Journal of Engineering Research and Reports

Volume 26, Issue 3, Page 1-11, 2024; Article no.JERR.113035
ISSN: 2582-2926

Musculoskeletal Effects of Prolonged Use of Safety Footwear among Construction Workers in Selected Sites of Port Harcourt, Rivers State, Nigeria

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/JERR/2024/v26i31088

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/113035

Original Research Article

Received: 11/12/2023
Accepted: 15/02/2024
Published: 20/02/2024

ABSTRACT

Occupational injuries and work-related musculoskeletal disorders are among the significant issues affecting the construction industry. This work evaluated the musculoskeletal effects of prolonged use of safety footwear on the field construction workers of selected construction sites of a company in Port Harcourt, Rivers State. The study used a Nordic Musculoskeletal Questionnaire as the primary tool. The study revealed the short-term and long-term effects of repeated use of safety footwear for long periods. The gender distribution of the respondents showed that (76%) were male while (24 %) were female. The research also reported that (84.8%) of the respondents experienced

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ankle pain, (49.6 %) suffered hip pain, (34.8%) suffered neck pain and (34.8%) suffered lower back pain respectively from prolonged use of safety footwear which ranged from mild, moderate to severe pain. Chi-square test and correlation analysis at p-value (0.05) were conducted for the test hypotheses with a decision to reject the null hypothesis (H_0) if $p < 0.05$. The results showed p-values of (0.707), (0.434); (0,288), 0.066); (0.159), (0.828), and therefore the null hypotheses were not rejected for hypotheses 1, 2, and 3. The study revealed that 35.6 % of respondents were not trained to use safety boots properly. The study further recommends that organizations should ensure work rotation and break periods for workers, and adequate training, education, and awareness programs should be conducted in organizations to enlighten workers on the proper usage and hazards of safety footwear. Employers and decision influencers (managers and safety supervisors) should also be educated about foot health and safety footwear choices that will meet workers' requirements in the work environment, improve working conditions for workers, and impact the high level of MSDs repeatedly reported in the construction industry.

Keywords: Musculoskeletal disorders; occupational injuries; prolonged use of safety footwear.

1. INTRODUCTION

When people are upright, the feet serve as receptors and sensors vital to balance and stability. The feet keep you from plunging to the ground by providing stability and redistributing your weight [1]. Proper standing posture is essential in every industrial workplace, and so is footwear that meets safety standards. Steel toes or metatarsal guards, which protect the toes from compression and impact injuries, oil-resistant soles, laced shafts that extend 28.5 centimeters above the ankle joint, and distinct heels are all required safety features for work boots according to the American National Standards Institute (ANSI) [2]. It has been reported that mid-sole roughness has a positive effect on the coefficient of friction (COF), which is important because the walking surface's and the shoe's coefficient of friction must be adequate to oppose the forward resultant force at the point of contact to prevent the occurrence of a slip [3].

Holden shoes, the earliest defensive boots, were once known as Sabots and were used by French and Breton peasants in the early 20th century when they were initially regarded as industrial safety equipment [4]. These boots were designed to protect workers from sharp things, farmers' feet from being trodden on by horses and cows, and the workers' toes from falling objects. Before this time, it was more cost-effective and time-efficient to simply replace workers rather than invest in preventative safety measures. Red Wing Shoes first made steel-toed boots during the 1930s and World War II. Officers in the German armed forces who did not have commissions wore boots with metal toecaps during World War II. In 1970, the United States passed the Occupational Safety and Health Act to improve workplace safety. The act created an administration for workplace safety to guarantee the health and safety of workers. Construction and mining are only two of the many areas where safety shoes are now required [5].

Work boots are only one example of the many types of footwear designed to help you keep your balance and walk normally in the workplace. Work boots often do not offer the same degree of heel stability, shock absorption, or control for the rear foot that sports shoes do [6]. However, the high boot shaft commonly seen in orthopedic, athletic, hiking, and military boots is worn to give ankle support and stability, but may impede the wearer's range of motion (ROM) and, by extension, their ability to generate power from their ankles. Slip-resistant shoes are utilized to give grip on both dry and wet surfaces, while work boots are modified to improve support, protection, stability, and structure to accommodate a wide range of working environments. For instance, a steel toe is often regarded as the most effective defense against foot injuries caused by dropped objects or punctures. Workers should wear shoes that support their arches and should not cause them to wobble or tire when standing [7]. About 45 percent of falls reported in the elderly have been attributed to inappropriate clothing and footwear, and 75 percent of those who suffered a hip fracture were wearing inappropriate footwear at the time of the accident, all of which points to the importance of choosing the right footwear to prevent falls [8]. Numerous research on dynamic balance and muscular fatigue have focused on several of the elements and situations that influence balance, including sole hardness, heel height, heel collar height, and tread patterns [9,7,8].

The term "foot protection" refers to measures taken to prevent harm to the feet, including the toes, the ankles, and the soles. There are 26 bones in each foot that provide structure, and 38 joints that allow for mobility. It hurts because the foot contains sensitive structures including blood vessels, ligaments, muscles, and nerves. The feet play a crucial role in daily life and are therefore an important bodily component. The improper use of safety footwear in the workplace can lead to musculoskeletal diseases and other foot issues caused by exposure to physical dangers such as wet and slippery surfaces, caustic chemicals, hot and cold surfaces, sharp items, and falling objects [5].

Musculoskeletal diseases (MSDs) are a broad range of inflammatory and degenerative illnesses of the musculoskeletal system, as defined by the Occupational Safety and Health Administration (OSHA). As it relates to the workplace Musculoskeletal disease (WMSD) is an occupational illness that affects the muscles, tendons, nerves, cartilage, and other connective tissues of the body due to repetitive motion or overuse.

Musculoskeletal problems are more likely to occur as a result of working situations including walking and standing on a hard surface. Muscle mobility is especially important in the construction business, where constant carrying can lead to muscle fatigue in the upper limbs [10], therefore the shoes worn and the quantity of labour done can have a significant impact [11]. Safety shoes may play an important part in the health of employees since they are the first line of defense between the ground and their skeletal and muscular systems [12].

82% of construction workers are particularly vulnerable to musculoskeletal pain (MSP) with lower back pain (LBP) being the most frequently reported among occupational health issues [13]. Long hours of standing on the job have been linked to a variety of health problems, including musculoskeletal illnesses and acute injuries sustained in the workplace. Shoes are the only contact a person with the ground has, making them a viable target for interventions targeting musculoskeletal diseases. However, there is a lack of study into the design and development of shoes that take into account the physical limits of the workplace and the preferences of the employees themselves [14]. Standing for lengthy periods increases the risk of injury for at least half of the working population [15]. Prolonged standing is defined as standing for 50% or more of a complete working day [16] which results in different health difficulties such as carotid atherosclerosis, venous insufficiency, preterm delivery, and work-related musculoskeletal illnesses [17].

As the only point of contact between the body and the ground, footwear has a significant impact on the individual's posture, gait, and overall health [14]. Also, your feet need some sort of safety, which is why different shoe types might have different effects on the wearer's tiredness and pain [18]. Muscle contraction and pressure under the foot are also modified. Therefore, if work footwear is worn appropriately, MSD and acute injuries can be prevented [19].

The construction industry is a subset of the national economy that deals with the development, construction, and maintenance of buildings, roads, and other real estate. Road construction, maintenance, and repair are all considered part of the construction industry, which is defined as a subsector of manufacturing and commerce by the Standard Industrial Classification system. The building construction industry, which encompasses every general contractor and operative builder primarily involved in the construction of residential, industrial, commercial buildings, etc., is one of the three main categories of the construction business. The large construction industry is general contractors that are engaged in heavy constructions other than buildings such as bridges, highways and streets, railroads, irrigation and flood control projects, marine construction, etc. Contractors in the special trade construction business specialize in a variety of building-related tasks, such as painting, electrical work, plumbing, and more.

Slip-resistant shoes, rubber safety boots, safety toe boots, shock-absorbing shoes, water-resistant leather boots, and puncture-resistant shoes are just a few of the many types of safety footwear worn by construction workers to protect them from musculoskeletal injuries and improve their health [20].

There appears to be a lack of knowledge about foot problems, remedies to the problem, and relationships between MSD, feet, and footwear among construction workers, even though these employees spend a lot of time on their feet during their work day. Standing for long periods at work is associated with a much higher risk of

developing MSD than the general population. MSD is linked to factors including muscle use, blood pooling, muscular exhaustion, and personal factors (such as age and shoe size).

2. STUDY AREA

The study was carried out in Port Harcourt, Rivers State, Nigeria. Established in 1967 and witnessing the creation of Bayelsa State in 1996, the region has a diverse ethnic composition, including Ijaw, Kalahari, Ikwerre, Okrika, Ibani, Ekpeye, Ogba, Etche, Khana, Gokana, Eleme, Ndoni, and Abua-Odua groups. Administratively, the state comprises 23 Local Government Areas (LGAs), with a three-tiered government structure encompassing the Executive Council, Legislature, and Judiciary. Geologically, Rivers State sits on the eastern Niger Delta's coastal plain, characterized by fluvial deposits and diverse rock types. The relief features three major zones: the freshwater zone, mangrove swamps, and coastal sand ridges. With poor drainage due to high rainfall and tidal influence, the area faces ecological challenges such as beach erosion, floods, and soil fertility loss. The population, predominantly engaged in farming and fishing, is concentrated in urban centers like Port Harcourt, exhibiting low urbanization levels. Key sectors include oil production, agriculture, and burgeoning industrialization. The study's focus on the musculoskeletal effects of prolonged safety footwear use among construction workers in selected sites within this dynamic socio-economic and environmental context adds a vital dimension to occupational health research.

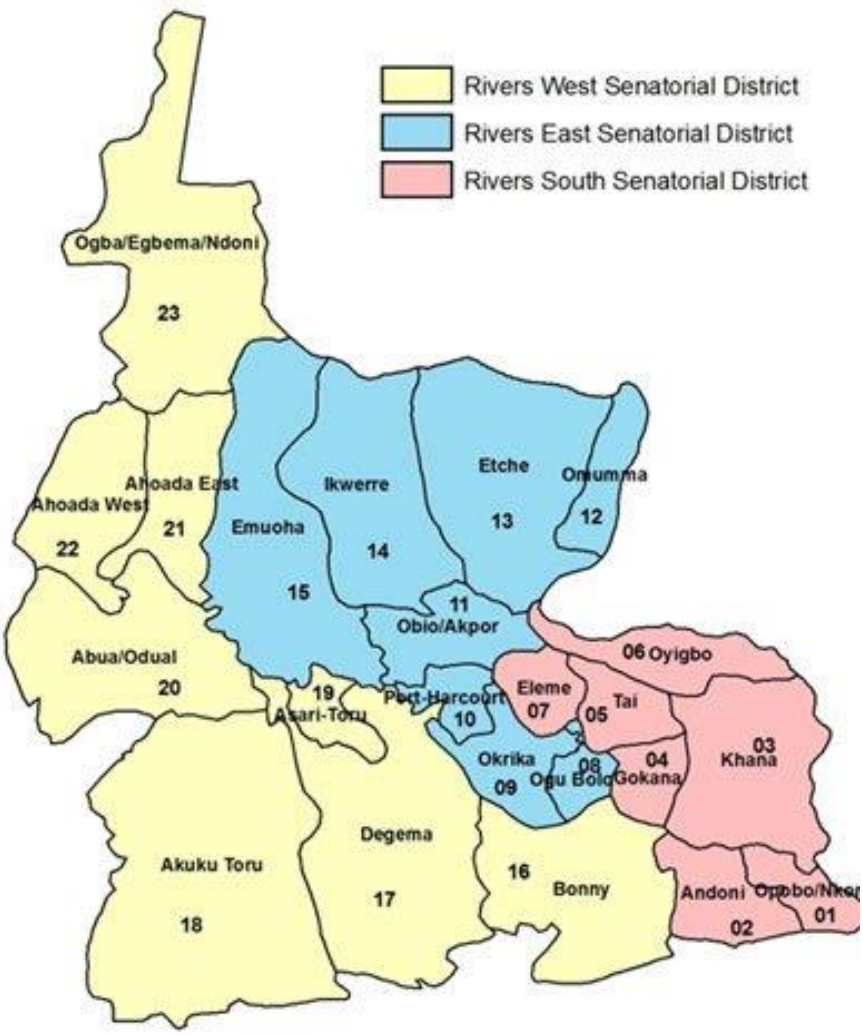

Fig. 1. Map of Rivers State
Source: Nigeria Postal Codes

3. METHODS

The primary research instrument employed in this study was a structured questionnaire, utilized to gather information on the musculoskeletal impacts resulting from extended usage of safety footwear among field construction workers at selected construction sites in Port Harcourt. A random selection of workers from seven prominent sites operated by XYZ Construction Company in Port Harcourt constituted the sample for quantitative data collection. A total of 275 reliable and validated structured questionnaires were formulated and distributed to construction workers. Section A of the questionnaire captured socio-demographic data, while Section B focused on inquiries regarding awareness of safety footwear use. Questions in Section B were designed to elicit straightforward 'yes' or 'no' responses, and a Likert 5-point scale was employed to enhance clarity. A response rate of 90.9% was achieved, with 250 questionnaires returned and analyzed. Each questionnaire included an introductory letter seeking respondents' consent and assuring the confidentiality of their information. Before questionnaire administration, a brief presentation was delivered to inform respondents about the potential impacts of prolonged safety boot usage. The collected data underwent statistical analysis using SPSS version 20, and the findings were presented through tables and charts, leading to interpretations and conclusions drawn from the study's results.

4. RESULTS AND DISCUSSION

Table 1 provides an overview of the bio-demographic characteristics of the participants in the survey. The majority of survey respondents were male, constituting 76%, while 24% were female. In terms of age distribution, 40% fell within the 25-34 age range, 52% were between 35-44 years, 7.2% were in the 45-54 age group, and 8% were above 55 years old. The largest group of participants belonged to the 35-44 age bracket. Marital status revealed that 31.2% were single, while the majority (68.8%) were married. Regarding educational qualifications, 37.6% had O' Level, 52.8% had B.Sc./HND, and 9.6% possessed M.Sc./Ph. D qualifications. Work duration distribution indicated that 43.2% had worked for 6-10 years, 35.2% for 1-5 years, 17.2% for 11-15 years, and 4.4% for more than 15 years. Concerning footwear size, 56% used sizes 40-44, 34.8% used sizes 45-49, and 9.2% used sizes 35-39.

The distribution of responses related to safety boots among the surveyed participants is presented in Fig. 2. Notably, 60.8% strongly agreed that proper training in safety footwear usage could reduce health issues, with an additional 35.6% in agreement. This contrasts with Anderson et al.'s [17] findings of inadequate formal training for 63% of workers, as this study revealed a well-informed and adequately trained majority. Respondents demonstrated knowledge about the suitability of rubber, anti-slip sole safety boots for wet construction environments, with 43.6% strongly agreeing and 47.2% agreeing. Participants also showed awareness of safety boots with midsole penetration resistance, with 39.2% strongly agreeing and 41.2% agreeing. A majority understood the relevance of antistatic sole safety footwear against electric hazards, with 36.4% strongly agreeing and 52.4% agreeing.

Concerns about the potential health impacts of prolonged safety footwear use were acknowledged by 22.0% of respondents, with 52.0% in agreement. This finding aligns with Orr et al.'s [21] study, linking prolonged safety footwear use to musculoskeletal injuries. Results also revealed that 44.0% strongly agreed and 53.6% agreed that well-fitted footwear reduced toe discomfort, aligning with Tally et al.'s [22] conclusion that appropriate and well-fitted safety footwear significantly reduced the likelihood of injuries and discomfort among workers.

Regarding the frequency of receiving new safety footwear, Fig. 3 illustrated that 83.2% of respondents received a new set every 6 months, indicating regular replacement. However, prolonged use, as seen in Fig. 4, raised concerns, as 72.4% reported wearing safety footwear for more than 8 hours daily, aligning with Alghadir and Anwer's [23] findings that the majority of construction workers worked for more than 8 hours daily wearing safety footwear. This resulted in issues such as corns (70.8%), hip pain (49.6%), neck pain (14.0%), ankle pain (84.8%), lower back pain (34.8%), athlete's feet (74.4%), blisters (85.6%), and musculoskeletal pains (52.8%), as seen in Figs. 5a, b, and c. These findings were in line with multiple studies by Anderson et al. [20], Alghadir and Anwer [23], and Marr and Quine [24], emphasizing the association between prolonged safety footwear use and various health problems.

The majority (75.6%) always reported harmful effects and health conditions resulting from

prolonged safety footwear use, with 24.4% not always reporting such effects (Fig. 5c). Additionally, 8.8% were current medical patients due to safety footwear-induced health conditions, and 7.6% had used ankle pads/braces.

In terms of health insurance, 66.4% had health insurance, and 33.6% did not (Fig. 5c). A significant proportion (90%) accepted that adverse effects from prolonged safety footwear use caused stress and reduced productivity at work, aligning with Orr et al.'s [21] study on the impact of footwear on occupational task performance and musculoskeletal injury risk in Australia.

Fig. 6 shows the percentage of reported discomfort associated with wearing safety footwear for up to 6 hours, categorized into different types of pain or issues. Neck pain appears to be a common concern, with 40.8% experiencing it sometimes, while ankle pain is more prevalent, with 53.6% reporting it often. Hip pain, lower back pain, athlete's feet, and smelly feet also show varying degrees of occurrence. Notably, athlete's feet and smelly feet have lower frequencies, with 14.8% and 17.2% often experiencing these issues, respectively. Blisters on toes show a relatively balanced distribution across the categories.

Hypothesis testing was conducted to assess the association between workplace factors (footwear size, age, and daily working hours) and musculoskeletal pain among employees. The hypothesis that there is no significant relationship between ankle pain and footwear size was supported by cross-tabulation and Chi-Square analysis (p-value = 0.707) and correlation analysis (p-value = 0.434). Similarly, the examination of lower back pain and employee age revealed no statistical significance in both cross-tabulation (p-value = 0.288) and correlation analysis (p-value = 0.066), suggesting that age is not a significant factor. The investigation into the link between neck pain and daily working hours also showed no statistical significance in cross-tabulation (p-value = 0.159) and correlation analysis (p-value = 0.828). These results collectively indicate that musculoskeletal discomfort is likely influenced by factors beyond footwear size, age, or working hours, emphasizing the importance of a comprehensive understanding of job-related factors contributing to pain.

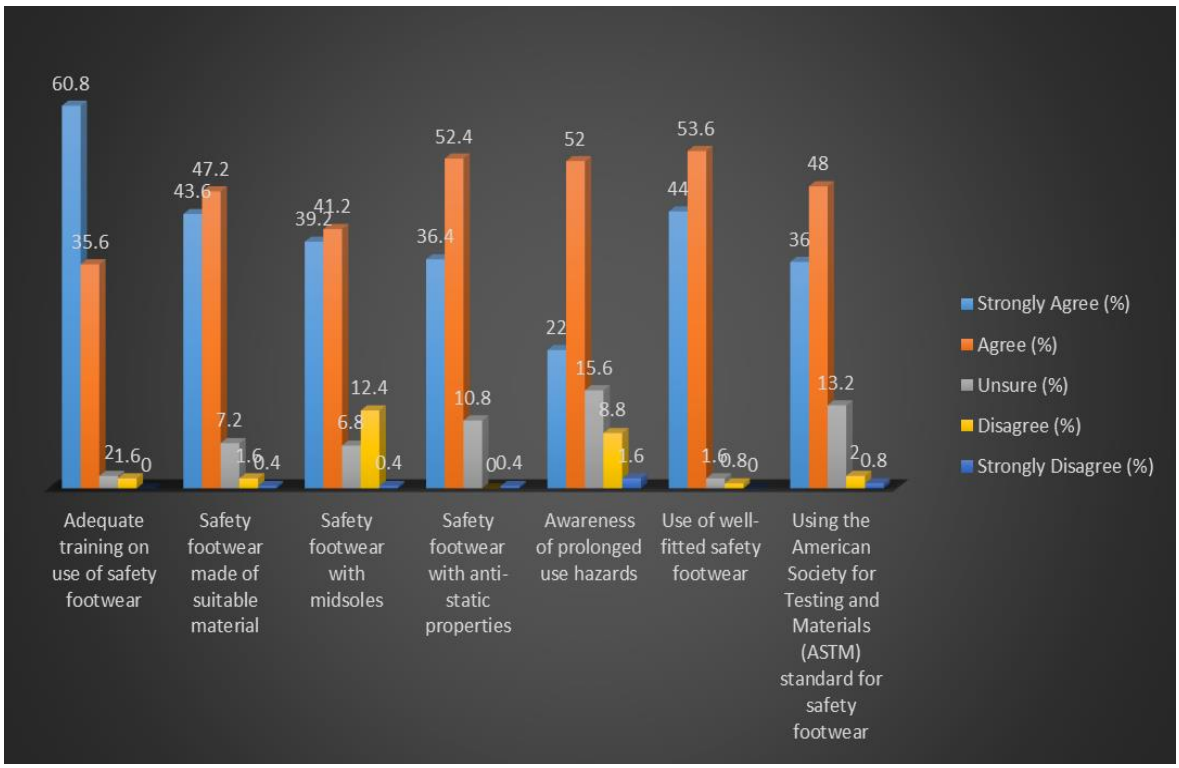

Fig. 2. Respondent distribution based on safety boot-related inquiries

Table 1. Bio-demographic characteristics of the respondents (n = 250)

Gender		Age Range		Marital Status		Educational Qualification		Work Duration		Size of Footwear	
Male	76%	25-34 Years	40%	Single	31.2%	O' Level	37.6%	1-5 Years	35.2%	35-39	9.2%
Female	24%	35-44 Years	52%	Married	68.8%	B.Sc. / HND	52.8%	6-10 Years	43.2%	40-44	56%
		45-54 Years	7.2%	Divorced	0	M.Sc. / Ph.D.	9.6%	11-15 Years	17.2%	45-49	34.8%
		> 55 Years	0.8%	Widowed	0			> 15 Years	4.4%	> 50	0

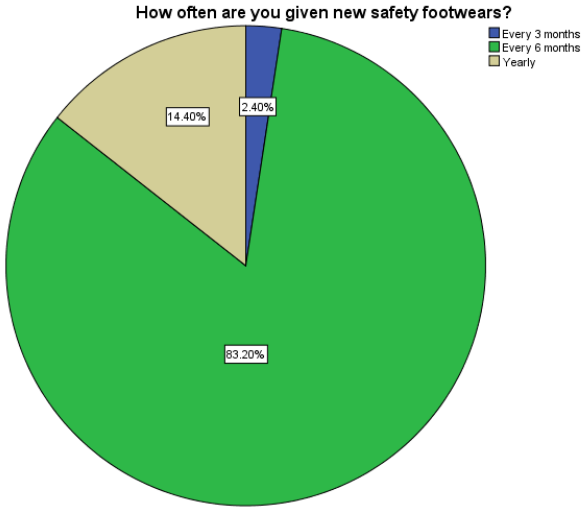

Fig. 3. The frequency of receiving new safety footwear

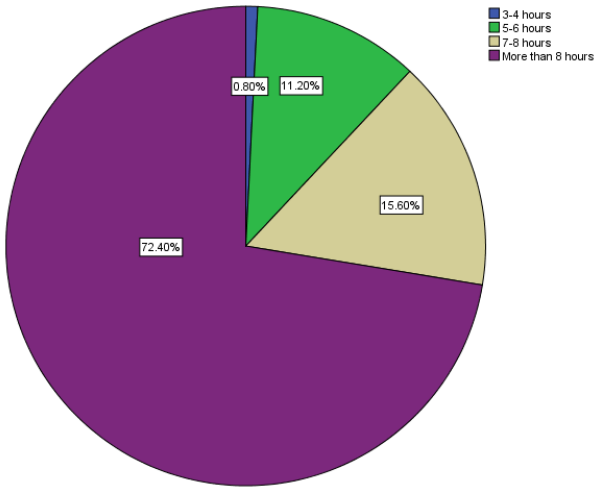

Fig. 4. Usage of Footwear on an Hourly Basis

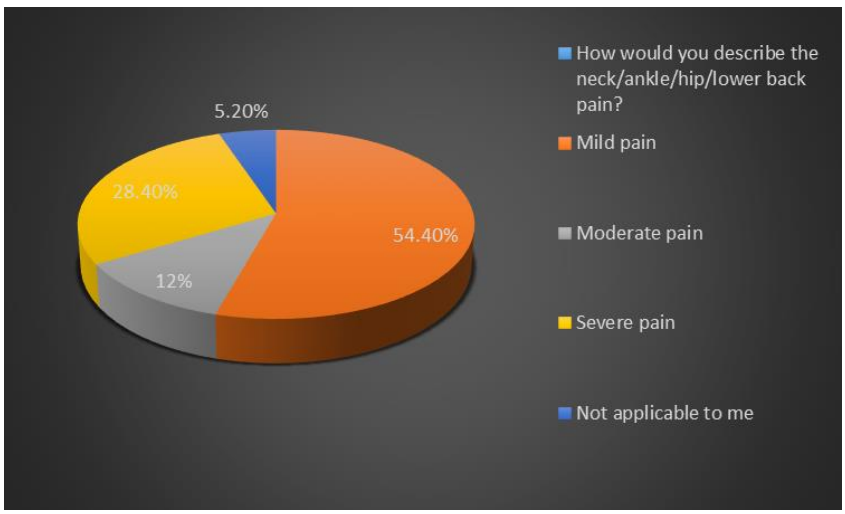

Fig. 5a. Respondent Distribution Regarding Health-Related Questions

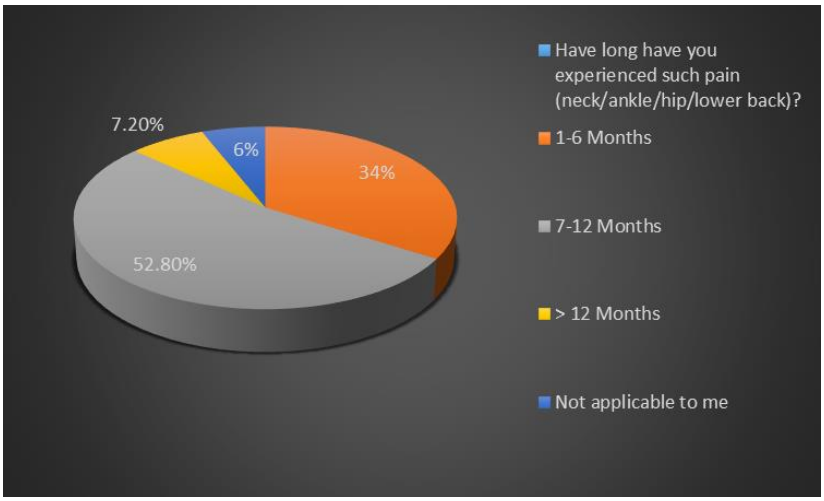

Fig. 5b. Respondent Distribution Regarding Health-Related Questions

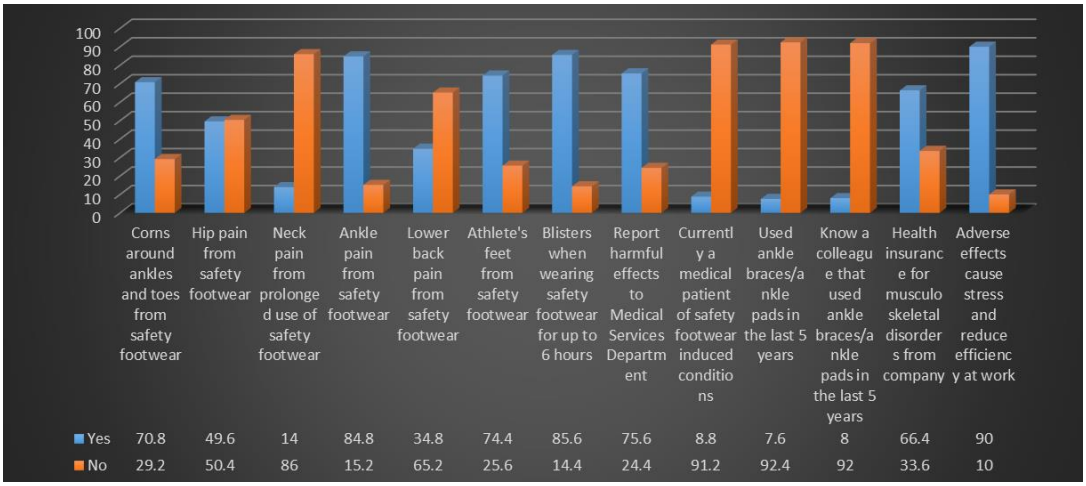

Fig. 5c. Respondent Distribution Regarding Health-Related Questions

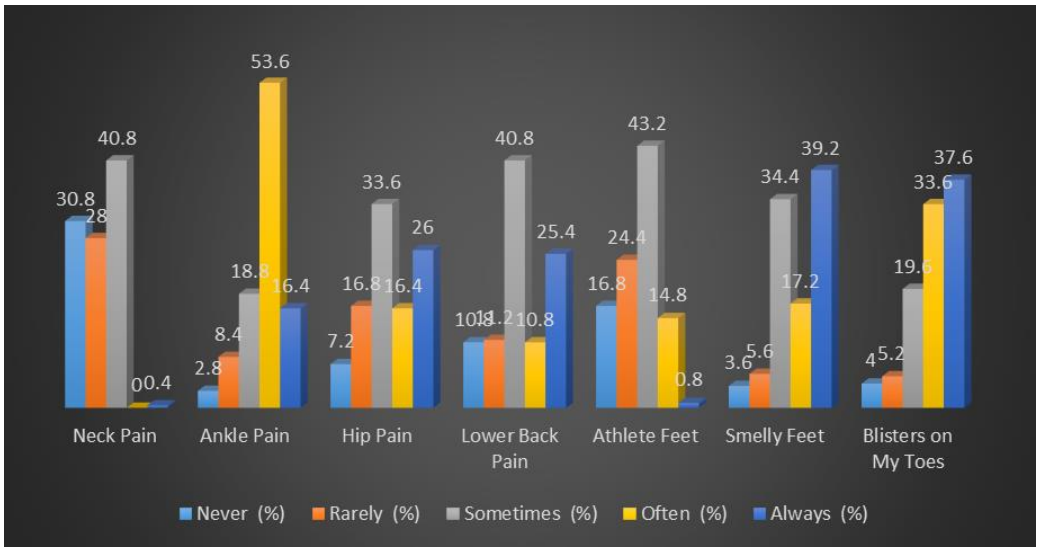

Fig. 6. Pain Levels in Safety Footwear Use (Up to 6 Hours)

5. CONCLUSION

In conclusion, the results highlighted a lack of adequate safety practices in construction sites in Port Harcourt, Rivers State. An overall assessment showed that the workers have adequate training on workplace hazards and safety. However, the majority of the workers reported various musculoskeletal injuries such as lower back/hip/neck/ankle pain for varying periods ranging from 3 months to more than 1 year.

Adherence to safety practices and guidelines is necessary to reduce the risk of musculoskeletal injuries to workers occurring from prolonged use of safety footwear in the construction industry.

Further research is needed to explore the topic of musculoskeletal injuries in the construction industry and safety practices such as the ergonomic design of safety footwear, workplace environment, injury risk, training and education programs, psychosocial factors, etc. to gain a deeper understanding of the factors contributing to musculoskeletal injuries in the construction industry and identify effective strategies for prevention and intervention.

CONSENT

As per international standards or university standards, respondents' written consent has been collected and preserved by the author(s).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/113035