level by utilising the findings of this study on LBP in their clinical practices. Chiropractors should set up interventions aimed at increasing awareness of factors that predispose construction workers to LBP. The findings of this study can assist employers in the construction industry with policy development and effective preventive measures to mitigate LBP.

5.6 SUMMARY

Low back pain experienced by construction workers in the eThekwini Municipality is common, as per previous LBP studies conducted. This study reported a moderate point and period prevalence of LBP in construction workers in the eThekwini Municipality**.** This study showed a few statistically significant associations between risk factors and LBP, and more non-significant associations. The significant findings were a longer duration of smoking and a higher number of cigarettes smoked per day, and the presence of work-related, personal stress or both, which are significantly associated with LBP. None of the demographic, occupational and characteristics of LBP were significantly associated with LBP and information from previous studies into the selected risk factors for LBP in construction workers. This study has, therefore, provided valuable information that can strengthen existing literature. This study can also further assist construction workers, chiropractors and companies, with the diagnosis, treatment, management and prevention of LBP in construction workers.

The following chapter will conclude all the findings of the present study.

CHAPTER SIX

CONCLUSION

6.1 INTRODUCTION

This chapter draws conclusions from the results and discussion of the study on how LBP affects construction workers in the eThekwini Municipality. The chapter presents the strengths of the study, as well as entailing some weaknesses. Moreover, recommendations for future studies are highlighted, with an emphasis on achieving a greater understanding of LBP in construction workers.

6.2 KEY FINDINGS

- The point prevalence of LBP was 16.8% (*n*=43)
- The period prevalence of LBP was 26.2% (*n*=67)
- 54.3% of the participants experienced LBP on both sides of the lumbar spine
- 43.2% of the participants experienced LBP daily and 48.1% had mild pain
- The most frequently used treatment was accessing a GP, followed by self-medication
- A high number of participants did not seek any form of treatment (63%; *n*=20)
- Demographic factors such as height (*p*=0.507), weight (*p*=0.657) and BMI (*p*=0.657) were not significantly associated with LBP
- Age (*n*=81; *p*=0.124) was borderline non-significantly higher in those with LBP
- LBP was equally likely in men and women (31% in men and 37.5% in women)
- A longer duration of smoking (*p*=0.015) and a higher number of cigarettes smoked per day (*p*=0.047) were significantly associated with LBP
- The presence of work-related stress, personal stress, or both, was significantly associated with LBP (*p*=<0.001)
- The general workers and erectors were found to be most affected by LBP

6.3 STRENGTHS OF THE STUDY

This was the first study done in eThekwini, South Africa, on the epidemiology of LBP in construction workers. It was also the first South African study, to our knowledge, that has investigated this topic and significantly contributes to and strengthens the body of literature related to this industry in South Africa. A further benefit includes the addition of knowledge regarding the prevalence of LBP and its associated risk factors, which is beneficial to healthcare professionals on better aiding LBP-related health injuries within this industry.

6.4 LIMITATIONS OF THE STUDY

As with any cross-sectional occupational survey, this study may be subject to the healthy worker effect, where employees who suffered from LBP and could not perform their work were not surveyed, as they would not be at work or have changed jobs. Therefore, the current prevalence may be underestimated in this study. Similarly, the association between risk factors and LBP might be biased, because it was not established whether these behaviours or risk factors occurred before the onset of the LBP, or after. If it was after the onset, there may have been consequences of the LBP (e.g. alcohol use could increase in order to deal with the pain of LBP). Therefore, the cross-sectional design can only point out associations between factors and LBP, rather than identifying causal factors. A smaller proportion of female to male construction workers was included in the sample size. This study showed a few statistically significant associations between risk factors and LBP, and more non-significant associations, which was probably because the study was not powered to show moderate to small differences between the groups. A larger study would either confirm or refute the trends observed in this study.

6.5 RECOMMENDATIONS FOR FUTURE STUDIES

- A larger population of construction workers should be included in future studies. These could include other municipalities in KZN or a national study that includes all provinces in South Africa. This would allow for a greater understanding of LBP and would also provide more accurate data due to a larger sample size.
- More female construction workers should be included in the sample size of future studies.
- Future studies may also determine the prevalence of LBP through a physical examination as opposed to using a questionnaire.

- The study did not collect information on all the potential risk factors or confounders, such as psychosocial risk factors, or diseases that could be associated with LBP. Future studies should do this.
- The assessment of stress among the construction workers in this study assessed basically with yes/no responses. Future studies should use a properly validated tool to assess stress comprehensively.
- Investigate the years working in the construction industry and then ascertain if LBP was present prior to taking up construction work or not. Further clarification could also come from a question as to whether there was a traumatic event leading to up to LBP (eg car accident, fall etc) or what was reported from participants in the questionnaire specific to their day-to-day job as a construction worker

6.6 CONCLUSION

Low back pain continues to be a major health burden for construction workers, impacting their daily activities and causing disability. This has significant effects on the gross domestic product of the South African economy, as the construction industry plays a vital role in it. This study was guided by its aim and objectives to investigate the epidemiology of LBP in construction workers in the eThekwini Municipality. The prevalence of LBP reported in the study was similar to some of the previous studies, whilst it varied with the others. The demographic factors in this study did not have any significant association with LBP. The lack of significant associations between age and LBP in our study concurred with previous studies, whilst some of the previous literature had different findings. The sex and BMI findings in our study were the same as in previous studies. It was noted in our study that some of the lifestyle factors were associated with LBP. These associations were with a longer duration of smoking, a higher number of cigarettes smoked per day, the presence of work-related stress, personal stress, or both, being significantly associated with LBP. These associations were also found in previous literature. The results of this study related to occupational factors were different from previous studies. Among construction workers, LBP is a massive concern requiring urgent attention. A joint intervention strategy between health professionals and the construction industry is required. This will reduce absenteeism, stress, decreased productivity and activity limitations.

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APPENDICES

Appendix A: Ethical approval

Institutional Research Ethics Committee
Research and Postgraduate Support DDUT-IRECtorate
2nd Floor, Berwyn Court
Gate 1, Steve Biko Campus
Durban University of Technology

P O Box 1334, Durban, South Africa, 4001

Tel: 031 373 2375
Email: lavishad@dut.ac.za
http://www.dut.ac.za/research/institutional_research_ethics

www.dut.ac.za

4 May 2023

Mr V Moodley
7 Birkett Drive
Morningside
Durban

Dear Mr Moodley

The epidemiology of low back pain in construction workers in the eThekwini Municipality of KwaZulu-Natal
Ethical Clearance number IREC 303/22

The DUT-Institutional Research Ethics Committee acknowledges receipt of your final data collection tool for review.

We are pleased to inform you that the data collection tool has been approved. Kindly ensure that participants used for the pilot study are not part of the main study.

Please note that FULL APPROVAL is granted to your research proposal. You may proceed with data collection.

Any adverse events [serious or minor] which occur in connection with this study and/or which may alter its ethical consideration must be reported to the DUT-IREC according to the DUT-IREC Standard Operating Procedures (SOP's).

Please note that any deviations from the approved proposal require the approval of the DUT-IREC as outlined in the DUT-IREC SOP's.

It is compulsory for a student or researcher to apply for recertification on an annual basis. The failure to do so will result in withdrawal of ethics clearance. It is the responsibility of the researcher and the supervisor to apply for recertification.

Please note that you are required to submit a Notification of Completion of Study form together with an abstract to the DUT-IREC office on completion of your study.

Yours Sincerely

Prof J K Adam
Chairperson: DUT-IREC

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fairness · professionalism · commitment · compassion · excellence

Appendix B: Letter of information to the construction workers

LETTER OF INFORMATION

Title of the Research Study: The epidemiology of low back pain in construction workers in the eThekwiniMunicipality of KwaZulu-Natal

Principal researcher: Verushan Moodley BTech Chiro

Supervisor: Prof JD Pillay (PhD: Physiology)

Brief Introduction and Purpose of the Study: The study will be on the epidemiology of low back pain in construction workers in the eThekwini Municipality of KwaZulu-Natal. Low back pain is currently the most reported musculoskeletal complaint amongst construction workers and is caused by a number of factors. Understanding the epidemiology of low back pain in construction workers can therefore help the employers to make necessary changes within thework environment or incorporate employee assistant schemes to limit exposure to risk factors identified as possible contributors to low back pain.

Gooday research participant I am a 6th year student currently completing my research for my master's degree in Chiropractic at DUT. I would like to invite you to participate in my research. Institutional research ethics clearance number (303/22). Your time is appreciated and will assistin providing valuable information regarding how best health professionals, especially us as Chiropractors can helpmanage and treat your low back pain. Research is a systematic search for generalized new knowledge. Your participation will help us contribute to the knowledge that exists on the epidemiology of low back pain amongst construction workers and how best health professionals can assist in managing this low back pain. You are welcome to ask as any questions, I am happy to explain further. You are under no obligation to commit at this stage.

Outline of the Procedures:

The aim of this study is to determine the epidemiology of LBP in construction workers in the eThekwini Municipality of KwaZulu-Natal. Participants will take a questionnaire to fill out. The expected time to complete the questionnaire is approximately7 minutes. You will be expected to complete and sign Informed Consent (Appendix H) as well as the questionnaire (Appendix I). Once the questionnaire is completed, the process is complete, and you will not be contacted further.

Risks or Discomforts to the Participant:

There are no risks or risk of discomfort to you during this study.

Reason why you may be withdrawn from the study:

If you are non-compliant and have not completed at least 80% of the questionnaire, you will be withdrawn from thestudy. As a voluntary participant in this research study, you are free to leave the study at any given time without giving a reason for withdrawing and without consequence.

Benefits:

By participating in this study, you will allow Chiropractors and other health care professionals to build our knowledge on the epidemiology of low back pain in construction workers. This benefits you as the patient as we can provide improved healthcare in the future.

Remuneration:

You will not be receiving any monetary or other type of remuneration for participation in this study

Costs of the Study:

You will not be expected to cover any costs towards the study.

Confidentiality:

All patient information is confidential. You will not be expected to record any personal details that could identify you. The results of this study will be used for research purposes only. Only individuals that are directly involved inthis study (Professor Pillay and myself) will be allowed to access these records.

Results:

Once the information has been collected, the results from the study will be published in the dissertation section ofthe DUT Library which can be taken out through normal library protocol. There will also be an online copy available to you through the DUT online library system.

Research-related Injury:

There is no risk or injury that you can sustain by participating in this study.

Storage of hard copies:

Questionnaires collected will be safely stored and will be kept for 5 years in the DUT Chiropractic department, thereafter, will be destroyed by shredding.

Persons to contact in the Event of Any Problems or Queries:

Please contact the researcher (0822576337) my supervisor (0826039111) or the Institutional Research Ethics Administrator on 031 373 2375. Complaints can be reported to the Director: Research and Postgraduate Support on 031 373 2577 or researchdirector@dut.ac.za

Appendix C: Letter of information to the relevant managers

LETTER OF INFORMATION

Title of the Research Study: The epidemiology of low back pain in construction workers in the eThekwini Municipality of KwaZulu-Natal

Principal researcher: Verushan Moodley BTech Chiro

Supervisor: Prof JD Pillay (PhD: Physiology)

Brief Introduction and Purpose of the Study: The study will be on the epidemiology of low back pain in construction workers in the eThekwini Municipality of KwaZulu-Natal. Low back pain is currently the most reported musculoskeletal complaint amongst construction workers and is caused by a number of factors. Understanding the epidemiology of low back pain in construction workers can therefore help the employers to make necessary changes within the work environment or incorporate employee assistant schemes to limit exposure to risk factors identified as possible contributors to low back pain.

Gooday research participant I am a 6th year student currently completing my research for my master's degree in Chiropractic at DUT. I would like to invite you to participate in my research. Institutional research ethics clearance number (303/22). Your time is appreciated and will assist in providing valuable information regarding how best health professionals, especially us as Chiropractors can help manage and treat your low back pain. Research is a systematic search for generalized new knowledge. Your participation will help us contribute to the knowledge that exists on the epidemiology of low back pain amongst construction workers and how best health professionals can assist in managing this low back pain. You are welcome to ask as any questions, I am happy to explain further. You are under no obligation to commit at this stage.

Outline of the Procedures:

The aim of this study is to determine the epidemiology of LBP in construction workers in the eThekwini Municipality of KwaZulu-Natal. Participants will take a questionnaire to fill out. The expected time to complete the questionnaire is approximately seven minutes. You will be expected to complete and sign Informed Consent (Appendix H) as well as the questionnaire (Appendix I). Once the questionnaire is completed, the process is complete, and you will not be contacted further.

Risks or Discomforts to the Participant:

There are no risks or risk of discomfort to you during this study.

Reason why you may be withdrawn from the study:

If you are non-compliant and have not completed at least 80% of the questionnaire, you will be withdrawn from the study. As a voluntary participant in this research study, you are free to leave the study at any given time without giving a reason for withdrawing and without consequence.

Benefits:

By participating in this study, you will allow Chiropractors and other health care professionals to build our knowledge on the epidemiology of low back pain in construction workers. This benefits you as the patient as we can provide improved healthcare in the future.

Remuneration:

You will not be receiving any monetary or other type of remuneration for participation in this study.

Costs of the Study:

You will not be expected to cover any costs towards the study.

Confidentiality:

All patient information is confidential. You will not be expected to record any personal details that could identify you. The results of this study will be used for research purposes only. Only individuals that are directly involved inthis study (Professor Pillay and myself) will be allowed to access these records.

Results:

Once the information has been collected, the results from the study will be published in the dissertation section ofthe DUT Library which can be taken out through normal library protocol. There will also be an online copy availableto you through the DUT online library system.

Research-related Injury:

There is no risk or injury that you can sustain by participating in this study.

Storage of hard copies:

Questionnaires collected will be safely stored and will be kept for five years in the DUT Chiropractic Department, thereafter, will be destroyed by shredding.

Persons to contact in the Event of Any Problems or Queries:

Please contact the researcher (0822576337) my supervisor (0826039111) or the Institutional Research Ethics Administrator on 031 373 2375. Complaints can be reported to the Director: Research and Postgraduate Support on 031 373 2577 or researchdirector@dut.ac.za.

Appendix D: Letter of information to the pilot group

LETTER OF INFORMATION

Title of the Research Study: The epidemiology of low back pain in construction workers in the eThekwini Municipality of KwaZulu-Natal

Principal researcher: Verushan Moodley BTech Chiro

Supervisor: Prof JD Pillay (PhD: Physiology)

Brief Introduction and Purpose of the Study: The study will be on the epidemiology of low back pain in construction workers in the eThekwini Municipality of KwaZulu-Natal. Low back pain is currently the most reported musculoskeletal complaint amongst construction workers and is caused by a number of factors. Understanding the epidemiology of low back pain in construction workers can therefore help the employers to make necessary changes within the work environment or incorporate employee assistant schemes to limit exposure to risk factors identified as possible contributors to low back pain.

Gooday research participant I am a 6th year student currently completing my research for my master's degree in chiropractic at DUT. I would like to invite you to participate in my research. Institutional research ethics clearance number (303/22). Your time is appreciated and will assist in providing valuable information regarding how best health professionals, especially us as Chiropractors can help manage and treat your low back pain.

Research is a systematic search for generalised new knowledge. Your participation will help us contribute to the knowledge that exists on the epidemiology of low back pain amongst construction workers and how best health professionals can assist in managing this low back pain. You are welcome to ask as any questions, I am happy toexplain further. You are under no obligation to commit at this stage.

Outline of the Procedures:

The aim of this study is to determine the epidemiology of LBP in construction workers in the eThekwini Municipality of KwaZulu-Natal.Participants will take a questionnaire to fill out. The expected time to complete the questionnaire is approximately seven minutes. You will be expected to complete and sign Informed Consent (Appendix H) as well as the questionnaire (Appendix I). Once the questionnaire is completed, the process is complete, and you will not be contacted further.

Risks or Discomforts to the Participant:

There are no risks or risk of discomfort to you during this study.

Reason why you may be withdrawn from the study:

If you are non-compliant and have not completed at least 80% of the questionnaire, you will be withdrawn from thestudy. As a voluntary participant in this research study, you are free to leave the study at any given time without giving a reason for withdrawing and without consequence.

Benefits:

By participating in this study, you will allow Chiropractors and other health care professionals to build our knowledge on the epidemiology of low back pain in construction workers. This benefits you as the patient as we can provide improved healthcare in the future.

Remuneration:

You will not be receiving any monetary or other type of remuneration for participation in this study.

Costs of the Study:

You will not be expected to cover any costs towards the study.

Confidentiality:

All patient information is confidential. You will not be expected to record any personal details that could identify you. The results of this study will be used for research purposes only. Only individuals that are directly involved in this study (Professor Pillay and myself) will be allowed to access these records.

Results:

Once the information has been collected, the results from the study will be published in the dissertation section of the DUT Library which can be taken out through normal library protocol. There will also be an online copy available to you through the DUT online library system.

Research-related Injury:

There is no risk or injury that you can sustain by participating in this study.

Storage of hard copies:

Questionnaires collected will be safely stored and will be kept for five years in the DUT Chiropractic Department, thereafter, will be destroyed by shredding.

Persons to contact in the Event of Any Problems or Queries:

Please contact the researcher (0822576337) my supervisor (0826039111) or the Institutional Research Ethics Administrator on 031 373 2375. Complaints can be reported to the Director: Research and Postgraduate Support on 031 373 2577 or researchdirector@dut.ac.za.

Appendix E: Letter of information to the focus group

LETTER OF INFORMATION

Title of the Research Study: The epidemiology of low back pain in construction workers in the eThekwini Municipality of KwaZulu-Natal

Principal researcher: Verushan Moodley BTech Chiro

Supervisor: Prof JD Pillay (PhD: Physiology)

Brief Introduction and Purpose of the Study: The study will be on the epidemiology of low back pain in construction workers in the eThekwini Municipality of KwaZulu-Natal. Low back pain is currently the most reported musculoskeletalcomplaint amongst construction workers and is caused by a number of factors. Understanding the epidemiology of low back pain in construction workers can therefore help the employers to make necessary changes within thework environment or incorporate employee assistant schemes to limit exposure to risk factors identified as possible contributors to low back pain.

Gooday research participant I am a 6th year student currently completing my research for my master's degree in Chiropractic at DUT. I would like to invite you to participate in my research. Institutional research ethics clearance number (303/22). Your time is appreciated and will assistin providing valuable information regarding how best health professionals, especially us as Chiropractors can helpmanage and treat your low back pain.

Research is a systematic search for generalised new knowledge. Your participation will help us contribute to the knowledge that exists on the epidemiology of low back pain amongst construction workers and how best health professionals can assist in managing this low back pain. You are welcome to ask as any questions, I am happy toexplain further. You are under no obligation to commit at this stage.

Outline of the Procedures:

The aim of this study is to determine the epidemiology of LBP in construction workers in the eThekwini Municipality of KwaZulu-Natal.Participants will be taking a questionnaire to fill out. The expected time to complete the questionnaire is approximately seven minutes. You will be expected to complete and sign Informed Consent (Appendix H) as well as the questionnaire (Appendix I). Once the questionnaire is completed, the process is complete, and you will not be contacted further.

Risks or Discomforts to the Participant:

There are no risks or risk of discomfort to you during this study.

Reason why you may be withdrawn from the study:

If you are non-compliant and have not completed at least 80% of the questionnaire, you will be withdrawn from thestudy. As a voluntary participant in this research study, you are free to leave the study at any given time without giving a reason for withdrawing and without consequence.

Benefits:

By participating in this study, you will allow Chiropractors and other health care professionals to build our knowledge on the epidemiology of low back pain in construction workers. This benefits you as the patient as we can provide improved healthcare in the future.

Remuneration:

You will not be receiving any monetary or other type of remuneration for participation in this study.

Costs of the Study:

You will not be expected to cover any costs towards the study.

Confidentiality:

All patient information is confidential. You will not be expected to record any personal details that could identify you. The results of this study will be used for research purposes only. Only individuals that are directly involved inthis study (Professor Pillay and myself) will be allowed to access these records.

Results:

Once the information has been collected, the results from the study will be published in the dissertation section ofthe DUT Library which can be taken out through normal library protocol. There will also be an online copy availableto you through the DUT online library system.

Research-related Injury:

There is no risk or injury that you can sustain by participating in this study.

Storage of hard copies:

Questionnaires collected will be safely stored and will be kept for five years in the DUT Chiropractic Department,thereafter, will be destroyed by shredding.

Persons to contact in the Event of Any Problems or Queries:

Please contact the researcher (0822576337) my supervisor (0826039111) or the Institutional Research Ethics Administrator on 031 373 2375. Complaints can be reported to the Director: Research and Postgraduate Support on 031 373 2577 or researchdirector@dut.ac.za.

Appendix F: Statement of confidentiality focus group

IMPORTANT NOTICE: This form is to be read and filled in by every member participating in the focusgroup, before the focus group meeting convenes.

CONFIDENTIALITY STATEMENT AND CODE OF CONDUCT: Focus group

All information contained in the research documents and any information discussed during the focus group meeting must be kept private and confidential. This is especially binding to any information that may identify any of the participants in the focus group.

None of the information shall be communicated to any other individual or organization outside of this specific focus group as to the decisions of this focus group.

The information from this focus group will be made public in terms of a dissertation/thesis and/or journal publication, which will in no way identify any of the participants involved in this focus group.

The returned questionnaires will be coded and kept anonymous in the research process.

The focus group may be either voice or video recorded, as a transcript of the proceedings will need to be made.The data will be stored securely under password protection.

All data generated from this focus group (including the recording) will be kept for one year in a secure locationat Durban University of Technology and thereafter will be destroyed.

Once this form has been read and agreed to, please fill in the appropriate information below and sign toacknowledge agreement.

Focus Group M_______________ Signature: __________________

Witness Name: ________________ Signature: __________________

Researcher's Name: ____________ Signature: __________________

Supervisor's Name: _____________ Signature: __________________

Co-supervisor's Name: __________ Signature: ___________________

____________________ ______________ _________________

Full Name of Legal Guardian Date Signature

(If applicable)

Age: _________________ Date of birth: ___________________

Appendix G: Permission to Conduct Research at a construction company.

Dear Sir/Madam I'm currently a registered MHSC Chiropractic student at the Durban University of Technology. One of the requirements for this qualification is to conduct a research study. I would like to therefore request your permission to conduct the following study, entitled: "The epidemiology of low back pain in construction workers in the eThekwini Municipality of KwaZulu-Natal." Institutional research ethics clearance number (303/22). The details of my intended study are briefly outlined below:

The aim of this study is to:

Establish the point, period, and lifetime prevalence of low back pain amongst construction workers employed in eThekwini Municipality.

Identify possible lifestyle, demographic, occupational risk factors that may contribute to low back pain in construction workers in the eThekwini Municipality.

To determine the association, if any, between low back pain and risk factors.

With this study, I hope to broaden the knowledge about low back pain among construction workers which is a very important issue as construction workers play such a significant role in this country. I hope that as more knowledge in this field is gained, preventative measures can be put in place to decrease the risk of low back pain among construction workers in the future. As such, I kindly request your permission to conduct this study among construction workers in your company.

Participation in this study will be voluntary. The information will remain confidential and will be available in the form of a dissertation in the Durban University of Technology Library after the data has been captured and analysed, and a conclusion drawn. Attached please find copies of letters of information and informed consent to be provided to the construction workers.

Please contact me should you have any queries.

Researcher: Verushan Moodley (0822576337)
Supervisors: Prof. J. D. Pillay (PhD: Physiology)

Appendix H: Informed consent

CONSENT

Full Title of the Study: The epidemiology of low back pain in construction workers in the eThekwini Municipality of KwaZulu-Natal

Names of Researcher/s:

Principal researcher: Verushan Moodley BTech Chiro

Supervisor: Prof JD Pillay (PhD: Physiology)

Statement of Agreement to Participate in the Research Study:

- ☐ I hereby confirm that I have been informed by the researcher, ________________________ (name of researcher), about the nature, conduct, benefits, and risks of this study — Research Ethics Clearance Number: ___(303/22) ____________________.
- ☐ I have also received, read, and understood the above written information (Participant Letter ofInformation) regarding the study.
- ☐ I am aware that the results of the study, including personal details regarding my sex, age, date ofbirth, initials and diagnosis will be anonymously processed into a study report.
- ☐ In view of the requirements of research, I agree that the data collected during this study can beprocessed in a computerised system by the researcher.
- ☐ I may, at any stage, without prejudice, withdraw my consent and participation in the study.
- ☐ I have had sufficient opportunity to ask questions and (of my own free will) declare myself prepared toparticipate in the study.
- ☐ I understand that significant new findings developed during the course of this research which mayrelate to my participation will be made available to me.

____________________ _____ ______ ______________________

Full Name of Participant Date Time Signature/RightThumbprint

I, ______________________ (name of researcher) herewith confirm that the above participant has been fully informed about the nature, conduct and risks of the above study.

____________________ _________ ___________________________

Full Name of Researcher Date Signature

Full Name of Witness (If applicable) Date Signature

_________________________ ___________ _____________________

Full Name of Legal Guardian Date Signature

(If applicable)

Age: ___________________

Date of birth: ____________

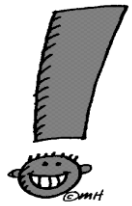
Appendix I: Assent for minor

ASSENT FORM FOR MINORS

TITLE OF THE RESEARCH PROJECT: The epidemiology of low back pain in construction workers in the eThekwiniMunicipality of KwaZulu-Natal

RESEARCHERS' NAME(S): Verushan Moodley

RESEARCHERS' CONTACT NUMBER: 0822576337



What is a research study?

Research studies help us learn new things. We can test new ideas. First, we ask a question. Then we try to find the answer. This paper talks about our research and the choice that you have to take part in it. We want you to ask us any questions that you have. You can ask questions any time.

Important things to know…

You get to decide if you want to take part.

You can say 'No' or you can say 'Yes'.

No one will be upset if you say 'No'.

If you say 'Yes', you can always say 'No' later.

You can say 'No' at any time.

We would still take good care of you no matter what you decide.

Why are we doing this research?

We are doing this research to find out more about Low back pain that is caused by a number of factors. Understanding the epidemiology of low back pain in construction workers can therefore help the employers to make necessary changes within thework environment to limit exposure to risk factors identified as possible contributors to low back pain.

Why have I been invited to take part in this research project?

Your participation will assist in providing valuable information regarding how best health professionals, especially us as Chiropractors can help manage and treat your low back pain.

Who is doing the research?

My name is Verushan Moodley and I am a 6th year student currently completing my research for my master's degree in Chiropractic at DUT. Institutional research ethics clearance number (303/22)

What will happen to me in this study?

Your parent/guardian will be expected to complete and sign the Informed Consent form (Appendix H) and you will be required to complete questionnaire(Appendix I). Once the questionnaire is completed, the process is complete, and you will not be contacted further.

Can anything bad happen to me?

There is no risk or injury that you can sustain by participating in this study.

Can anything good happen to me?

By participating in this study, you will allow Chiropractors and other health care professionals to build our knowledge on the epidemiology of low back pain in construction workers. This benefits you as the patient as we can provide improved healthcare in the future.

What else should I know about this research?

If you do not want to be in the study, you do not have to be. It is also OK to say yes and change your mind later. You can stop at any time. If you want to stop, please tell the researcher. You can say 'no' to what we ask you to do for the research at any time and we will stop.

Will anyone know I am in the study?

All patient information is confidential. The results of this study will be used for research purposes only. Only individuals that are directly involved in this study (Professor Pillay and myself) will be allowed to access these records

Who can I talk to about the study?

Please contact the researcher (0822576337) my supervisor (0826039111) or the Institutional Research Ethics Administrator on 031 373 2375. Complaints can be reported to the Director: Research and Postgraduate Support on 031 373 2577

What if I do not want to do this?

You may refuse to take part even if your parents have agreed to your participation. As a voluntary participant in this research study, you are free to leave the study at any given time without giving a reason for withdrawing and without consequence.

Do you understand this research study and are you willing to take part in it?

YES	NO

Has the researcher answered all your questions?

YES	NO

Do you understand that you can STOP being in the study at any time?

YES	NO

Printed Name of Researcher ____

Signature of Researcher ____

____________   _______________

Date   Time

Appendix J: Letter of information to the guardian

LETTER OF INFORMATION

Title of the Research Study: The epidemiology of low back pain in construction workers in the eThekwiniMunicipality of KwaZulu-Natal

Principal researcher: Verushan Moodley BTech Chiro

Supervisor: Prof. J.D. Pillay (PhD: Physiology)

Brief Introduction and Purpose of the Study: The study will be on the epidemiology of low back pain in construction workers in the eThekwini Municipality of KwaZulu-Natal. Low back pain is currently the most reported musculoskeletalcomplaint amongst construction workers and is caused by a number of factors. Understanding the epidemiology of low back pain in construction workers can therefore help the employers to make necessary changes within thework environment or incorporate employee assistant schemes to limit exposure to risk factors identified as possible contributors to low back pain.

Gooday research participant I am a 6th year student currently completing my research for my master's degree in Chiropractic at DUT. I would like to invite you to participate in my research. Institutional research ethics clearance number (303/22). Your time is appreciated and will assistin providing valuable information regarding how best health professionals, especially us as Chiropractors can helpmanage and treat your low back pain. Research is a systematic search for generalised new knowledge. Your participation will help us contribute to the knowledge that exists on the epidemiology of low back pain amongst construction workers and how best health professionals can assist in managing this low back pain. You are welcome to ask as any questions, I am happy to explain further. You are under no obligation to commit at this stage.

Outline of the Procedures:

The aim of this study is to determine the epidemiology of LBP in construction workers in the eThekwini Municipality of KwaZulu-Natal. Participants will take a questionnaire to fill out. The expected time to complete the questionnaire is approximatelyseven minutes. You will be expected to complete and sign Informed Consent (Appendix H) as well as the questionnaire(Appendix I). Once the questionnaire is completed, the process is complete, and you will not be contacted further.

Risks or Discomforts to the Participant:

There are no risks or risk of discomfort to you during this study.

Reason why you may be withdrawn from the study:

If you are non-compliant and have not completed at least 80% of the questionnaire, you will be withdrawn from thestudy. As a voluntary participant in this research study, you are free to leave the study at any given time without giving a reason for withdrawing and without consequence.

Benefits:

By participating in this study, you will allow Chiropractors and other health care professionals to build our knowledge on the epidemiology of low back pain in construction workers. This benefits you as the patient as we can provide improved healthcare in the future.

Remuneration:

You will not be receiving any monetary or other type of remuneration for participation in this study.

Costs of the Study:

You will not be expected to cover any costs towards the study.

Confidentiality:

All patient information is confidential. You will not be expected to record any personal details that could identify you. The results of this study will be used for research purposes only. Only individuals that are directly involved inthis study (Professor Pillay and myself) will be allowed to access these records.

Results:

Once the information has been collected, the results from the study will be published in the dissertation section ofthe DUT Library which can be taken out through normal library protocol. There will also be an online copy available to you through the DUT online library system.

Research-related injury:

There is no risk or injury that you can sustain by participating in this study.

Storage of hard copies:

Questionnaires collected will be safely stored and will be kept for five years in the DUT Chiropractic Department, thereafter, will be destroyed by shredding.

Persons to contact in the Event of Any Problems or Queries:

Please contact the researcher (0822576337) my supervisor (0826039111) or the Institutional Research Ethics Administrator on 031 373 2375. Complaints can be reported to the Director: Research and Postgraduate Support on 031 373 2577 or researchdirector@dut.ac.za.

Appendix K: Informed consent to guardian

CONSENT

Full Title of the Study: The epidemiology of low back pain in construction workers in the eThekwini Municipality of KwaZulu-Natal

Names of Researcher/s:

Principal researcher: Verushan Moodley BTech Chiro

Supervisor: Prof JD Pillay (PhD: Physiology)

Statement of Agreement to Participate in the Research Study:

- ☐ I hereby confirm that I have been informed by the researcher,________________(name of researcher), about the nature, conduct, benefits, and risks of this study - Research Ethics ClearanceNumber: (303/22)_____,
- ☐ I have also received, read and understood the above written information (Participant Letter ofInformation) regarding the study.
- ☐ I am aware that the results of the study, including personal details regarding my sex, age, date ofbirth, initials and diagnosis will be anonymously processed into a study report.
- ☐ In view of the requirements of research, I agree that the data collected during this study can beprocessed in a computerised system by the researcher.
- ☐ I may, at any stage, without prejudice, withdraw my consent and participation in the study.
- ☐ I have had sufficient opportunity to ask questions and (of my own free will) declare myself prepared toparticipate in the study.
- ☐ I understand that significant new findings developed during the course of this research which mayrelate to my participation will be made available to me.

______________________ ______ ______ ____________

Full Name of Participant Date Time Signature/RightThumbprint

I, ________________________________ (name of researcher) herewith confirm that the above participant has been fully informed about the nature, conduct and risks of the above study.

__________________ ______________ ___________________

Full Name of Researcher Date Signature

______________________ ____________ ___________________

Full Name of Witness Date Signature
(If applicable)

______________________ ____________ ___________________

Full Name of Legal Guardian Date Signature
(If applicable)
Age: ________________________
Date of birth: _________________

Appendix L: Permission to use questionnaire

12:35 35%

Thembelihle Dlungwa... 03 Apr
to me

Dear Verushan

Thank you for the email.

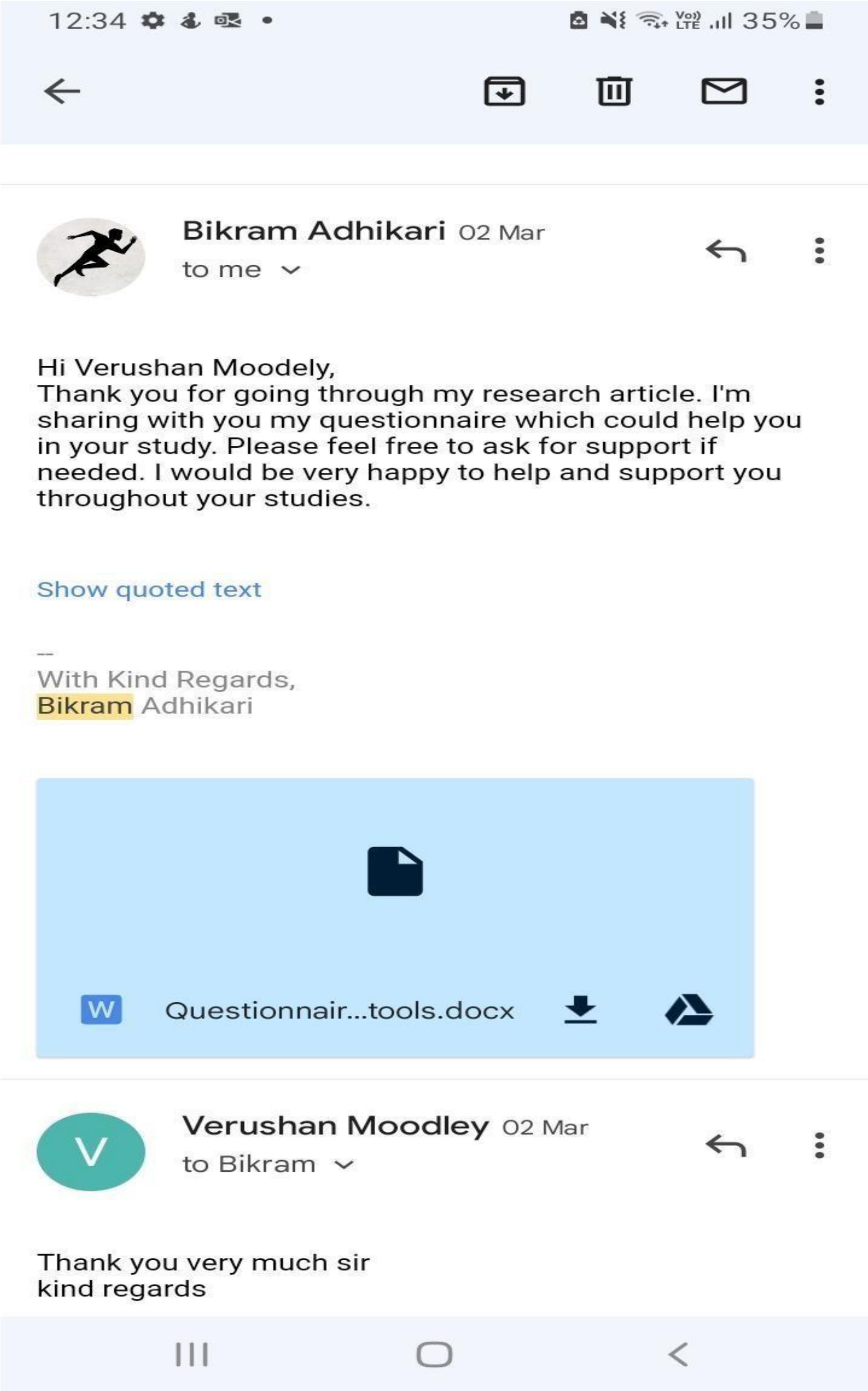
You may use the questionnaire and wishing you all the best with your research study.

Regards

Show quoted text

UKZN email disclaimer:
The contents of this e-mail may contain personal information, and/or privileged information, and/or confidential information. The information contained herein is therefore only meant for consumption by the recipient mentioned and for the purpose as specified in the body of the e-mail. Should you receive this e-mail in error kindly inform the sender of such by responding to the sender via a response e-mail and thereafter please delete the original e-mail received as well as the response e-mail. The University of KwaZulu-Natal e-mail platform is meant for business purposes (of the University) only and the University therefore does not accept any liability whatsoever that may arise from instances where such platform is utilised for personal reasons. Any views or opinions expressed in this e-mail represent those of the author and may not necessarily be binding on the University. The author of the e-mail may also not bind the

Appendix M: Permission to use questionnaire



12:34 35%

Bikram Adhikari 02 Mar
to me

Hi Verushan Moodely,
Thank you for going through my research article. I'm sharing with you my questionnaire which could help you in your study. Please feel free to ask for support if needed. I would be very happy to help and support you throughout your studies.

Show quoted text

--
With Kind Regards,
Bikram Adhikari

W Questionnair...tools.docx

Verushan Moodley 02 Mar
to Bikram

Thank you very much sir
kind regards

Appendix N: Permission from company

GVK-SIYA ZAMA
CONSTRUCTION

18 August 2022

RE: Permission to conduct research

Dear Verushan

I have the pleasure of informing you that permission has been granted to conduct your study titled" The epidemiology of low back pain in construction workers in the eThekwini Municipality of Kwazulu-Natal" with our construction workers at our company.

Please note that you are to contact this office before your research commences and all information is to be kept confidential.

I would like to wish you all the very best with your studies.

Yours sincerely

BUILDING **STRENGTH**

Directors: DS Madi JN Meder TJ Serithi BC Dladla

GVK-Siya Zama Building Contractors (Pty) Ltd Reg. no. 1994/005438/07
33 Umbilo Road Durban 4001 PO Box 5618 Durban 4000
Tel: +27 (0)31 314 3700
Email: natal@siyazama.co.za Website: www.siyazama.co.za

Appendix O: Permission from company

RAUBEX
BUILDING

17 Neptune Place

Midrand

JHB 1684

Date 15 August 22

Attention: Verushan Moodley

Permission to conduct research at Raubex Construction: The epidemiology of low backpain in construction in the eThekwini Municipality of KwaZulu-Natal

Please take note that permission has been granted to conduct research with our construction workers. Please ensure that all information is kept strictly confidential. Wewish you well with your studies.

Kind regards

Dale Pillay Safety Manager

Appendix P: Research questionnaire

DUT DURBAN UNIVERSITY OF TECHNOLOGY | INSTITUTIONAL RESEARCH ETHICS COMMITTEE

Code:

Welcome to this research study entitled: "The epidemiology of low back pain in construction workers in the eThekwini Municipality of KwaZulu-Natal".

Please answer the questions below (tick the appropriate box or fill in where necessary).

Section A: Demographics

1. Sex
   - ☐ Male
   - ☐ Female
2. Age in (years) ___________
3. Height (meters) __________
4. Weight (kilograms) ____________

Section B: Lifestyle factors

5. What is your smoking status?
   - ☐ Current smoker
   - ☐ Ex-smoker
   - ☐ Non-smoker
6. If current /ex-smoker, how many years have you smoked for?
   - ☐ Less than 1 year
   - ☐ 1-5 years
   - ☐ 6-10 years
   - ☐ 11-15 years
   - ☐ More than 15 years
7. If current /ex-smoker, how many cigarettes do/did you smoke per day?
   - ☐ 1-5
   - ☐ 6-10
   - ☐ 11-15
   - ☐ 16-20
   - ☐ More than 20
8. Do you consume alcohol?
   - ☐ Yes
   - ☐ No
9. If yes, how many years have you been drinking alcohol for?
   - ☐ Less than 1 year
   - ☐ 1-5 years
   - ☐ 6-10 years
   - ☐ 11-15 years
   - ☐ More than 15 years
10. How often do you drink alcohol?
    - ☐ Everyday
    - ☐ Once a week
    - ☐ Twice a week
    - ☐ Occasionally

11. How many tots of alcohol do you drink per week? Note: 1 tot equals 1 glass of beer, 1 glass of wine, a single spirit drink
    - ☐ Less than 1 tot
    - ☐ 1-6 tots
    - ☐ 7-12 tots
    - ☐ 13-18 tots
    - ☐ More than 18 tots
12. Do you exercise regularly (i.e. 3 times per week or more)? If not, please move to question 17?
    - ☐ Yes
    - ☐ No
13. If yes, please select the type of exercise performed? (You may tick more than one option)
    - ☐ Running/jogging
    - ☐ Walking
    - ☐ Cycling
    - ☐ Gyming
    - ☐ Swimming
    - ☐ Soccer
    - ☐ Basketball
    - ☐ Other (please specify) ____________________
14. How many exercise sessions do you perform per week?
    - ☐ 3-4
    - ☐ 5
    - ☐ Greater than 5 times
15. How long (in minutes) do you exercise per session?
    - ☐ Less than 30
    - ☐ Approximately 30 minutes
    - ☐ Between 30 and 60 minutes
    - ☐ 60 minutes or more
16. How vigorous (strong/intense) is your exercise?
    - ☐ Light breathing
    - ☐ Moderately fast breathing
    - ☐ Fast breathing
    - ☐ Very fast breathing
17. Are there any stresses that you currently experience or have experienced in the last 6 months?
    - ☐ No stress experienced
    - ☐ Work-related stress
    - ☐ Personal stresses
    - ☐ Both work and personal stresses
18. Have you ever been booked off work for stress in the last 6 months?
    - ☐ Yes
    - ☐ No
19. If yes, for how many days were you absent from work over the past 6 months?
    - ☐ 0-1 day
    - ☐ 2-3 days
    - ☐ 4-5 days
    - ☐ More than 5 days

Section C: Occupational factors

20. How many years have you been working in construction?
    - ☐ Less than one year
    - ☐ 1-5 years
    - ☐ Between 5 and 10 years
    - ☐ 10 years or more

21. How many days do you work per week?
    - ☐ Less than 3 days
    - ☐ 3-5 days
    - ☐ 6-7 days
22. How many hours do you work per day?
    - ☐ Less than 8 hours
    - ☐ 8-11 hours
    - ☐ 12 hours
    - ☐ More than 12 hours
23. What job do you perform? (Please tick one option)
    - ☐ Bricklayer
    - ☐ Scaffolder
    - ☐ Erector
    - ☐ Excavation
    - ☐ Form work
    - ☐ Concrete mixer
    - ☐ Carpenter
    - ☐ General worker
    - ☐ Other (please specify) _________________________
24. Does your job involve any of the following? (You may tick more than one option)
    - ☐ Performing the same task over and over
    - ☐ Sitting/ standing for long periods
    - ☐ Bending or twisting movements
    - ☐ Working in awkward positions
    - ☐ Carrying/lifting of heavy materials and equipment
    - ☐ Other (please specify) __________________________

Section D: Low back pain history

25.1 Have you experienced low back pain in the last 6 months?
- ☐ Yes
- ☐ No

25.2 Are you currently experiencing low back pain?
- ☐ Yes
- ☐ No

If you have no low back pain or no history of low back pain over the last 6 months, you do not need to answer this section.

26. Which side is the low back pain experienced?
    - ☐ Right
    - ☐ Left
    - ☐ Both right and left sides
27. How often do you experience low back pain?
    - ☐ Daily
    - ☐ Weekly
    - ☐ Monthly
    - ☐ Permanently

28. How would you describe the pain?
    - ☐ Mild
    - ☐ Moderate
    - ☐ Severe
29. Does the low back pain extend into your leg/s?
    - ☐ Yes
    - ☐ No
30. Does the low back pain affect your ability to perform your job?
    - ☐ Yes
    - ☐ No
31. Have you ever taken time off from work due to the low back pain?
    - ☐ Yes
    - ☐ No
32. f yes, how many days in total over the last 6 months?
    - ☐ 1-3 days
    - ☐ 4-7 days
    - ☐ More than 7 days
    - ☐ More than 14 days
    - ☐ More than 1 month
33. Have you ever received treatment for low back pain over the past 6 months?
    - ☐ Yes
    - ☐ No
34. If yes to the above, please tick what treatment? (You make tick more than one option)
    - ☐ General Practitioner
    - ☐ Physiotherapist
    - ☐ Chiropractor
    - ☐ Traditional healer
    - ☐ Self-medication
    - ☐ Neurologist
    - ☐ Orthopedic surgeon
    - ☐ Other (please specify) ___________________
35. What was the diagnosis by the health care provider for the low back pain?
    - ☐ Muscle spasm
    - ☐ Strain/sprain
    - ☐ Slipped disk
    - ☐ Sciatica
    - ☐ Osteoarthritis
    - ☐ Fracture
    - ☐ Not sure
    - ☐ Other (please specify) __________________

Thank you for participating in my research study you may now hand in the questionnaire.

Appendix Q: Plagiarism report

ORIGINALITY REPORT

12%	9%	8%	2%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	openscholar.dut.ac.za Internet Source	2%
2	www.mdpi.com Internet Source	1%
3	www.ncbi.nlm.nih.gov Internet Source	1%
4	www.studyblue.com Internet Source	<1%
5	bmcmusculoskeletdisord.biomedcentral.com Internet Source	<1%
6	link.springer.com Internet Source	<1%
7	ir.dut.ac.za:8080 Internet Source	<1%
8	www.researchgate.net Internet Source	<1%
9	Minghelli, Beatriz, Raul Oliveira, and Carla Nunes. "Non-specific low back pain in adolescents from the south of Portugal:	<1%

Appendix R: Editor's certificate

Helen Bond

IMPELA EDITING SERVICES

impelaediting@gmail.com

079 395 5873

24 March 2024

CERTIFICATE

Verushan Moodley

Dear Verushan

Thank you for using Impela Editing Services to edit your Master's thesis entitled "*The epidemiology of low back pain of construction workers in the eThekwini Municipality*".

I have proofread for errors of grammar, punctuation, spelling, syntax and typing mistakes. I have formatted your work and checked the references (this means checking the formatting).

PLEASE NOTE: Impela Editing accepts no fault if an author does not accept the corrections suggested or makes changes to a document after a certificate has been issued. A client may choose to accept none, some, or all of the editor's editorial changes and/or suggestions.

I wish you the very best in your submission.

Kind regards

Helen Bond (Bachelor of Arts, HDE)