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Regular Article

An examination of the occurance of work-related musculoskeletal disorders (WMSDS) and symptoms among small scale construction workers in WINDHOEK, Namibia

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ABSTRACT

Even though the topic has been the focus of numerous global researches, few studies have examined the incidence of WMSDs symptoms among small-scale construction workers in developing countries of Africa. The purpose of this study was to ascertain the prevalence of WMSDs among small-scale construction workers in Namibia's capital city of Windhoek, located in Southern Africa. A cross-sectional survey in Windhoek, Namibia, involved 117 workers from four small-scale construction companies. Self-administered questionnaires and in-depth interviewing procedures were employed in the research to compile data on the occurrence of WMSDs associated with among workers in small-scale construction. Both descriptive and inferential statistical data analysis were conducted using the Statistical Package for Social Sciences (SPSS). The findings revealed the symptoms and prevalence of WMSDs in several body parts among the small-scale construction employees surveyed. The research findings further showed that 28 % of respondents lacked safety knowledge for the intention to work safely, whereas 72 % of respondents who planned to work safely indicated greater levels of safety knowledge. Age, brick size and repetitive work were the job risk factors that positively correlated with WMSDs. The results suggest for instance that as the worker ages, so do the chances to contract WMSDs. Overall, the study demonstrated that mechanical, individual, and psychosocial factors all influence the frequency of WMSDs among workers in small-scale construction. However, further research is needed to provide solutions on occupational health of small scale construction workers and on training and awareness of ergonomic risk factors in relation to WMSDs.

1. Introduction

Construction, which encompasses the building of hospitals, factories, highways, bridges, stadiums, tunnels, airports, docks, civil engineering, demolition, and maintenance companies is among the world's largest industrial sectors. Due to its ability to boost economies and generate employment, the construction industry is crucial to the socioeconomic growth of many countries (Bogue, 2018; D'Souza et al., 2021; Sánchez et al., 2017; Whiting et al., 2012). The construction industry employs eleven million people in the United States of America (USA) (Center for Construction Research and Training, 2018). Over 3 million people are employed in Bangladesh's construction industry, which makes up a sizable portion of the country's labour force (Brahmachary et al., 2018).

Around the world, the construction industry makes up between 9 % and 15 % of GDP in most countries (Bawane, 2017; Oesterreich & Teuteberg, 2016). One of the biggest industries, the construction sector generated over US $110 billion (or 7 % of the United Kingdom (UK) GDP) in 2018, supporting 2.93 million people, or around 10 % of all UK employment (ONS, 2018). China's construction sector produced a total value of 25.63 % of the country's GDP in 2021 (Gandolfi et al., 2021).

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About ten percent of Bangladesh's GDP, or $12 billion, comes from the construction sector (Brahmachary et al., 2018). The Ghanaian's construction industry contributes 13.7 % to GDP (GSS, 2017). However, Mustapha et al. (2022) opined that construction employees in Ghana are exposed to work-related musculoskeletal disorders due to various tasks they perform. Pain and inflammation resulting from injuries and conditions affecting soft tissues, including muscles, tendons, ligaments, joints, and cartilage, are referred to as musculoskeletal diseases (Antwi-Afari., 2023; Lee et al., 2023; Jeong et al., 2024; Tesfaye et al., 2023).

However, the construction industry continues to be the leading source of worker fatalities and injuries (Belay et al., 2024; Punnett & Wegman, 2004; Ndiwa 2019; Lee et al., 2023). At least 5333 people lost their lives as a result of workplace accidents in 2019, according to data from the US Bureau of Labor Statistics (BLS). This is an increase of 2 % from 5250 in 2018 (BLS, 2020). According to Kim (2017), fatalities and injuries not only hinder productivity but also cause short- and long-term incapacity as well as missed work. Workplace stress, both physical and psychological, is linked to workplace injuries and significantly contributes to the disruption of workers' well-being. According to Ndiwa (2019), the lack of statistics on ergonomic injuries conceals the actual frequency of these accidents across all economic sectors in poor nations. Available and official data coming from developing countries are inconsistent and there are possibilities of underreporting (Kyung et al., 2023; Punnett & Wegman, 2004).

Construction workers' occupational health has emerged as a key area of study interest (Bavafa et al., 2018). At workplace, construction workers face a wide range of risks and hazards, including asbestos, dusts, fumes, large loads, awkward postures, inclement weather, heights, noise, and vibrations from machinery. Any business can be encounter a significant increase in diseases due to work related musculoskeletal disorders (Storheim & Zwart, 2014). A variety of disorders identified as WMSDs, which impact the nerves, muscles, ligaments, tendons, joints, cartilage and spinal discs when performing job duties, are caused by and made worse by poor working circumstances (Coledam et al., 2019; Ojukwu et al., 2018). WMSDs are common in the construction industry pose serious risks and challenges to workers's physical wellbeing and mental health (Arndt et al., 2005; Boschman et al., 2012; Kee, 2023; Nyamboki et al., 2024).

WMSDs have a significant impact on workers' occupational health and are often associated with a reduction in work capacity and quality (Bugajska et al., 2013; Arsalani et al., 2014; Leite & Araújo, 2021). Musculoskeletal conditions affect billions of individuals globally each year (Safiri et al., 2021). While there are a number of potential causes of WMSDs, repeated stress building up over time is the most frequent one. Disability-adjusted life years (DALY) associated with musculoskeletal illnesses increased by 19.6 % between 2006 and 2016 (Safiri et al., 2021). This represents a total increase of 61.6 % between 1990 and 2016. According to government statistics, WMSDs are the main cause of non-fatal injuries in the construction sector in the United States of America (Wang et al., 2017. It is well recognized that WMSD-related injuries result in missed or limited work time because of days away from the workplace (Yasobant & Rajkumar, 2014). The rate of compensable WMSD claims in Washington State in 2010 was approximately 50 % higher in the construction sector than in the manufacturing sector (Howard et al., 2016). According to Wang et al. (2015), there was a greater incidence of WMSDs among construction workers in West Virginia, USA, in 2012.These incidents were linked to the trunk body part, and workers with WMSDs may find it more difficult to do their tasks.

Construction workers in developing countries are three to six times more likely to be exposed to hazardous activities and sustain work-related injuries than the average injury incidence across all industries (Amissah et al., 2019). A 2009 study by Henning et al. found that construction activities are associated with a number of risks and hazards that can seriously endanger the health and safety of its employees. Small-scale construction businesses are starting up and expanding at a faster rate in developing nations, particularly in Africa (Jimoh et al., 2020). Employees of small-scale construction companies are more vulnerable to WMSDs than those in large firms (D'Souza et al., 2021). Poor ergonomic design, sometimes referred to as improper work design, is a problem for small-scale construction workers. Workers are susceptible to WMSDs symptoms such as tendon disruption and soft tissue injuries due to inadequate safety measures and design (Kanahole, 2019). Digging trenches, working at heights, tiling, applying force while pushing or dragging heavy things, laying brick, and vibrating when using handheld roller compactors and jackhammers are common construction work activities that cause WMSDs (Ajayi et al., 2015).

According to Hale et al. (2015), the frequency of WMSDs is 21 per 100,000 workers in Sub-Saharan Africa, whereas the incidence of disability is 16 per 100,000 workers. Every year, 54 million WMSDs and around 42 million permanent impairments are reported, resulting in three or more days of absence from work (Hale et al., 2015). Employees are exposed to incidents and accidents through various activities performed at their jobs (Palikhe et al., 2020). According to the theory put forward by Adhikari et al. (2021), small-scale construction workers are subjected to intolerable rates of occupational illnesses and injuries. According to Fernandes et al. (2010), bursitis, abrupt disc prolapse, fractured bones, and damaged cartilage are among the prevalent types of occupational injuries sustained by small-scale construction workers. Other frequent injury types in small-scale construction include fractures, open wounds, headaches, traumatic injuries to nerves, and accidents resulting from slips and falls, working at heights, tight spaces, and hot work (Amissah et al., 2019). Considering that these tissues comprise a substantial portion of the human body, WMSDs cover a distinct type of damage (Oakman et al., 2019).

Certain areas of Sub-Saharan Africa have been studied on WMSDs among small-scale construction employees. It is believed that between 15 % and 93.5 % of Africans have WMSDs (Wanyonyi & Frantz, 2015). Body discomfort and skin conditions linked to WMSDs are among the health problems that construction workers in Abuja and Nigeria face (Somasundaram, 2022). According to research done in Ghana, WMSDs differ among construction employees (Amissah et al., 2019). A study by Amissah et al. (2019) revealed that construction workers in Ghana reported a range of occupational injuries, including traumatic amputation and concussions. These studies, however, did not look at the factors connected to WMSDs in the small-scale construction sector; instead, they relied on prevalence figures in the large-scale construction industry. As a result, there is a dearth of information on the diseases and working conditions that small-scale construction workers face.

As a result, little is known about the WMSDs aspects that employees in Namibia's small-scale construction sector deal with. Thus, the aim of this research was to determine the occurrence of WMSDs among small-scale construction workers and, in light of the results, to recommend WMSD prevention strategies. Examining the WMSDs in Namibia's small-scale building sector is essential because it can yield more precise and dependable data and information for WMSDs treatment and prevention. The results of this study should help countries to prevent WMSDs in order to reduce occupational fatalities, hazards, and health risks in the construction sector.

Studies of Work-related Musculoskeletal Disorders within small-scale construction employees are important because these disorders are common in physically demanding jobs. In underdeveloped nations like Namibia, Work-related Musculoskeletal Disorders can result in chronic discomfort, decreased productivity, and higher healthcare expenses. Work-related Musculoskeletal Disorders are more likely to occur in small-scale construction environments where employees frequently perform manual labour without proper safety precautions or ergonomic standards.

The research on Work-related Musculoskeletal Disorders in small-scale construction settings in underdeveloped countries is still noticeably lacking, despite the increased awareness of occupational health concerns worldwide. There is a significant gap in knowledge on the particular difficulties experienced by small-scale employees because the majority of current research focuses on larger businesses or other industries. This dearth of focused research restricts understanding of the ways in which work environments, cultural perspectives on safety and health, and social as well as economic variables affect the prevalence of Work-related Musculoskeletal Disorders.

Therefore, this study was carried out in order to close this gap, enhance occupational health measures that are suitable to the requirements of small-scale construction employees, and influence policy-making. Through the identification of particular risk factors and symptoms that are common in this group, stakeholders may create efficient plans to reduce these risks, which will eventually improve employee productivity and well-being. In this context, addressing Work-related Musculoskeletal Disorders is essential to improving sustainable development and enhancing workplace conditions in Namibia's rapidly growing construction sector.

2. Materials and methods

2.1. Study area

Windhoek is regarded as the capital city of Namibia. The geographical coordinates of the study area are 22.56° S, 17.06° E (Fig. 1). The research area's geographic coordinates are 22.56o S and 17.06o E (Fig. 1). Windhoek is situated in the highland plateau region of Khomas, approximately 1700 m above sea level. The average annual rainfall is around 534 mm, despite the unpredictable patterns of precipitation.

The general climate of Namibia is characterized by hot and dry conditions throughout the year. The daily temperature can reach 40 °C on a really hot day, with an average temperature of around 22 °C (Nghitanwa & Lindiwe, 2017). There are more sunshine days in Namibia throughout the year, with October to April marking the start of summer. Approximately 92 percent of the country is classified as hyper arid or semi-arid.

2.2. Research design

A cross-sectional survey was carried out in October 2023 for three weeks to examine the occurrence of WMSDs among Windhoek's small-scale construction workers. The study employed mixed techniques based on self-administered questionnaire surveys and in-depth interviews to gather data regarding the prevalence of WMSDs among small scale construction workers. A mixed methodology approach has the advantage of encompassing all the process of data gathering and incorporation of both qualitative and quantitative studies (Olsen 2016). The questionnaires that were administered to the small-scale construction employees had specific and general questions concerning the socio-economic demographic characteristics, health status, and workplace safety environment. In-depth interviews of key informants and supervisors from four small-scale construction companies complemented the questionnaires surveys for data collection.

2.3. Target population

Four small-scale construction-related companies in the City of Windhoek were purposefully chosen for this study: Royal Builders CC, ETB Technical Services, Omplili Construction, and Kamati Renovators.

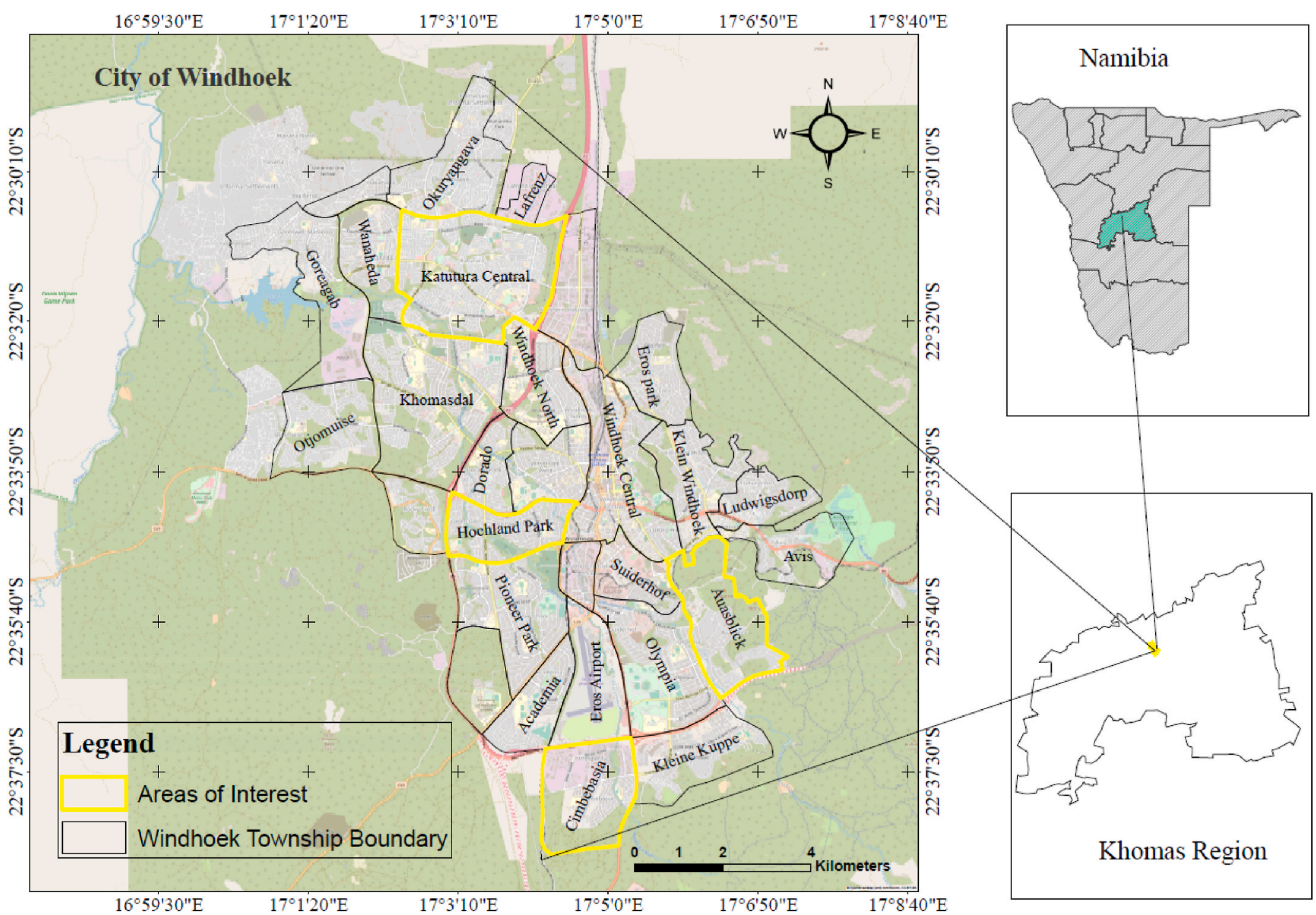

Fig. 1. Location of the study area.

Next, four small-scale construction enterprises in the City of Windhoek and their 138 employees were the target group (Table 1). Employees had to be at least eighteen years old to take part in the research. Personnel in management and supervisory positions, including departmental supervisors, safety officers and personnel, and construction site agents were the main targets. The other target category consisted of workers who performed construction-related tasks, such as labourers, masons, tilers, and painters. Simple random sampling was used to select questionnaire respondents. The sample size was estimated using a single population proportion calculation (Daniel and Cross 2018), assuming a 95 % confidence interval (CI), a 5 % margin of error, and a 65 % prevalence of WMSD symptoms (Chakraborty et al., 2018; López-Aragón et al., 2017). A random sampling technique was used to select 138 small scale construction workers after deducting 10 % for the non-response rate. Purposive sampling was used to select key interviewees such as Safety Officers and Site supervisors. Only permanent staff members who have worked for the same company for a minimum of a year were included in the research sample. The study did not include temporary workers.

2.4. Data collection approaches

2.4.1. Quantitative data collection

Small-scale construction workers were asked to respond to a questionnaire that collected quantitative data on the occurrence of WMSDs in order to express their opinions about the subject. The majority of the questions had a framework that called for several answers. Since most Namibians can speak English and other languages, the questionnaire was written in English and translated into Afrikaans and Oshiwambo. A thorough evaluation of previous research on Work-related Musculoskeletal Disorders in construction environments served as the foundation for questionnaire development. This was done to make sure that the questions covered significant hazards and symptoms of WMSDs that are unique to small-scale construction employees. A pilot research with a small number of Windhoek construction workers was carried out and this yielded some positive feedback as the participants in the pilot survey revealed that the questionnaire was clear, easy to understand and complete.

The participants in pilot survey were later interviewed and their verbal responses matched those they had filled in the questionnaire, revealing its reliability and guarantying the validity. This group's input was utilized to improve the questions relevancy and clarity. The questionnaire comprised questions on biographical data, employment history, particular jobs done, frequency of symptoms such as pain or discomfort, and ergonomic risk factors such as lifting practices. Furthermore, those who understood the goal of the study, had over a year of experience in the construction sector, and consented to participate met the inclusion criteria. Either individuals who did not consent to participate in the study or those who did not adequately reply were excluded. All participants were thoroughly informed of the study's objectives and essential details, and after they signed a consent form, the experiment was carried out.

2.4.2. Qualitative data collection

Key informants were interviewed to get more information about frequency of musculoskeletal disorders linked to the construction industry among key informants. This set of key informants consisted of site managers, human resources manager, site foremen, and safety officers.

Table 1
The number of employees sampled from each construction firm.

Name of Construction firm	Number of workers
Royal Builders CC	45
ETB Technical Services	35
Ompili Construction	25
Kamati Renovators CC	33
Total	**138**

2.5. Rapid Entire Body Assessment (REBA)

In order to investigate the occurrence WMSDs among small-scale construction workers in the study area, the Rapid Entire Body Assessment (REBA) instrument (Hignett & McAtamney, 2000) was used in addition to other data gathered through interviews and questionnaires. The REBA was created to make it simple to evaluate the risk of WMSDs connected to certain jobs or job functions. It uses a systematic strategy to evaluate the occupational activity under review's biomechanical and WMSDs in the upper and lower musculoskeletal systems (Joshi & Deshpande, 2020). The REBA was specifically utilized in this research to measure the arm, thigh, back, cervical spine, and hand size/span using a tape measure in order to evaluate the entire body among small-scale construction workers. The units of measurement for all measures were centimetres (cm). Over the course of three weeks, measurements of various body parts were obtained on various days. The utilization of a numerical rating scale to assess pain was implemented, offering the benefit of pinpointing risk factors associated with a particular job.

2.6. Ethical consideration

In this non-interventional study, the ethics approval from an ethics committee, institutional review board (IRB) was not required since the research did not use human samples and/or inclusion in a retrospective study. However, before conducting the research, all ethical principles were followed. The supporting letters to carry out the research were obtained from the Department of Geography, Environmental Sustainability and Resilience Building of Midlands State University in 2023. All respondents who participated in the study were made to understand the purpose of the study, verbally assured of confidentiality for their responses and that they should not write anything on the questionnaire that could reveal their identity. The respondents signed a written informed consent form prior to enrolment and participation in the study.

2.7. Data analysis

Statistical softwares were used to code and analyse all the data collected from the study based on the questionnaire survey. The Pearson correlation analysis was used to determine the relationship between risk factors (independent variables) and WMSDs. Numerous factors including duration of work, age, ergonomic practices and physical workload can affect Work-related Musculoskeletal Disorders. The extent that these independent variables relate with the incidence or severity of Work-related Musculoskeletal Disorders can be measured by using Pearson correlation analysis. This enables a clear interpretation of the potential relationships between changes in one variable and changes in another. The independent variables comprised individual characteristics, physical and psychological risk factors associated with the occupation. The various bodily parts of WMSDs were the dependent variables. In the descriptive analysis, categorical variables were described using frequencies and percentages. Content analysis was used to analyse qualitative data. Fig. 2 shows research methodology flowchart from research design to data analysis.

3. Findings and discussion

3.1. Questionnaire response rate

One hundred and thirty-eight (138) respondents from four distinct small-scale construction enterprises in Windhoek, Namibia, were given questionnaires to complete for this study. However, only 117 questionnaires were correctly completed, while 21 questionnaires were not completed, giving, a 84 % response rate. It is implied that the study's 84 % response rate was appropriate for data processing and objective

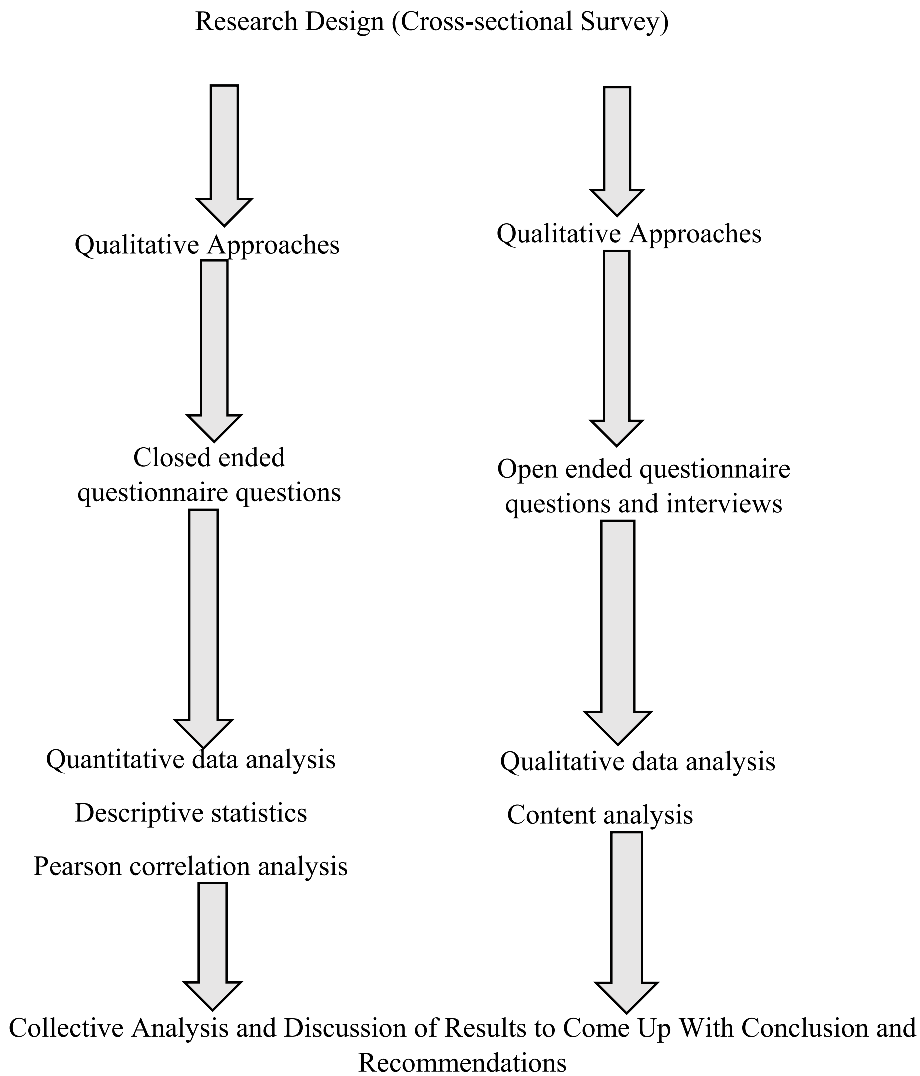

Fig. 2. Research methodology flowchart from research design to data analysis.

reporting of the occurrence of WMSDs and related risk variables among small-scale construction workers. Haile (2023) stated that a power analysis of 64 subjects would be required to detect statistically significant changes if they are available, with a threshold set at 0.05 and target power of 0.80 (Haile, 2023). The study surpasses the threshold, since its sample size is 117, indicating that the research is sufficiently powered to detect significant effects. Additionally, high response rate of 84 % reduces non-response bias, that can distort results and impair generalizability, and this make our results more reliable. As a result, the sample size of this study not only, satisfies the criteria for sufficient statistical power, however it also shows that the targeted group participate actively during the study. This increases the reliability of the findings of the study and analysis of Work-related Musculoskeletal Disorders. Al Kurdi et al. (2023) postulated that a 60 % response rate is considered respectable, while a 70 % response rate is quite outstanding.

3.2. Gender proportion

Table 2 indicates that males constituted 81.2 %, while females were 18.8 % of the study participants. The result is commensurate with employee ratios at the four small scale companies where there are more males than females. Namibia has a number of socio-economic and cultural elements that contribute to this unequal gender ratio in small scale construction industries. Social norms that link physical labour to masculinity have historically resulted in male dominated construction industry. The idea that men are better suited for physically hard work is prevalent in various societies, including Namibian society and it can deter women from choosing careers in construction sector (Jonson, 2016). This means females' access to job opportunities in the construction industry may be restricted by cultural bias. However, conditions in construction industries and safety issues may also discourage women to work in construction industries. Due to possible harassment or insufficient facilities for females, females may feel that the construction is unsafe and many of them decide to ignore employment opportunities in construction industries. This result is in line with studies by Ajayi et al. (2015) and Sambandan et al. (2020), which claimed that the construction industry is difficult and favours men, which explains why men predominate there as demonstrated by the cases of four small small-scale construction workers. Additionally, research indicates that men continue to dominate most construction businesses (English et al.,

Table 2
Gender information of participants.

Sex	Frequency	*Proportion* (%)
Males	95	81.2
Females	22	18.8
Total	117	100

2006; Johnson & Mathur-Helm, 2011; Menches & Abraham, 2007). Some studies have published comparable study findings about the underrepresentation of women in the construction sector (Broderick, 2012). In their evaluation of the musculoskeletal morbidities among construction workers in Chennai Metropolitan Area, Reddy et al. (2016) discovered that 91.6 % of the study participants were men.

The dominance of the males could also be related to the nature of tasks involved in the construction sector that are strenuous task and physically demanding for females (Lingard & Turner, 2022). Moreover, Fielden et al. (2000) hypothesized that bias towards masculinity exists even in the enrolment/recruitment and processes.

3.3. Age group of participants

The majority (80 %) of those who responded to the questionnaire survey were between the age of 18 and 29 (Fig. 3). Because of its reputation for being physically hard, the construction business frequently attracts younger employees who may have greater muscular strength and resilience than older employees. A lot of young people join the construction industry because of limited work possibilities in other industries, or they want to get experience before going to school or getting specialized training (Yibeltal Yizengaw, 2018). Furthermore, entry requirements in the construction industry frequently have low requirements, which makes them available to younger people who may not have finished their higher education. In light of this accessibility, there may be more young people employed in small-scale construction industry projects. Between the ages of 18–29, people are seen as youthful, agile, and capable of achieving goals (Ewart and Ore, 2001). On the other hand, Fig. 3 shows that less than 8.5 % of the workers were older over 60. Moreover, the nature of many occupations in small-scale businesses requires use of physical strength (Savinainen et al., 2004). The age range of the bulk of respondents (66.2 %) was 21–40 years old as indicated in Fig. 3. Nevertheless, according to Hashiguchi et al. (2021), it is believed that older workers are more capable of working since they have more experience, knowledge, and expertise. Fig. 3 shows how the age groups are distributed.

3.4. Trend patterns of the occurrence of WMSDs

In this study, 96 % of respondents admitted to experiencing discomfort at work, whereas 4 % reported that they did not suffer from any discomfort in different body parts (Fig. 4). The high percentage of pain reported may be related to the challenging working circumstances experienced by the small-scale construction workers. The physical demands of construction activities, poor ergonomic procedures and extended exposure to awkward postures or repetitive motions are some of the reasons behind this high percentage. Moreover, these problems might also be made worse by restricted access to occupational safety resources and education as well as safety training in small-scale construction industries. These findings support those made by D'Souza et al. (2021), who observed that physically demanding jobs cause discomfort among employees (Kisilu, 2018). In a similar vein, Chung et al. (2019) claim that irregular working hours, unstructured meal times, and dusty labor exacerbate pain severity in small-scale construction workers. According to Eaves et al. (2016), small-scale construction activity is related to diseases and injuries that commonly occur on the workplace (Parida & Ray, 2015). On the other hand, 4 % of those who claimed not to have felt pain at work may have done so out of fear of negative feedback.

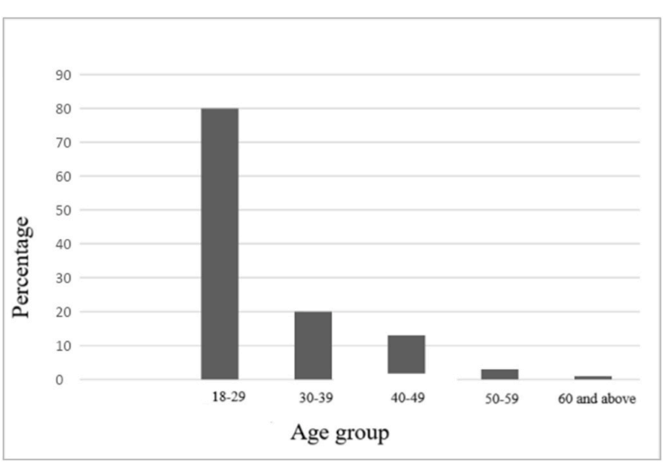

Fig. 3. Age groups of respondents.

Fig. 4. Experience of pain among small scale construction workers.

3.5. Linking types of trade/profession and work related musculoskeletal disorders

Masons, or bricklayers, stated in the questionnaire that they frequently deal with L-spine discomfort, swollen hand muscles, and fatigue/weariness (Table 3). Masonry labour requires a lot of repeated activities, like lifting heavy objects and twisting and bending. However, the L-spine is severely strained by these activities, which can cause pain and even injury. One of the main risk factors for lower back discomfort among construction employees is manual handling activities (Anwer et al., 2021). Additionally, muscle soreness and exhaustion can result from the rigorous demands of brickwork. This suggests that using tools that need to be gripped in construction industries can overstretch the hand muscles, leading to discomfort. Bricklayers are a category of workers that are simply made up of individuals without a specific skill; they often do tasks such as combining and carrying bricks, blocks, and mortar physically (Lop et al., 2017; Van Der Molen et al., 2009). Masonry professionals are particularly vulnerable to WMSDs because of the nature of activities they conduct and the physical demands of their jobs (Davis et al., 2014). In construction, companies masons workers in Pakistan reported more symptoms of severe WMSDs (Khan et al., 2019). Bricklaying was judged to be the most difficult activity among workers found at the construction site, according to Van Der Molen et al. (2009).

Ndiwa (2019) indicated that bricklayers comprised around 51 percent of Saudi Arabia's small-scale construction labourers and were the craftsmen with the greatest incidence of musculoskeletal issues. Bricklayers had twice cases of overexertion in the construction

Table 3
Workplace occupation and musculoskeletal disorders connected to the job.

Professional Work and Trade	Reported symptoms of WMSDs
Masons	Swollen hand muscles, L-spine pain and fatigue
Labourers	Fatigue, L-spine pain and hand injuries
Tilers	Hand and arm discomfort, shoulder pain and swollen hand muscles
Painters	T-spine pain and Thrombosis
Carpenters	Bone dislocation and broken bones.

companies compared to other industries in certain developed nations, including the United States of America (USA) (Ryu et al., 2023). According to Shaukat and Fatmi (2022), bricklayers are the backbone of the small-scale construction sector and are more susceptible to musculoskeletal problems than workers in any other trade. Table 3 demonstrates that workers suffered from a combination of L-spine issues, fatigue, and hand injuries. Furthermore, the workers in small-scale construction are subjected to difficult circumstances that may impair their cognitive abilities (Chung et al., 2019).

Based on the questionnaire survey, Tilers/Floor Layers indicated that they experienced shoulder pain, T-spine discomfort, hand and arm pain, and inflamed hand muscles (Table 3). In particular, the repetitive overhead activities required for floor laying and tiling frequently result in shoulder pain. The shoulder joints and muscles are strained by activities carried by Tilers/Floor Layers, which frequently calls for extended periods of stretching arms. There have also been reports of thoracic spine (T-spine) pain, which could be caused by awkward posture when performing tasks like twisting or bending while laying tiles. Chronic upper back pain and discomfort maybe exacerbated by such postural problems. These professionals frequently have hand and arm pain as a result of holding heavy objects necessary for tiling and floor layering. This may be related to the type of work they do, which necessitates using their hands frequently and over any other body parts. Tilers/Floor Layers in small scale construction sector are exposed to hand dislocation and finger numbness (Kanahole, 2019). According to Ogunseiju et al. (2021), tilers are more likely to get lower back problem since they bend awkwardly most of the time during work. The US Bureau of Labor Statistics reported that floor layers missed many days of work in 2019 compared to any other category of worker. In order to reduce the risks of work-related musculoskeletal disorders, these findings emphasize the necessity of ergonomic improvements and preventive measures designed especially for floor layers and tillers.

Table 3 demonstrates that Painters experienced both thrombosis and issues related to T-spine. This is not surprising because painters frequently work at different heights while performing repetitive tasks for extended periods of time. Nevertheless, this may result in strained muscles especially in the upper and lower back. Poor immobility or poor circulation from extended work hours might result in thrombosis. Painters are more likely to develop venous stasis since they usually work in confined areas or high places with restricted mobility. In addition, painters work while they are standing most of the time. Jilcha and Assefa (2020) found that manual painters had a greater prevalence of thrombosis symptoms. According to a South Indian research, painters extended standing hours which cause them to develop symptoms of WMSDs (Shanmugam et al., 2021). Table 3 demonstrates that WMSD symptoms, including fractured and dislocated bones, were encountered by carpenters. Due to the lifting, tugging, and lugging of heavy items involved in carpentry, trades people may have a variety of injuries to the muscles. According to Kohammadi et al. (2016), a lot of unfavourable postures are used in carpentry, which can lead to ligament tears and other injuries to the body. As a result of very few individuals in some trade occupations, such as plumbing, electrical work, and steel fabrication, prevented the symptoms of WMSDs from being documented.

3.6. Awareness level of ergonomic risk factors

The research's awareness level findings are shown in Fig. 4. According to the questionnaire survey results, 28 % of participants did not demonstrate any knowledge of ergonomic risks related to their work, while 72 % of participants said they were aware of ergonomic risks. High knowledge of ergonomic dangers among employees can be ascribed to the several seminars, trainings, and awareness campaigns they may have participated in. Regular staff training leads to greater workplace safety and fewer injuries, according to Kao et al. (2021). However, the worker's poor literacy level may be the reason why 28 % were unaware of the hazards associated with ergonomics. It might be challenging for a worker to follow safety regulations and instructions if they are illiterate (Tan et al., 2021).

3.6.1. Correlation between safety knowledge and safety incidences

The study was also interested in establishing the relationship between safety knowledge and the intention to work safely among the 72 % of the respondents were attentive of the ergonomic risks related to their employment. The intention to work safely and safety knowledge were shown to have a substantial positive association ($r = 0.759$, $p < 0.05$) (Fig. 5(a)). Therefore, workers' intention to follow safe work procedures tends to improve substantially as their level of safety knowledge improves. This strong relationship practically implies that improving safety education and training may result in better safety practices among workers in small-scale construction companies. Employees' dedication to safety increases when they receive thorough training that explains safety procedures in an efficient manner (Shabani et al., 2023). As a result, safety knowledge is important in reducing incidences of Work-related Musculoskeletal Disorders which are common in construction companies where awkward postures and physical strains are prevalent. The high levels of literacy of those who wanted to work safely can be connected to their ability to follow instructions and standard operating procedures. The results are corroborated by a research done by Nilsen and Kongsvik (2023), which shows that workers with higher reading levels have better safety awareness. Furthermore, the outcomes of the study supports the objectives of the study by emphasizing the importance of safety knowledge as a requirement for safer workplaces. Stakeholders may be able to reduce the hazards related to Work-related Musculoskeletal Disorders by concentrating on educational initiatives meant to raise safety awareness. Therefore, the findings of the study highlight the necessity of approaches that focus on promoting knowledge and intention to work safely as two crucial elements for improving construction worker's occupational safety and health.

Fig. 5(b) shows that there was no association ($r = -0.022$) between the intention to work safely and the 28 % of respondents who lacked safety awareness. This is surprising because, aside from a lack of safety understanding, there are many other elements that contribute to a person operating in an unsafe manner. The research findings suggest that there are several reasons why participants might not want to work in a safe manner. A contributing factor is the lack of support from top-level management, which is connected to the scarcity of workshops and safety trainings. Through the promotion of a safety culture and the allocation of both financial and non-financial resources to decrease safety occurrences, top management is essential to the occupational health and safety processes.

According to Abdul-Rahman et al. (2012), small-scale construction workers tend to prioritize profits over safety and usability when purchasing equipment. At a small-scale construction site, unsafe equipment will result in incidents and accidents (Erogul & Alyami, 2017). In addition, earlier research conducted in Taiwan by Chi and Wu (1997) and Chi et al. (2005) discovered that a significant percentage of fatal fall accidents involved construction workers with less experience. In various construction professionals, such as masons, rebar workers, and construction labourers and assistants, higher levels of experience and competence are strongly linked to a reduced occurrence of both fatal and non-fatal accidents (Karimi & Taghaddos, 2019).

3.7. Factors linked to the prevalence the WMSDs among small-scale construction workers

The study findings based on the Pearson correlation analysis revealed differential trends of relationship between various personal risk variables and WMSDs (Table 4). The study between back length and back pain were not statistically significant ($p > 0.05$) and research findings indicated that there was no association ($r = 0.046$), suggesting that variations in back size or spinal length may not be a major factor in the back discomfort that small-scale construction workers face. Taller

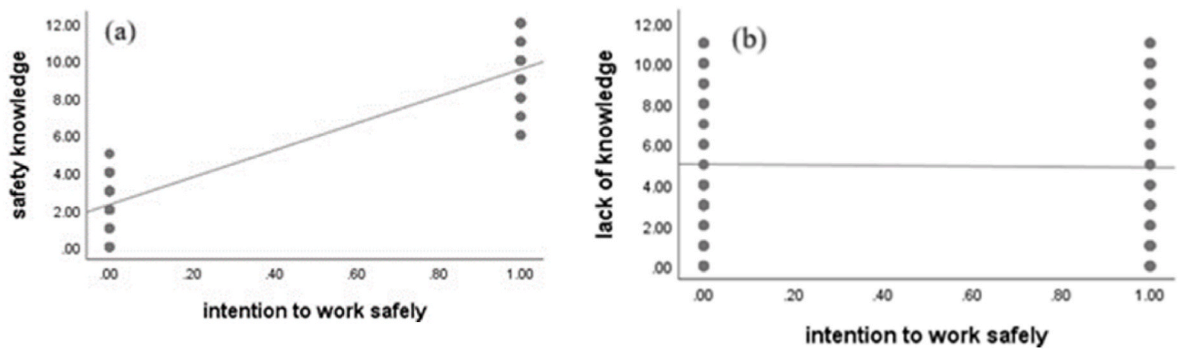

Fig. 5. (a) Pearson positive correlation (r = 0.759) and (b) no correlation (r = −0.022) between safety knowledge and intention to work safely.

Table 4
Pearson correlation concerning personal risk factors and WMSDs.

Personal risk factors	Pain	No pain	Pearson correlation coefficient (r)	P-*values*
Back length	100	17	0.046	0.638
Arm-length	95	22	−0.46	0.624
Hand size	101	16	−0.005	0.933
Age	112	5	0.896	0.000***
Neck length	60	57	−0.003	0.952
Thigh length	68	49	−0.041	0.669

*** Statistically significant ($p < 0.05$).

workers responded differently to back discomfort than shorter workers, according to Chaffin and Ashton-Miller (1991). Taller workers are more prone to have back discomfort and to be affected by it than are shorter workers. Although, the study's findings demonstrated moderate and negative correlation (r = −0.46) between small-scale construction workers' discomfort levels and arm sizes (Table 4), this result was not statistically significant ($p > 0.05$). The findings of Chaffin and Ashton-Miller (1991) and Dziedzic et al. (2011), who reported that arm length has no correlation with WMSDs but suggests strength as a major determinant, are not supported by this data.

The research findings showed that the relationship between size of the hand and the various pain feelings were not statistically significant ($p > 0.05$) further indicating that there was no relationship between neck length and neck discomfort (r = −0.003) (Table 4). These results also rule out the possibility that neck length and neck pain are correlated, stating that load is the primary source of neck discomfort. This can be attributed to the fact that a person's neck size has no bearing on their likelihood of developing neck pain issues. According to Dziedzic et al. (2011), heavy loads are the main reason for neck pain. However, a previous study by Griffin et al. (2001) found clear correlation between neck discomfort and static loading. There was no significant relationship (r = −0.041, $p > 0.05$) between workers' pain levels and thigh length as indicated in Table 4. This indicates that tendon and muscle issues in the thigh region may have other underlying reasons. However, other studies suggest that bending over and squatting for extended periods of time at work may result in thigh pain (Abas et al., 2020). According to Buckle (2011), small-scale construction workers get thigh soreness as a result of the lateral stress they receive while kneeling.

Table 4 indicates a strong and positive connection (r = 0.896, $p < 0.05$) between age and pain experience, implying that an increase in age corresponds with an increase in the worker's level of discomfort. This might be explained by the worker's declining physical stability and strength as they become older, making it harder for them to do demanding jobs. Previous studies have also indicated a connection between age and complaints of WMSDs (Descatha et al., 2007; Reddy et al., 2016). A research by Abas et al. (2020) found that construction employees above the age of 40 were significantly more likely than those under 25 to experience T-spine problems. Age has emerged as a major global risk factor for a variety of WMSDs among construction workers (Nurminen, 1997). Furthermore, aging is a personal risk factor that has been linked to WMSDs even in industrialized nations like Canada (Ryu et al., 2020). A study by Biswas et al. (2017) in India found that workers below the age of 25 years who perform manual labour on a daily basis are at risk for WMSD. The results of their study suggest that due to demanding nature of job, many employees retire before reaching the age of 60 years.

3.8. *Qualitative data presentation*

Table 5 summarizes the interview responses that was done interview with the Safety Officer, Site Foreman, Site Supervisor and Human Resource Manager (HRM) for factors linked the Prevalence of Work-related Musculoskeletal Disorders among small-scale construction workers.

4. Conclusion

The objective of the conducted study was to examine the trend patterns of the occurrence of WMSDs among the workers at four small scale construction companies in Windhoek, Namibia. Thrombosis, fractured bones, bone dislocation, shoulder pain from the T spine, hand and arm pain, swelling hand muscles, pain from the L spine, exhaustion, and hand injuries were among the common symptoms of WMSDs that were described. According to the study, 72 % of small-scale construction workers who were surveyed acknowledged that there were ergonomic risks, while 28 % admitted that they were unaware of them. The only personal risk factor that showed a positive correlation with WMSDs among small-scale construction workers was age, followed by back length, arm length, hand size, neck length, thigh length, and age. These results highlight the significance of WMSDs training and safety awareness initiatives at Namibian construction sites. Furthermore, the research suggested that the four construction companies senior management, including the Safety and Health Managers, should prioritize occupational and safety. They should also undertake capacity building by offering training and awareness programs linked to ergonomic dangers. This will assist in combating WMSDs and lowering occupational injuries, accidents, and non-fatal illnesses. To guarantee compliance with safety and occupational health regulations, small-scale construction enterprises should undergo regular safety inspections by occupational health and safety regulatory organizations.

4.1. *Study limitations*

The following are some possible limitations of the study.

- The study's findings may not apply to all construction workers in Namibia, including those employed by large construction companies, as it focused mostly on small-scale construction firms.

Table 5
Factors Linked the Prevalence of Work-related Musculoskeletal Disorders with Key informants.

Interviewee	Factors identified	Analysis of the Responses
Safety Officer	➢ Inadequate ergonomic instruments and tools within the small scale construction site. ➢ Insufficient instruction in safe lifting methods. ➢ Uncomfortable postures due to poor site layout.	The Safety Officer indicated that most small-scale construction industries lack suitable ergonomic tools however, this expose workers to risks such as work-related musculoskeletal disorders.
Site Supervisor	➢ Extended working hours without sufficient breaks. ➢ Lack of suitable rest areas for workers. ➢ Significant physical exertion for duties performed within the company.	The Site Supervisor and Safety Officer noted that workers get insufficient training regarding proper lifting of heavy objects. Adequate training on proper ways to lift objects at a construction company
Construction Site Foreman	➢ Repetitive motions required when performing tasks such as plastering and bricklaying. ➢ Manual lifting of heavy objects. ➢ Shortage of Personal Protective Equipment/ Cloth.	protect workers from risks related to musculoskeletal injuries. The Safety Officer highlighted that poor site layout expose workers to uncomfortable postures. Therefore, proper site management is vital in reducing dangers associated
Human Resource Manager (HRM)	➢ Limited access to occupational safety and health resources. ➢ Poor communication in terms of WMSDs affecting small construction workers. ➢ Lack of continuous health examinations among employees.	with poor site layout. According to the Site Supervisor long working hours without sufficient breaks exacerbate risks of work-related musculoskeletal disorders. The Construction Site Foreman indicated that tasks performed at construction sites are associated with repetitive movements but, this lead to muscular strains among workers. The HRM designated that, access to health resources is limited among workers within the construction site and this impair the capacity to manage work-related musculoskeletal disorders successfully among workers. Additionally, there is lack of awareness among workers regarding work-related musculoskeletal disorders at small-scale construction sites due to communication gaps about the risks. The Human Resource Manager specified that there is lack of continuous health examinations among employees. This implies that some health problems may go unnoticed until their level of severity increase. Overviews from key interviewees indicates that's various factors result to work-related musculoskeletal disorders among workers in construction industries in Windhoek.

- This study did not examine the social-economic and environmental factors that contribute to the prevalence of WMSDs among small-scale construction workers. Future studies should consider other factors including environmental factors, mechanical (eg excessive repetition, awkward postures, and heavy lifting) psychosocial (e.g., family mental challenges, time constraints) and individual risk factors (e.g., gender, monthly income, smoking behaviour, drinking behaviour, educational level) that contribute to the development of WMSDs among the small scale construction workers.
- This study did not look at the causal relationship between risk factors (either mechanical psychosocial, or individual) and WMSDs among the small scale construction workers. Future studies should consider not only correlation analysis but also regression analysis in establishing a causal relationship between risk factors and WMSDs.
- The study relied on self-reported data, which may be biased and prone to measurement error, from cross-sectional questionnaire surveys and in-depth interviews about the presence or absence of discomfort in specific body areas among the scale construction workers. The information about the general physical activity levels of workers and their medical history (e.g., neurological and mental health concerns, obesity, heart difficulties, severe chronic obstructive lung disease, metabolic disorders, etc.) that this study did not examine could have a significant impact on WMSDs.
- The previously described limitations suggested that we should proceed with caution when interpreting our results and that more study on the prevalence or occurrence of WMSDs among construction workers is needed.
- Correlation analysis used provides insights into relationships between variables but it does not imply causation. As a result, more investigation is required to fully explore casual relationships. Regression analysis may be used in future research as a methodological strategy to investigate these dynamics in greater detail. Researchers can better evaluate the influence of particular risk indicators on the occurrence of work-related musculoskeletal disorders by controlling for confounding variables through the use of regression techniques.

CRediT authorship contribution statement

Pedzisai Kowe: Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Robson Spencer Nyamuziwa:** Writing – review & editing, Writing – original draft, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Amato Chireshe:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Leon Poshai:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Steven Jerie:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Methodology, Investigation, Formal analysis, Data curation. **Mark Makomborero Matsa:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Shadreck Matindike:** Writing – review & editing, Visualization, Validation, Methodology, Formal analysis, Data curation. **Tapiwa Shabani:** Writing – review & editing, Writing – original draft, Visualization, Supervision, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Takunda Shabani:** Writing – review & editing, Writing – original draft, Visualization, Supervision, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **John Hove:** Writing – review & editing, Writing – original draft, Visualization, Supervision, Project administration, Methodology, Investigation, Data curation.

Data availability statement (DAS)

Data sharing is not applicable to this article. The derived data supporting the findings of this study are available from the corresponding author on request.

Ethics

The supporting letters to carry out the research were obtained from the Department of Geography, Environmental Sustainability and Resilience Building of Midlands State University. All sources were acknowledged.

Declaration of generative *Artificial intelligence* (*AI*)

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