Research article

Musculoskeletal disorders (MSDs) and their associated factors among quarry workers in Nigeria: A cross-sectional study

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ABSTRACT

Quarry workers are commonly afflicted with musculoskeletal disorders (MSDs). This health problem has been recognized as a significant threat to the quarry workers' safety but is rarely reported, particularly in Nigeria. Therefore, this study aimed to assess the prevalence of MSDs and their associated factors among quarry workers.
Method: A cross-sectional study was conducted, and data were collected using a self-administered Standard Nordic Musculoskeletal Questionnaire. A total of 266 participants were selected through systematic random sampling method among male and female quarry workers in Ebonyi State, Nigeria. The data were analysed using SPSS version 26, and descriptive statistics were used to determine the prevalence and types of MSDs. Simple and multiple logistic regressions were used to identify the factors associated with MSDs.
Results: The results revealed that majority of the respondents (89.8%) had MSDs, with the most common types being lower back pain (83.1%) and elbow pain (45.9%). Based on multiple logistic regression modelling, BMI (Adjusted OR 0.17, 95% CI 0.06,0.55, p = 0.003), age (Adjusted OR 1.14, 95% CI 1.07, 1.23, p < 0.001), work experience (Adjusted OR 2.08, CI 1.00, 4.30, p = 0.049), Vibration exposure (Adjusted OR 0.45, CI 0.27, 0.74, P = 0.002), working hour (Adjusted OR 6.84, CI 0.84, 53.4, p = 0.007) and break time (Adjusted OR 0.95, 95% CI 0.91,0.98, p = 0.006) were significantly associated with MSDs.
Conclusion: MSDs are prevalent among the quarry workers in Ebonyi State, Nigeria. Thus, there is an urgent need to increase the workers' and employers' awareness of appropriate ergonomic and personal measures needed to improve the workers' safety and well-being.

1. Introduction

Musculoskeletal disorders (MSDs) constitute major occupational health problems globally (Ekpenyong and Inyang, 2014; Ayub and Shah, 2018; Rahman et al., 2019). According to the Canadian Centre for Occupational Safety (2015), MSDs are complex group of painful disorders of tendons, muscles and ligaments caused by frequent and recurrent work activities or awkward occupational posture. MSDs commonly affect the musculoskeletal framework of the body such as tendon, ligaments, joints, nerves and blood vessels (Schierhout et al. 1995; Punnett and Wegman, 2001; Adegbehingbe et al., 2009; Caicoya and Delclos, 2010; Tinubu et al., 2010; Shafiezadeh, 2011; Kulin and Reaston, 2011). Accordingly, MSDs occur in nine parts of the body, namely: neck, shoulders, forearms, elbows, lower back, waist, wrists, thighs and knees with diverse rate across the parts of the body (Health and Safety Executive, 2017; Hamid and Mohammad, 2017).

According to Health and Safety Executive (2017), MSDs affect over 507,000 persons per year and account for 8.9 million lost workdays per year in developed and developing countries, with a higher rate projected in developing countries. It accounts for 34% of annual workdays lost to ill health, resulting in low productivity and economic backwardness of the organization (Ontario Ministry of Labour, 2009; Xu et al., 2013). MSDs exert deleterious effects on the life of the workers in all fields, especially those requiring manual labour (Health and Safety Executive, 2017). Empirical studies have recognized MSDs as one of the costliest and common work-related disorders (Eurogip,

2004; Orhan and Asad, 2019). About 10,739 cases of occupational injury compensations were recorded in 2017, with 95.96% being MSDs (Health and Safety Executive, 2017). Studies have also shown that MSDs make up 39% of all work-related health burdens on the employees, leading to loss of body parts and time, low productivity, change of career, handicap and total or partial dependence on the society (Darragh, 2009; Egwuonwu, 2013; Health and Safety Executive, 2017).

Quarry industries under the umbrella of construction companies have been reported in earlier studies as the second most risky forms of employment across the world after agriculture (Azlina et al., 2014; Health & Safety Executive, 2017; Lop et al., 2018), but are currently regarded as the riskiest employment due to probability of MSDs (Health and Safety Executive, 2019). The workers in this sector face numerous health hazards and are more than twice at risk for occupational health disorders than others (Ajayi et al., 2015). Quarry industries employ over 20 million people in developing countries, providing a source of income to the workers and their dependents (Adeyemi et al., 2013; Uwakwe et al., 2015) but simultaneously exposing them to serious health hazards (Azlina et al., 2014). Generally, quarry and other related industries are commonly labour intensive with most works being done manually (Ayub and Shah, 2018) and often offshored to developing countries with the products exported to developed countries for want of low cost for labour (Parteka, 2018).

Moreover, in most third-world countries, workers are often used as a substitute for automation creating avenues for occupational hazards (Ayub and Shah, 2018). Low technological know-how, inadequate occupational laws and inadequacy in implementing occupational safety measures further make the working condition unfavourable in developing countries (World Health Organisation, 2000; International Labour Organisation, 2014; Koaja et al., 2018). Quarrying is often characterised by harsh and challenging conditions involving manual handling of materials, heavy lifting, repetitive movements and tasks, forceful manual-exertion, and exposure to the whole body or segmental vibration (Scharf et al., 2007). This gruelling nature of work predisposes workers to MSDs (Scharf et al., 2007).

The quarry industry in Nigeria has been recognised as one of the major sources of employment and livelihood among Nigerians in rural and urban areas (Ukomi et al., 2013). The industry contributes about 7–9% percent of Nigeria's economy and over 42% of the fixed domestic products in the last few decades. Most recently, the quarry industry contributes 11.17% of the nation's economic growth in 2017 compared to 7–9% recorded in 2012 (National Bureau of Statistics, 2017). With the current high unemployment rate in Nigeria at 27.1% (National Bureau of Statistics, 2020), quarry and related industries serve as the immediate sources of livelihood for the people. At least every state of the federation has one or two quarry sites where stones are crushed for many purposes. The industries employ a reasonable number of workers in different capacities such as drivers, blasters, evacuators, loaders, operators and lifters, most of which are literate and few illiterate men and women (Egwonwu, 2013). Ebonyi State, the area of this study is one of the new states in Nigeria without any traceable industries except the quarry industry. It is also reported as the third poorest state in Nigeria, with high poverty index of 79.76% (Simona, 2020). Due to the lack of industries in the region, occupational safety and laws are not considered as a necessity by the government.

Despite the above contribution of the quarry industries to the economic growth and the known dangers associated with the work, there is a severe paucity of empirical evidence on the work-related disorders and the associated factors among quarry workers. Hence, this study seeks to determine the prevalence of MSDs and their associated factors among quarry workers in Nigeria.

2. Materials and methods

2.1. Study design

This study utilized a cross-sectional research design to assess the MSDs and their associated factors among the quarry workers in Nigeria. It was conducted in the quarry industries in Ebonyi state, South-eastern Nigeria, between July to September 2020.

2.2. Study setting

This study was carried out in the quarry industries in Abakaliki Ebonyi State, Nigeria.

2.3. Sample size determination

This study's sample size was determined based on the single proportion formula n = p (1-p) (Z/E)2 (Naing, 2006), whereby n = sample size, p = proportion of MSDs in population, Z = standard normal distribution (1.96), E = precision (0.06), p = proportion of MSDs in population (0.5; Cochrane 1977). This study's estimated sample size was 266 respondents, which was the highest number among the sample sizes estimated based on this study's objectives.

2.4. Inclusion/exclusion criteria

The quarry workers who fulfilled the inclusion criteria were selected as the respondents of this study. These include those who were currently working in the quarry industries in Ebonyi at the time of this study, aged between 18 years old and above, involved directly in the stone crushing processes in the above quarry industries such as blasters, operators of crushers, lorry drivers, manual stone handlers and loaders and had working experience of one or more years. While for the exclusion criteria, those who had less than one-year working experience in quarry industry in Ebonyi state, having musculoskeletal disorders before employment in quarry industry including arthritis, had involved in road traffic accidents (self-reported MSDs), and work as administrative staff (workers whose work does not involve stone crushing such as office workers, secretaries and others) were excluded from the study.

2.5. Ethical consideration

Ethical approval for this study was obtained from the Human Research Ethics Committee of the Universiti Sains Malaysia (USM/JEPeM/20020133) and approval from the management of the quarry industries Ebonyi, Nigeria (EBSSCA/2019/1607/213).

2.6. Instrument for data collection

This study's data were collected using a questionnaire comprising of four sections on sociodemographic variables, workplace factors, Standard Nordic Musculoskeletal Questionnaires (SNMQ) and pain scale. The SNMQ was developed by Kuorinka et al. (1987). It was developed for epidemiological study of work-related MSDs among workers in different employment settings and used to assess the nine parts of the body that commonly affected by MSDs within 7-day duration and 12-month duration. The SNMQ had been tested for reliability with an acceptable Cronbach's alpha value of 0.78 (Crawford, 2007) and was used in other study conducted in Nigeria with good cultural adaptation (Egwuonwu, 2013).

The Pain Scale was developed by Breivik et al. (2008) to assess pain severity among the respondents. It is also a reliable scale with Cronbach's alpha value of 0.76 (Breivik et al., 2008).

2.7. Data collection method

Systematic random sampling technique was applied to select 266 respondents from the sample frame of 540 persons who met the inclusion criteria for the study. The sampling was done when all the workers gathered in one location, which was during their routine meeting time. The study procedure was explained to the selected respondents to enhance informed decision about their participation in the study. The respondents' information sheet and consent form were distributed for them to sign, following a brief assessment for inclusion criteria, after which the questionnaires for this study were administered to them. The data were collected using a set of self-administered questionnaires, whereby the respondents were encouraged to respond independently. However, the researcher was present during the data collection period, just in case there is a need to clarify any doubts that may arise. The respondents took about 20–30 min to complete the questionnaires.

2.8. Data analysis

Data collected were coded, cleaned and analysed using SPSS version 26. Descriptive statistics (frequency, percentages) were used to present the respondents' demographic characteristics, the prevalence of MSDs and the types of MSDs among the quarry workers. Univariate logistic analysis of factors associated with MSDs was conducted using simple logistic regression at p-value <0.25 based on experts' opinions, which recommended using p-value 0.25 to screen variables at univariate analysis (MacDonald, 2014). Therefore, independent variables with p-values <0.25 were selected for inclusion in the multiple logistic regression analysis.

The dependent variable, MSDs, was coded as a categorical variable (yes = 1 and no = 0 responses) where 'yes' means the presence of MSDs, while 'no' means absence of MSDs. The independent variables (socio-demographic and workplace factors) were screened at this level before proceeding to multiple logistic regression. Independent variables with p-values < 0.25 at simple logistic regression were then tested in multiple logistic regression. Forward stepwise and backward stepwise logistic regression techniques were applied in the modelling. Following this, the final model was determined by including the independent variables with p-values <0.05. Multicollinearity and interaction among the independent variables were also assessed. The goodness of fit of the model was assessed using the Hosmer Lemeshow Test, percentage of classification correctly and area under the Receiver Operating Characteristics (ROC) curve.

3. Results

Table 1 presents the sociodemographic features of the quarry workers. The mean (standard deviation) age of the respondents was 31.0 (8.28). Majority of the workers were young, less than 30 years old (46.2%), males (66.9%) and had a secondary level of education (49.6%). Most of them were married (49.6%), worked as blasters (24.4%) and had a normal BMI (62.9%).

As seen in Table 2, most of the respondents had 0 to 2 children (54.5%), family income more than 10,000 Naira per month and 51.5% had 3 to 6 family members being catered for by the monthly income.

Table 3 shows the work-related factors of quarry workers. About 66.2% of the workers had work experience of 1–5 years with a mean of 4.9 years. The majority of the workers (96.6%) worked for 7–9 h per day with a mean work hour of 8.0 h and mean break time per day of 14.0 min. About 86.6% reported a lack of work training, while almost all the respondents (94.4%) worked under high temperatures. The majority of the workers (95.5%) continued to work even after injury, while 97.4% was noted on non-use of personal protective equipment (PPE) at work.

Table 4 displays that majority of the respondents (89.8%) had MSDs. About 45.5% of the respondents rated the pain as moderate pain,

Table 1. Socio-demographic characteristics of quarry workers in Ebonyi state, Nigeria (N = 266).

Variables	Mean (SD)	Frequency (n)	Percentage (%)
Socio-demographics factors			
Age	31.0 (8.28)		
<20		17	6.4
20-29		109	39.8
30-39		92	34.6
40-49		51	19.2
Gender			
Female		88	33.1
Male		178	66.9
Education level			
No formal education		0	0
Primary education		94	35.3
Secondary education		132	49.6
Tertiary education		40	15.0
Marital status			
Single		106	39.8
Married		132	49.6
Divorced		14	5.3
Widow/widower		14	5.3
Work type			
Blasters		65	24.4
Drivers		38	14.3
Loaders		56	21.1
Manual workers		41	15.4
Evacuators		28	10.5
Operators		38	14.3
Health-related Factors			
BMI	26.2 (4.10)		
Obese (BMI ≥ 30)		98	36.8
Not obese		167	62.8
Other Health problem			
Yes		18	6.8
No		248	93.2
Use of Medication			
Yes		58	21.8
No		208	78.2
Smoking			
Yes		108	40.5
No		158	59.4

followed by the mild level of pain with 24.8%. About 62.4% of the respondents had difficulties in performing daily activities due to MSDs.

Mostly, nine parts of the body were reportedly affected by the pains, with the lower back had the highest cases of MSDs with 83.1%, followed by the elbows and shoulders with 45.9% and 42.5%, respectively (Table 5).

Based on Table 6, independent variables with p-value <0.25 were selected for multiple logistic analysis which are age of the individual workers (OR Unadj 1,11, 95% CI, 1.04,1.18, p-value = 0.001), gender with female gender as reference (OR Unadj 1.72, 95% CI, 0.76, 3.84 P-value = 0.189), work experience (OR Unadj 1.31, 95% CI, 1.06, 1.60, p-value = 0,011), BMI(OR Unadj 0.35, 95% CI 0.13, 0.96, p-value = 0.041), no of children (OR Unadj1.27, 95% CI 1.04, 1.56, p-value = 0.021), working hours (OR Unadj 1.27 95% CI 0.82, 1.97, p-value = 0.200) and break time (OR Unadj 0.96, 95% CI, 0.92, 0.99, p-value = 0.013).

Table 7 presents the final model that shows BMI (ORadj 0.17, CI 0.06, 0.55, P-value = 0.003), age (ORadj 1.14, 95% CI 1.07, 1.23, p-value<0.001) and break time (OR adj 0.95, 95% CI 0.91, 0.98, p-value =

Table 2. Socio-demographic characteristics of the Quarry Workers - continue (N = 266).

Variables	Mean (SD)	Frequency (n)	Percentage (%)
Number of Children	2.3 (2.34)		
0 – 2		45	54.5
3 – 5		87	32.7
6 - 8		34	12.8
Monthly Income (Naira) 10,625# (7500)			
<10,000		160	60.2
10,000 – 15,000		54	20.3
16,000 – 21,000		25	9.4
22,000 – 27,000		16	6.0
28,000 – 33,000		8	3.0
34,000 – 39,000		1	0.4
≥40,000		2	0.8
Number of Family members			
< 3		78	29.3
3 - 6		137	51.5
7 - 10		50	18.8
11 -14		1	0.4

Table 3. Work-related Factors of the Quarry workers (N = 266).

Variables	Mean (SD)	Frequency(n)	Percentages (%)
Work Experience	4.9 (3.00)		
1-5		176	66.2
6-10		76	28.6
11-15		11	4.1
16-20		3	1.1
Working Hours			
<4		1	0.4
4-6		5	1.9
7-9		257	96.6
10-12		3	1.1
Duration of break time	14.0 (11.80)		
<10 min		100	37.6
10–15 min		25	9.4
20–25 min		89	33.5
30–35 min		50	18.8
>35 min		3	0.8
Exposure to vibration			
Yes		124	46.6
No		142	53.4
Work Training			
No		231	86.8
Yes		35	13.2
High temperature workplace			
Yes		251	94.4
No		15	5.6
Repetitive work			
Yes		264	99.2
No		2	0.8
Awkward posture			
Yes		235	88.3
No		31	11.7
High job demands			
Yes		262	98.5
No		4	1.5
Working with injury			
Yes		254	95.5
No		12	4.5
Use of Personal Protective Equipment			
Yes		7	2.6
No		259	97.4
Poor work design			
Yes		231	87.2
No		34	12.8

0.006) remained significantly associated with MSDs. Further modelling of types of MSDs with workplace factors revealed that work experience (Adjusted OR 2.08, CI 1.00, 4.30, p = 0.049), Vibration (Adjusted OR 0.45, CI 0.27, 0.74, P = 0.002) and working hour (Adjusted OR 6.84, CI 0.84, 53.4, p = 0.007) remained as significant predictors of lower back and elbows MSDs.

Test for the logistic regression analysis assumptions showed no multicollinearity and interaction among the independent variables. Hosmer and Lemeshow's test for goodness of fit of the model showed a p-value (0.933), which was greater than 0.05; hence, the model is fitted with the data (MacDonald, 2014). The classification table revealed that 89.5% were correctly classified. The area under the curve from the Receiver Operating Characteristics (ROC) curve was 0.80, indicating that the model can accurately discriminate 80% of the cases (MacDonald, 2014).

4. Discussion

The prevalence of MSDs in this study is 89.5%, with lower back being the most affected body parts among the quarry workers. This finding is congruent with other study on MSDs that reported 83.3% incidents of MSDs among quarry workers (Egwuonwu et al., 2013).

About 70.3% of the respondents classified their pain as mild to moderate, with 62.4% experiencing difficulties in performing daily activities due to pain. This is higher than the rate reported among grocery workers in the United States of America, in which only 11.0% were unable to perform work activities due to musculoskeletal pains (Anton and Weeks, 2016). This reveals that the workers at quarry industries are experiencing adverse musculoskeletal impacts due to their work, which has also affected their daily lives (Egwuonwu et al., 2013). Due to frequent stooping or squatting activities and heavy lifting from the floor, the lower back accounts for the workers' higher rate of MSDs. This is a deviation from the ergonomic principles of work which stipulates that tasks should be adapted to the workers and are also supposed to work in neutral position and comfort zones (Middlesworth, 2020).

Compared to other MSDs study, the finding of this study was higher than that reported among construction companies in Saudi Arabia (48.5%), with lower back pain being the most common (Alghadir and Anwer, 2015). Another studies of MSDs among construction workers in Malaysia reported the prevalence at 66.5% (Fairus et al., 2014) and 39.25% among construction workers in Nigeria (Ekpenyong and Inyang, 2014). These are far below the finding of the present study. The above

findings could imply that MSDs are associated with industrial works requiring manual handling of materials and intense use of human energy in place of technological advancement like quarry (Ayub and Shah, 2018). This finding also echoed the report by Health and Safety Executive (2017) that quarry, construction and mining workers are twice at risk for occupational disorders than other workers in the society.

Furthermore, this study's finding also revealed that all quarry workers are educated at least with a primary level of education (Table 1). This is comparable to the findings of an earlier study among quarry workers, which reported a 68.9% literacy level with about 10.5% no response (Egwuonwu et al., 2013). Additionally, the study setting is one of Nigeria's most educated regions, with 86.7% literacy level (Simona, 2020). This implies that quarry industries are increasingly becoming a source of living even for the educated class, dismissing the assertion that high-level of illiterate workers do not allow for the adoption of technological techniques in developing countries (Ayub and Shah, 2018). This

Table 4. Prevalence of MSDs among quarry workers (N = 266).

Item	Frequency	Percentage (%)
MSDs		
Yes	239	8.8
No	27	10.2
Level of Pain		
No pain	26	9.8
Mild pain	66	24.8
Moderate pain	121	45.5
Severe pain	53	19.9
Very severe pain	0	0
Effect of pain on Daily Activity		
Yes	166	62.4
No	100	37.6

Table 5. MSDs based on Body parts involved (N = 266).

Types	Frequency	Percentages
Neck		
Yes	64	24.1
No	202	75.9
Shoulders		
Yes	113	42.5
No	153	57.5
Elbows		
Yes	122	45.9
No	144	54.1
Hands		
Yes	69	25.9
No	197	74.1
Upper back		
Yes	72	27.0
No	194	73.0
Lower back		
Yes	221	83.1
No	45	16.9
Thighs		
Yes	28	10.5
No	238	89.5
Knees		
Yes	100	37.6
No	166	62.4
Ankles		
Yes	31	11.7
No	235	88.3

Table 6. Simple Logistic Regression Analysis of Factors associated with MSDs.

Variables	Crude OR (95% CI)	P-Value
Age	1.11 (1.04, 1.18)	0.001*
Gender		
Female	1	
Male	1.72 (0.77, 3.84)	0.189
Education:		
Primary	1	
Secondary	1.19 (0.29, 1.79)	0.486
Tertiary	0.87 (0.24, 2.96)	0.783
Work experience	1.31 (1.06, 1.60)	0.011*
Work type:		
Blasters	1	
Drivers	0.43 (0.11, 1.72)	0.433
Loaders	0.85 (0.20, 3.58)	0.852
Manual work	0.32 (0.09, 1.17)	0.084*
Evacuators	0.55 (0.11, 2.62)	0.450
Operators	0.56 (0.13, 2.37)	0.429
Marital status		
Single	1	
Married	1.96 (0.87,4.42)	0.107*
BMI	0.35 (0.13, 0.96)	0.041*
Smoking		
Yes	0.99 (0.44, 2.23)	0.988
No	1	
Use of medication		
Yes	1.25 (0.45, 3.47)	0.663
No	1	
No of children	1.27 (1.04, 1.56)	0.021*
Income	1.00 (1.00, 1.00)	0.273
Family size	1.00 (0.99, 1.00)	0.869
Working hours	1.27 (0.82, 1.97)	0.280
Breaktime	0.96 (0.92, 0.99)	0.013*
Repetitive work		
Yes	≤0.01 (≤0.01)	0.999
No	1	
Awkward posture		
Yes	1.37 (0.44, 4.25)	0.591
No	1	
Work training		
Yes	1.17 (0.38, 3.60)	0.788
No	1	
Exposure to vibration		
Yes	1.33 (0.59, 2.97)	0.493
No	1	
Poor work design		
Yes	1.58 (≤0.01)	0.388
No	1	

* P value less than 0.05

therefore calls for the implementation of measures to improve the ergonomic condition at quarry industries to ensure improved working conditions, culminating in more industrial output and reduced wastage of resources in terms of human resources and days of work lost to illness. As almost all sectors of the economy in both developed and developing countries require the quarry industry's services to ensure continuous growth, a need to promulgate and enforce occupational laws in the industries is of utmost importance for the sake of safeguarding the workers and improving the economic output.

Simple logistic regression analysis of sociodemographic and workplace factors revealed a significant association with MSDs (Table 6). Such independent variables include age, BMI, gender, break time, work experience and working hours per day. This, therefore, means that the MSDs are caused by certain personal and workplace factors that can actually be moderated to improve their safety at work. The older the

individual workers, the more the likelihood of having MSDs. Those workers with higher BMI have a higher tendency to develop MSDs, as reported in other research studies in which BMI has been implicated as predictors of many disorders of the musculoskeletal system (Egwuonwu et al., 2013). In addition, the duration of break time in between working hours has a strong association with MSDs, which indicates that the shorter the break time, the lower the likelihood of the muscles to recover from stress and strains of work before further exposure, hence, would predispose to MSDs. This finding is in line with the findings of other studies on MSDs in Saudi Arabia (Alghadir and Anwer, 2015) and China (Yan et al., 2017). Work experience was also positively associated with

Table 7. Final Model of Factors associated with MSDs.

Overall MSDs		
Variable	Adjusted OR (95% CI)	P-value
BMI	0.17 (0.06,0.55)	0.003*
Breaktime	0.95 (0.91,0.94)	0.006*
Age	1.14 (1.07, 1.23)	<0.001*
Lower Back pain		
Age	5.87 (1.79, 19.18)	0.003*
Work experience	2.08 (1.00, 4.30)	0.049*
BMI	0.23 (0.09, 0.57)	0.001*
Elbows pain		
Vibration	0.45 (0.27, 0.74)	0.002*
Working hours	6.84 (0.84, 53.4)	0.007*

* significant at p-value<0.05, OR Odds Ratio, CI = confidence interval.

MSDs, which is similar with other studies (Ekpenyong and Inyang, 2014) and (Rahman et al., 2019).

Moreover, multiple logistic regression modelling showed that three key factors remained significantly associated with MSDs among quarry workers. These factors were age of the workers, BMI and the break time with p-values, as shown in Table 7. The older the individuals, the higher the odds of developing MSDs when BMI and break time are controlled. Therefore, an individual worker with a one-year increase in age have a higher odd (1.143) of developing MSDs. This is in line with the report of Health & Safety Executive on MSDs, in which younger workers have a lower risk for the disorders (Health and Safety Executive, 2019). Furthermore, the individual workers' BMI score had a significant association with the MSDs, implying that the workers with a one-digit increase in BMI score have higher odds of suffering from MSDs when break time and age of the workers were controlled. This also implies that individuals with a BMI score of more than 30 have a higher chance of developing MSDs than workers with lower BMI scores. Workers who are not obese have 0.17 less odd of developing this disorder. Similar finding was indicated in a study among sawmill workers in Bangladesh, whereby their BMI was significantly associated with MSDs (Rahman et al., 2019).

Similarly, the duration of break time between work hours remained a significant predictor of MSDs when the workers' age and BMI scores were controlled. From the workers' workplace characteristics, the mean break time for 8 h of work was 14 min. This is far below the recommendation of research for productive work in which most countries of the world allowed 30 min to 2 h break time for workers working 8 h per day. This time is divided into a coffee break, toilet break and meal break (International Labour Organisation, 2003). Therefore, the shorter the break time, the more the chance of developing MSDs at work.

Furthermore, more modelling of the workplace factors with the two most common types of the MSDs (lower back and elbows MSDs) among the respondents using multiple logistic regression revealed that work experience, exposure to vibration and working hours in addition to the other sociodemographic factors remained significant predictors of MSDs. This, therefore, calls for the implementation of ergonomic and personalized measures to prevent MSDs among workers. These measures include adequate break time at work, consideration of workers' age before work allocation and training on ergonomic principles. This is in line with the World Health Assembly Global Plan of action for workers' health (Wolf et al., 2018). The measures would help save the workers and employers from health deviations and economic wastes in terms of lost workdays, compensation and low productivity.

5. Conclusion

The prevalence of MSDs is high among quarry workers in Nigeria, with lower back pain being the most common type. Some key sociodemographic and workplace factors have also been significantly associated with MSDs, which include age, BMI, work experience, working hours, exposure to vibration and break time at work. This obviously reveals the need to improve working conditions and policy making to enhance the safety of the workers and the productivity of the company while continuously contributing to the country's economic growth.

6. Strength and limitation

This study has key strengths; it is one of the very first research evidence on MSDs among quarry workers in developing countries. The larger sample size used in this study is another major strength because the findings can be generalised among quarry workers in Nigeria. This study had also utilised a valid and reliable scale to identify MSDs among quarry workers. However, the use of a questionnaire for the data collection posed a limitation as it may not document the entirety of the workers' experiences; hence, not reflecting the situation as a whole.

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