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Associations Between Worker Characteristics, Workplace Factors, and Work-Related Musculoskeletal Disorders: A Cross-Sectional Study of Male Construction Workers in Nigeria

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Objective. *This study assessed the association between worker characteristics, workplace factors, and work-related musculoskeletal disorders (WMSDs) in Nigeria's construction industry.* ***Methods.*** *A cross-sectional site-by-site survey was conducted in 5 existing construction companies in Uyo, Nigeria. The subjects (*n = *1200 males), aged 18–55 years, filled in the semistructured Nordic musculoskeletal questionnaire and the job content questionnaire on demographics, work and lifestyle characteristics, and workplace risk factors for WMSDs.* ***Results.*** *The overall prevalence of WMSDs was 39.25%. Differences in age, race, weight, body mass index (BMI), education status, and employment status were significantly associated with the prevalence of WMSDs. Prevalence according to trade was as follows: ironworkers highest at 49% and administrative staff lowest at 31%. Ironworkers (55.7%), administrative staff (53.3%), and security staff (38.7%) scored higher on physical, psychosocial, and individual risk factors, respectively. Workplace factors with increased odds for WMSDs were psychological demands and mental workload, age, BMI, low work experience, low education status, awkward movement of head and arms, working against force or vibration, fast work pace, and race.* ***Conclusion.*** *The recorded high prevalence was multifactorial in etiology; hence, multi-intervention strategies are required.*

work-related musculoskeletal disorders risk factors construction workers Nigeria

1. INTRODUCTION

Musculoskeletal disorders constitute a major health challenge for construction workers and the general population. When caused or aggravated primarily by performance of work or by the effect of the immediate working environment, they are described as work-related musculoskeletal disorders (WMSDs). They include injuries affecting muscles, tendons, ligaments, joints, nerves, and blood vessels [1, 2, 3, 4, 5, 6, 7].

Worldwide, these disorders are the most frequent occupational injury, and the commonest cause of severe long-term pain and physical disability among workers [8, 9, 10, 11, 12]. They are widespread in many countries, generating substantial cost in terms of lost workdays, medical expenses, and impact on health-related quality of life [2, 13].

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Evidence-based studies have identified WMSDs as the most expensive occupational disease in the workplace [14, 15, 16] and the leading work-related health concern, in developed as well as developing countries, accounting for over 30% of all injuries requiring time away from work [17].

The International Labour Organization estimates that the cost of work-related ill-health incidents and accidents amounts to 4% of the world's gross domestic product (GDP) (USD 1.25 trillion). According to the National Research Council and the Institute of Medicine, the total cost associated with reported WMSDs is as high as USD 45–54 000 million (~0.8% of the USA's GDP). This figure is merely the tip of the iceberg, because data for estimating nonfatal illness and injuries are not available for most of the globe, especially the developing nations. Additionally, these figures do not include injuries suffered by public sector workers, nor do they reflect the under-reporting of WMSDs by employers. Based on studies and experience, Occupational Safety and Health Administration estimated that WMSDs were understated by at least a factor of two [18]. These disorders have, therefore, become an important issue for employers as well as employees.

Previous epidemiological studies have shown considerable differences in the prevalence between countries; e.g., according to a European survey carried out in 2005, 23%–25% of workers in 27 member states of the European Union states reported symptoms of WMSDs. A similar survey in Greece recorded a 46%–47% prevalence rate; in the UK, the prevalence stood at 9%–11% [19]; in The Netherlands, one year's prevalence stood at 45% [20]; and in Australia, it was recorded as 41.7% of all injuries [21]. The disparities in the prevalence rates across countries could be due to the lack of an internal standard definition of WMSDs, which would lead to variations in case definitions and data collecting procedures across studies [22]. In some countries, neck disorders are classified separately from shoulder disorders, while in others, neck and shoulder disorders are combined. Further, in some epidemiological studies, WMSDs may be defined based only on symptoms, whereas in others, the definition includes symptoms and findings from physical examinations. Differences in studied populations, socioeconomic inequalities, and customs of the studied area may also contribute to the disparity in prevalence [23]. Again, variation in trade, working environment, and existing ergonomics policies aimed at reducing WMSDs within the workplace contribute to the variations in the prevalence of WMSDs across countries.

The etiology and pathogenesis of WMSDs are complex and multifactorial, involving various risk factors, with combinations and interactions between them. These disorders are associated with many physical, psychosocial as well as individual modifiable and unmodifiable risk factors [24]. Specific physical factors include intense, rapid, awkward movement of body parts (e.g., bending, straightening, griping, holding, twisting, clenching, and outstretching of hands and arms). Others include extreme postures of the body, insufficient recovery time, and exposure to vibrations [25]. Psychosocial factors include monotonous work, poor social interaction, isolated working environment, pressure to achieve high performance, lack of job control, time pressure, and a poor supervisor–employee relationship [26]. Individual risk factors consist of gender, age, anthropometry, physical activity strength, social class, education level, smoking status, alcohol intake, dietary habit, years of experience at work, etc. [24, 27, 28]. Different models and theories have been used to explain the interaction between these risk factors and the prevalence of WMSDs. These include the multivariate interaction theory of musculoskeletal injury precipitation, the differential fatigue theory, the cumulative load theory, and the overexertion theory [29]. According to a number of epidemiological and ergonomics studies, the presence and effect of these factors are more pronounced in some occupations and occupational environments than others, thereby increasing the vulnerability of workers in these occupations to WMSDs in comparison with their counterparts in different occupations and trades [28, 30, 31, 32, 33].

Compelling evidence shows that the construction industry provides an environment that increases the vulnerability of workers to sustaining WMSDs. This is currently one of the first four industries with a high risk of WMSDs for

workers [33, 34]. Tasks carried out within construction trades require the use of hand tools and power tools, entailing the use of multiple body regions, constant movement in awkward positions (e.g., stooping, kneeling, and working with the hands above shoulder level), and repetitive and forceful use of the back and upper and lower extremities. The particular tasks undertaken by construction workers largely depend on the trades they are employed in and the particular construction site they are on. However, irrespective of these, tasks are often performed at maximum pace to meet deadlines, thereby placing the workers at increased risk of not only chronic musculoskeletal disorders but also of acute injuries [33]. Given this, large numbers of construction workers are leaving the industry before their retirement age due to WMSDs [34].

The risk of WMSDs in construction industries varies widely across countries and states. Each country faces different risks, different sectors present different risks in different countries, and the causes of injury and ill health vary across countries. Therefore, each country needs to develop its own national plan and national system to deal with its particular priorities [35]. Current risk factors eventually become future diseases and public burdens. Knowledge of risk factors can then be applied to shift their population distribution.

Thus, this survey aims to determine the prevalence of WMSDs and associated risk factors; the relationship between these factors and the odds for WMSDs among construction workers in southern Nigeria has not been documented. We hope the outcomes will facilitate the development of interventions necessary to reduce the high prevalence and hence complications associated with WMSDs among construction workers in our cities and similar cities globally.

2. SUBJECTS AND METHODS

2.1. Design and Samples

A cross-sectional study was conducted between March and December 2011 in five construction companies in Uyo metropolis, southern Nigeria, at their sites. These companies engaged in various construction works within the metropolis, with total staff strength of 2256. Men constituted a greater proportion (~99.5%) of their workforce; they were 18–55 years old. The few female staff of these companies served in the administrative and catering department and constituted a nonsignificant number, and hence were excluded. Other exclusion criteria included declined participation, inadequate responses to the questionnaire, presence of any debilitating illness, being newly employed (under 1 year), and having musculoskeletal disorders known to be unrelated to work or the working environment. Of the total 2256, 1200 (53.2%) qualified workers gave written informed consent and participated. Prior to the onset of the study, the management of the participating construction companies granted approval, and an institutional research and ethics committee approved the study protocol. Participants' sociodemographic data such as age (years), weight (kilograms), height (meters), body mass index (BMI), race, education level, job experience or duration, and marital and employment status were recorded.

2.2. Measurement of Variables

Participants were individually interviewed and assessed in the companies' site clinics, with a semistructured self-administered questionnaire. The questionnaire comprised three parts concerning complaints of musculoskeletal disorders, physical work demands, and psychosocial risk factors. The part on musculoskeletal disorders was adapted from the general Nordic questionnaire of musculoskeletal symptoms [38] in different body regions, including the neck, shoulders, upper back, elbows, low back, wrists and hands, hips and thighs, knees, and ankles and feet [41]. A body map was provided for easy identification of the affected body region.

Respondents were asked if they had had any musculoskeletal problems in the past 12 months that could have prevented their normal activities. Those responding affirmatively were further asked to identify the area or areas of the body affected. Thus, those who sustained

musculoskeletal (e.g., muscle, tendons, joints, cartilage, nerves, and spinal discs) injury or disorder associated with exposure to risk factors in the workplace were classified as having WMSDs [7]. The Nordic musculoskeletal questionnaire is the most widely used assessment tool at present for this purpose [40], and it is repeatable, sensitive, and useful as a screening and surveillance tool [38]. The second and third parts of the questionnaire measured physical and psychosocial risk factors, using five and eight items adapted from the job content questionnaire (JCQ) scales, respectively. The section on physical risk factors measures the presence or absence of awkward posture, awkward movement of the head and arms, working against forces or vibration, manual materials handling (MMH), and fast work pace. The psychosocial items assessed were decision latitude, psychosocial demands and mental workload, social support, and job insecurity (see Appendix A on p. 462).

Each item was scored on a 4-point scale (*strongly agree* to *strongly disagree*). Responses to the items on physical demands were dichotomized (1 and 2 versus 3 and 4) and summed to produce total scores ranging from 0 to 5. Physical demands were then categorized as *low* (0–3) or *high* (4–5) physical demands. Responses to items for psychosocial demands were also dichotomized (1 and 2 versus 3 and 4) and summed to produce a total score ranging from 0 to 8. Psychosocial demands were then classified as *low* (0–5) or *high* (6–8) [42]. The JCQ has shown acceptable internal consistency in large sample studies and has presented good global performance with no substantial differences between studies; hence, it can equally be used in studies carried out in developing countries [41].

To ensure a better correlation between the task (load) and the risk of sustaining WMSDs, participants were categorized into heavy and light task groups. Heavy tasks were defined as those involving whole-body actions such as pushing, pulling, lifting, and moving heavy objects or equipment; also included in this group were those actions involving the use of the mouth in sucking and blowing, and those where hands were used in squeezing and pinching. Workers in this group include bricklayers, mechanics, ironworkers, carpenters, heavy equipment operators or drivers, workers in an earth-movement unit, and some workers in the electrical units (e.g., those involved in laying and pulling cables, and similar heavy tasks). Others were grouped into the light task category (e.g., administrative and security).

2.3. Statistical Analysis

Descriptive analysis was performed and its values reported as means (*SEM*) for continuous variables and as frequencies and percentages for categorical variables. An independent sample t test and χ^2 test were used to compare continuous and categorical variables, respectively.

Two separate multiple logistic regressions were performed, with WMSDs as the only dependent variable, and with psychosocial working environment, individual factors, and physical factors as the possible risk factors.

To ensure homogeneity of the population in terms of workload, two separate multiple logistic regressions were performed for the heavy and light task workers. Based on the models, separate odds ratios and 95% confidence intervals were estimated. All analyses were performed with SPSS version 17.0; $p < .05$ was considered statistically significant.

3. RESULTS

Significant associations were found between some sociodemographic variables (e.g., age, body weight, BMI, race, education status, and employment status) and WMSDs (all $p < .01$). However, WMSDs were not significantly associated with the participants' height, marital status, tenure, and trade. Black workers with less education, casual employment, and married status as well as ironworkers and those who had worked for 1–5 years reported higher prevalence of WMSDs (Table 1).

The overall prevalence of WMSDs was 39.25%. Prevalence varied according to workplace factors, with a significant association between some risk factors and WMSDs (Table 2). Multiple logistic regression showed that psychological demands and mental workload, age, BMI, work experience,

TABLE 1. Prevalence of Work-Related Musculoskeletal Disorders (WMSDs) by Demographic Characteristics of Respondents

Demographic Variables	Total ($N = 1200$)	With WMSDs ($n = 471$)	Without WMSDs ($n = 729$)	p
Age (years), $M \pm SD$	26.42 ± 0.38	28.46 ± 0.67	25.10 ± 0.45	.001***
Weight (kg), $M \pm SD$	59.52 ± 0.30	60.65 ± 0.50	59.42 ± 0.38	.049*
Height (m), $M \pm SD$	1.62 ± 0.002	1.62 ± 0.003	1.62 ± 0.004	.411
BMI, $M \pm SD$	23.56 ± 0.26	24.38 ± 0.22	23.03 ± 0.41	.013*
Race				
black	1169 (97.4)	466 (39.9)	703 (60.1)	.013*
white	31 (2.6)	5 (16.1)	26 (83.9)	
Education				
low	1010 (84.2)	411 (40.7)	599 (59.3)	.023*
high	190 (15.8)	60 (31.6)	130 (68.4)	
Marital status				
married	564 (47.0)	230 (40.8)	334 (59.2)	.336
single	636 (53.0)	241 (37.9)	395 (62.1)	
Tenure (years)				
<1	525 (43.8)	188 (35.8)	337 (64.2)	.160
1–5	508 (42.3)	216 (42.5)	292 (57.5)	
6–10	81 (6.8)	34 (42.0)	47 (58.0)	
>10	86 (7.2)	33 (38.4)	53 (61.6)	
Employment status				
casual	470 (39.2)	207 (44.0)	263 (56.0)	.001**
temporary	404 (33.7)	163 (40.3)	241 (59.7)	
permanent	326 (27.2)	101 (31.0)	225 (69.0)	
Trade/occupation				
earth movement	141 (11.8)	62 (44.01)	79 (56.0)	.152
carpentry	152 (12.7)	65 (42.8)	87 (57.2)	
mechanical	161 (13.4)	59 (36.6)	102 (63.4)	
bricklaying	183 (15.3)	67 (36.6)	116 (63.4)	
iron work	143 (11.9)	70 (49.0)	73 (51.0)	
electrical	131 (10.9)	52 (39.7)	79 (60.3)	
security	93 (7.8)	31 (33.3)	62 (66.7)	
transportation	82 (6.8)	28 (34.1)	54 (65.9)	
stores	67 (5.6)	22 (32.8)	45 (67.2)	
administrative	47 (3.9)	15 (31.9)	32 (68.1)	

Notes. *$p < .05$, **$p < .01$, ***$p < .001$; BMI = body mass index; numbers in parentheses represent percentages.

education level, awkward posture, awkward movement of head and arms, working against force or vibration, MMH, fast work pace, and race were significantly associated with WMSDs among heavy task workers. Similar results were obtained in the light task group, with the exception of race and working against force or vibration, which showed a nonsignificant association in the latter group (Table 3).

TABLE 2. Distribution of Possible Risk Factors for Work-Related Musculoskeletal Disorders (WMSDs) in Relation to WMSDs

Risk Factors for WMSDs	Total (N = 1200)	With WMSDs (n = 471)	Without WMSDs (n = 729)	p
Psychosocial risk factors				
psychological demands and mental workload (high/low)	554 (46.2)	287 (51.8)	267 (48.2)	.001***
insufficient job control (high/low)	420 (35.0)	169 (40.2)	251 (59.8)	.651
interpersonal conflict (high/low)	42 (3.5)	17 (40.5)	25 (59.5)	.996
job insecurity (high/low)	665 (55.4)	256 (38.5)	409 (61.5)	.288
Individual risk factors				
age (older) (high/low), $M \pm SD$	26.42 ± 0.38	28.46 ± 0.67	25.10 ± 0.45	.001***
weight (high), $M \pm SD$	59.89 ± 0.30	60.65 ± 0.50	59.42 ± 0.38	.049*
height (short), $M \pm SD$	1.62 ± 0.002	1.62 ± 0.003	1.62 ± 0.004	.411
BMI (high), $M \pm SD$	23.56 ± 0.26	24.38 ± 0.22	23.03 ± 0.41	.013*
physical strength (active)	811 (67.6)	402 (49.6)	409 (50.4)	.001***
alcohol intake (yes)	859 (71.6)	352 (41.0)	507 (59.0)	.060
smoking habits (smoker)	32 (2.7)	17 (53.1)	15 (46.9)	.148
work experience (high)	781 (65.1)	369 (47.2)	412 (52.8)	.001***
Race				
black	1169 (97.4)	466 (39.9)	703 (60.1)	
white	31 (2.6)	5 (16.1)	26 (83.9)	.013*
Education				
low	1010 (842)	411 (40.7)	599 (59.3)	
high	190 (15.8)	60 (31.6)	130 (68.4)	.023*
Physical risk factors				
awkward postures (high/low)	674 (56.2)	374 (55.5)	300 (44.5)	.001***
awkward movement of head and arms (high/low)	720 (60.0)	365 (50.7)	355 (49.3)	.001***
working against force or vibration (high/low)	685 (57.1)	367 (53.6)	318 (46.4)	.001***
MMH (high/low)	650 (54.2)	373 (57.4)	277 (42.6)	.001***
fast work pace (high/low)	742 (62.0)	396 (53.4)	346 (46.6)	.001***

Notes. *p < .05, **p < .01, ***p < .001; BMI = body mass index; numbers in parentheses represent percentages; manual materials handing.

Psychological demands, mental workload, and black race had approximately twice the odds for WMSDs, whereas older age, obesity, low education status, and less experienced workers had more than double the odds for WMSDs in the heavy task group. In addition, awkward movement of the head and arms had approximately quadrupled odds for WMSDs, whereas fast work pace and working against vibration were associated with more than quadrupled odds for WMSDs in the same group.

Furthermore, in the light task group, the odds for WMSDs were about twice as high among the older workers and those with low education status, awkward movement of the head and arms, and high psychological demands and mental workload, whereas characteristics of less work experience, fast work pace, and obesity in the same group indicated more than twice the odds for WMSDs (Table 4).

TABLE 3. Multiple Logistic Regression Showing Work-Related Musculoskeletal Disorders (WMSDs) and Associated Risk Factors

	Heavy Task			Light Task		
Risk Factors for WMSDs	***OR***	**95% CI**	***p***	***OR***	**95% CI**	***p***
Psychosocial risk factors						
psychological demands and mental workload (high/low]	1.59	[1.827, 2.984]	.015*	1.62	[1.55, 4972]	.034*
insufficient job control (high/low)	0.82	[0.425, 1.543]	.512	0.801	[0.092, 7.00]	.841
interpersonal conflict (high/low)	0.95	[0.563, 1.134]	.516	0.80	[0.416, 1.536]	.501
job insecurity (high/low)	1.42	[0.130, 14.321]	.472	1.35	[0.640, 3.452]	.506
Individual risk factor						
age (old/young adult)	2.35	[1.274, 4.260]	<.001***	1.94	[1.690, 11.186]	.004**
body mass index (obese/ nonobese)	2.21	[1.302, 3.716]	.003**	2.01	[1.536, 3.472]	.001***
physical activity (active/inactive)	1.75	[0.434, 6.815]	.434	1.30	[0.119, 14.564]	.822
alcohol intake (yes/no)	1.63	[0.528, 4.940]	.405	0.76	[0.256, 2.223]	.602
smoking habits (smoker/ nonsmokers)	1.88	[0.483, 7351]	.365	0.44	[0.045, 3.468]	.419
experience (high/low)	2.32	[1.307, 4.018]	.004**	2.13	[1.244, 3.784]	.008**
education (high/low)	2.13	[1.243, 3.742]	.017*	1.90	[1.108, 3.466]	.020*
race (black/white)	1.71	[1.0217, 3.463]	.026*	1.29	[0.797, 2.071]	.303
Physical risk factors						
awkward postures (high/low)	2.54	[1.142, 10.325]	.001**	0.864	[0.495, 1.512]	.609
awkward movement of head and arms (high/low)	3.96	[1.660, 9.426]	.002**	1.92	[1.116, 3.422]	.019*
working against force or vibration (high/low)	4.15	[1.642, 10.360]	.003**	1.06	[0.989, 1.127]	.101
MMH (high/low)	2.61	[1.149, 16.321]	.002**	0.97	[0.183, 5.217]	.982
fast work pace (high/low)	4.11	[1.004, 16.709]	.032*	2.04	[1.290, 3.34]	.025**

Notes. *$p < .05$, **$p < .01$, ***$p < .001$; *OR* = odds ratio, CI = confidence interval; manual materials handling.

TABLE 4. Prevalence of Risk Factors by Department/Trade

	Risk Factor		
Departments/Trades	**Physical** ***n*** **= 196 (41.60%)**	**Individual** ***n*** **= 136 (28.9%)**	**Psychosocial** ***n*** **= 139 (29.5%)**
Earth movement (*n* = 62)	27 (43.5)	15 (24.2)	20 (32.3)
Carpentry (*n* = 65)	32 (49.2)	21 (32.3)	12 (18.5)
Mechanical (*n* = 59)	22 (37.3)	21 (35.6)	16 (27.1)
Bricklaying (*n* = 67)	19 (28.4)	17 (25.4)	31 (46.3)
Iron work (*n* = 70)	39 (55.7)	18 (25.7)	13 (18.6)
Electrical (*n* = 52)	21 (40.4)	13 (25.0)	18 (34.6)
Security (*n* = 31)	14 (45.2)	12 (38.7)	5 (16.1)
Transport (*n* = 28)	9 (32.1)	8 (25.8)	11 (39.3)
Administrative (*n* = 15)	3 (20.0)	4 (26.7)	8 (53.3)
Stores (*n* = 22)	10 (45.5)	7 (31.8)	5 (22.7)

Notes. Numbers in parentheses represent percentages.

TABLE 5. Body Parts Distribution of Work-Related Musculoskeletal Disorders by Department/Trade

Departments/Trades	Neck and Upper Limb *n* = 227 (48.2%)	Trunk and Waist *n* = 119 (25.3%)	Lower Limb *n* = 120 (26.5%)
Earth moving (*n* = 62)	19 (30.6)	16 (25.8)	27 (43.5)
Carpentry (*n* = 65)	30 (46.2)	19 (29.2)	16 (24.6)
Mechanical (*n* = 59)	11 (45.8)	8 (33.3)	5 (20.8)
Bricklaying (*n* = 67)	39 (58.2)	6 (8.9)	22 (32.8)
Iron work (*n* = 70)	39 (55.7)	13 (18.6)	18 (25.7)
Electrical (*n* = 52)	29 (55.8)	13 (25.0)	10 (19.2)
Security (*n* = 31)	13 (41.9)	11 (35.5)	7 (22.5)
Transport (*n* = 28)	6 (21.4)	9 (32.1)	13 (46.4)
Stores (*n* = 22)	3 (13.6)	14 (63.6)	5 (22.7)
Administrative (*n* = 15)	3 (20.0)	10 (66.7)	2 (13.3)

Notes. Numbers in parentheses represent percentages.

4. DISCUSSION

The overall prevalence rate of WMSDs was 39.3% and was associated with individual and workplace-related risk factors. Physical factors constituted the greatest risk (41.6%), followed by psychosocial (29.5%) and individual (28.9%) factors. Further, 48.2% of the sample experienced symptoms of WMSDs in the upper body, including the neck; 25.3% experienced symptoms in the trunk, while 26.5% had symptoms in the lower body; and 36.8% had symptoms at multiple locations. In all, these values were consistent with the previously documented prevalence of 27%–63% [23, 43, 44], though the exact prevalence may vary with respect to country, state, and locality, and even between studies in the same locality. Variations may still exist even within the same industry, between different departments and trades as observed in this study. This is probably due to variations in the studied population, case definition, and data collection procedures as well as socioeconomic inequalities and effects of different ergonomics policies and trades. Thus, the population- and ergonomic-specific prevalence rate of WMSDs recorded in this study is substantiated.

As with previous studies [31, 45], inappropriate physical working environment constituted the greatest risk (41.6%) for WMSDs in this survey; more specifically, workers with WMSDs complained about the physical demands of the job more than did workers in the general working population. They attributed this to the "average" job in their respective construction sites being very physically strenuous compared with most other occupations. The variables under consideration included working against force or vibration, fast work pace, awkward movement of the head and arms, awkward postures, and MMH. Workers in the heavy task group exposed to these adverse physical factors had higher odds for WMSDs than those in the light task group with similar exposure.

As in most prior studies, MMH was significantly associated with higher odds for WMSDs in the heavy versus light task group. This shows that though MMH remains prevalent within the construction industry, workers in some trades are more vulnerable than others. The degree of vulnerability may depend on the interactions between several ergonomic factors. This assertion is supported by findings in a similar study in Ireland [46]. In that study, WMSDs were found to be more common in 10 heavy task trades associated with MMH. These include block laying, cable pulling, glazing installation, manhole installation, and pipe or drain installation. These tasks were observed to expose workers to a medium to very high level of WMSDs and ill health. WMSDs were observed to vary across sites depending on a number of factors such as the weight and frequency with which the loads were handled. Others include the tools and mechanical handling aids that are used, space constraints that may restrict the posture of individuals, communication

and co-ordination issues when working as part of a team, time pressures, and work demands.

Further, site-wise observations by our research team confirmed the various physical challenges faced by our studied participants. Workers were observed to be in different awkward postures, engaging in intense rapid movement of the body parts while trying to work against different forces, initiate an appropriate work pace, and undertake MMH.

The causal relationship between these factors and prevalence of WMSDs has been supported by previous epidemiological studies [47]. The combination and interactions of these with the poor psychosocial working environment typical of the construction industry will, therefore, magnify and exacerbate the odds for WMSDs among workers. Many studies have shown that the construction industry is characterized by factors indicative of poor psychosocial status such as job insecurity, low wages, monotonous work, time pressure, poor supervision, temporary employment, and poor social interaction [48]. Most of these characteristics were found in our participants. Further, the majority (40%–44%) reported either casual or temporary employment or low education qualifications, thus being more vulnerable to psychosocial stress in terms of exploitation and less bargaining power for better wages [49, 50]. This explains the marked psychosocial impact on prevalence of WMSDs observed in our participants.

Our findings also showed that construction workers with WMSDs experienced symptoms in virtually all anatomical areas, as did Eva, Lars, Evy, et al. [51], and that the part of the body affected had a considerable work-related component. Consistent with previous studies and global trends [52, 53], bricklayers recorded the highest prevalence of upper limb disorders (58.2%), followed by electricians (55.8%), ironworkers (55.7%), and carpenters (46.2%). Common features among construction workers in these trades are the intense involvement of muscles and other musculoskeletal structures of the upper segment of the body. Structures such as the deltoid muscle, rhomboid major and minor, trapezius, pectoral muscles, scapular, clavicle, and other structures around the shoulder, elbow, and wrist joints are often being poorly and abnormally utilized. This is because workers in these trades are often seen using machines (drilling, vibrating, cutting, welding, and melting) in awkward positions and directions [54], which leads to increasing unilateral and unequal stress on selected parts of these structures. Such interactions have been shown to be associated with high prevalence of WMSDs of the upper body segment [55].

The associated symptoms in other body segments (lower back, middle back, and neck), however, could be ascribed to the indirect, concerted effort by the musculoskeletal components of the back and neck to keep the head steady [56]. Similarly, administrative workers recorded the highest prevalence (66.7%) of upper and lower back symptoms (including the waist) of WMSDs, followed by storekeepers (63.6%) and transporters (32.1%). These trades have some common elements among them that are associated with a high vulnerability of workers to sustaining upper and lower back injuries and associated symptoms. A previous ergonomics survey of workers in these trades revealed common risk factors, including repetitive tasks, static loading or sustained exertion, awkward postures, and mechanical contact stress [57].

Performing similar motions repeatedly can result in trauma to the joints and surrounding tissues. Without time for rest and recovery, repetition can lead to injury. Such repetitive work includes typing with the keyboard, moving and clicking the mouse, and looking back and forth between the monitor and the documents on the desk. Common features among these trades are static loading or sustained exertion; hence, the muscles must hold the body in a single posture for a long time. In such postures, blood circulation is reduced and muscle tension is increased [57]. These types of office routines include keeping the head straight and still while reading from the monitor, sitting upright without back support, looking down on documents lying flat on the desk, and holding objects in the hands while carrying them a long distance [57]. Awkward postures and mechanical contact stress are common among administrative staff, storekeepers, and

drivers. Some tasks in these trades may require applying moderate force by a very small muscle, which may cause fatigue, swelling, and muscle and ligament strains (e.g., dragging thick files, manual stapling, stamping by hand, and occasional lifting of objects) [57].

We also found a significant association between WMSDs and some demographic variables: age, BMI, work experience, race, and education status. Older participants had higher odds for increased prevalence of WMSDs and, of note, this was greater in the heavy task than light task workers. This observation corroborates several others. Peterson and Zwerling found that construction workers (aged 51–60 years) were more susceptible to WMSDs [58]. They had 1.4 times the odds for incidental back pain and 1.3 times the odds for lower limb musculoskeletal disorders than younger blue-collar workers [33]. Holmström, Lindell, and Moritz showed that age was significantly associated with low back pain [59]. Guo, Tanaka, Cameron, et al. [60] and Welch, Hunting, and Nessel-Stephens [43] made a similar observation. Additionally, Chau, Bhattacherjee, Kunar, et al. demonstrated that the risk of injury was higher for workers aged ≥45 than those aged <30 or 30–44 years [61]. Physiological and physical strength changes in musculoskeletal structures, with a resultant decrease in physical ability and stamina to resist or withstand physical strains and stresses that characterize construction routines, offer the possible explanation.

However, others recorded contrasting results [62], showing no association between age and prevalence of WMSDs. This discrepancy could be due to different case definitions, diagnostic criteria, and variations in trade as well as the effect of other confounders such as working experience and physical activity status. It could also be due to survivor bias, which refers to the practice of avoiding jobs with high risk of injury. Survivor bias has been shown to be common among older and experienced construction workers.

Similarly, employment status, job experience, and skills were significantly associated with increased prevalence of WMSDs. We found a correlation between employment status and the skill level of employees and the link to the exposure to deleterious working conditions, with the greatest exposures found among the least skilled. Mechanisms of this relationship include exposure to physical and psychosocial risk factors. However, a consensus has not been reached on this association, as discrepant results have been recorded in several other studies [63]. In connection to previous studies [64, 65], we found that BMI was associated with increased prevalence of WMSDs. Participants with high BMI (indicative of obesity) had more than twice the odds for WMSDs, with those in the heavy task group having greater odds than those in the light task group. Increased BMI is a known risk factor for WMSDs, as it aggravates pain at most sites of the body through increased mechanical strain and progression of joint damage in workers with arthritis. However, other studies found no such association [66], possibly owing to the effect of other confounders such as good physical activity, which enhances musculoskeletal fitness [67].

Education, income, race, and gender influence the determination of which populations obtain low-skilled occupation and exposure to WMSD-related risk factors. In this study, race and education status were among the factors with significant association in relation to WMSDs. Being of black race and of low education status was associated with higher odds for WMSDs, and this was more prominent in the heavy versus light task workers. These findings have been documented in other studies [68, 69] and could be due to differences in trade and employment status, as more educated and white construction workers perform mainly supervisory and administrative duties. Further, the disproportionate ratio of the highly educated and white workers to the low educated and black workers offers another possible explanation.

Smokers and alcohol drinkers in the heavy task group, but not the light task group, had higher odds for WMSDs. Prior studies have documented higher rates of smoking and alcohol consumption among workers in stressful occupations (blue-collar workers) than among those in less stressful occupations (white-collar workers). The stress levels of workers in the heavy task group could

have been higher than those in the light task group. Further, there exists evidence that high rates of smoking and alcohol intake are associated with higher risks for WMSDs.

These assertions corroborate findings by Chau et al., who observed that smoking and alcohol abuse were associated with higher risks of injury in their sample [61]. However, contrary to the findings of this study, the association was significant in the univariate but not multivariate analysis and was limited to two age groups (<30 and ≥45 years) [70]. This is probably because smoking and alcohol abuse are associated with a number of diseases such as sleep disorders, neuromuscular disturbances, and impaired physical functions [71]. Smoking and alcohol abuse also impair the vestibule-ocular reflex and balance control [72], which could lead to higher risk of WMSDs.

5. CONCLUSION

The present findings have clearly shown the association between risk factors and the prevalence of WMSDs among construction workers in Nigeria. This study provides additional evidence to and complements the existing literature on the association between workers and workplace factors and the prevalence of WMSDs. The results have important policy implications for the introduction of stringent measures directed toward the reduction of the risk factors and hence WMSDs. Such measures should be directed either at changing the workers themselves through behavioral or education programs, or at changing the physical and psychosocial demands of work. Better yet, these could include preplanning of various jobs with the human interface in mind to minimize MMH hazards such as heavy and repetitive reaching and carrying of materials. Protocols for MMH at the job site should be developed (e.g., a pallet jack or forklift should be considered as the first alternative during preplanning), along with conducting regular materials handling and lifting inspections. Moreover, there should be incorporation of variety into jobs to avoid monotonous work as well as encouragement of warm-ups for a few minutes before full exertion. Workers should use appropriate personal protective equipment such as vibration-damping gloves, shoes, and eyeglasses to prevent eye injury. Workers should also be trained on the proper techniques for lifting, bending, and carrying of materials.

Beyond the measures described here, specific attention should be focused on changing the adverse psychosocial working environment. Rather than changing the work process, workers should be assisted in coping with work-related stress. Intervention programs to prevent WMSDs should target both individual factors with known etiologic roles in WMSDs and a combination of these factors with other risk factors, since some risk factors may exert their influence either individually or when present concomitantly with other risk factors. In addition, the choice of targeted risk factors should be based on the presence of reasonable evidence demonstrating their causal relationship with WMSDs, to avoid unfounded, expensive, and time-consuming intervention programs in the workplace that may be detrimental to productivity.

However, there are few limitations worth noting in this survey, including those due to outcome measures, which encompass clinical examination and self-reported symptoms. The reliability of physical examinations for specific disorders is variable and could have affected the overall prevalence. Self-reported symptoms could suffer from over- or underestimation, since the symptoms could range from nonspecific to specific, and the severity could range from mild to moderate to severe. Furthermore, observational studies are limited to on-the-spot assessment and cannot be used to estimate past exposures. Such limited observations could lead to misclassifications if exposures are not consistent over time. Finally, being a cross-sectional study, there is likelihood of oversampling those disorders that last for a long time and lower likelihood of capturing those that last for only a short period.

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APPENDIX A.

A1 Psychosocial demand items

My job

- Permits freedom of decision, acquisition, and application of new ideas.
- Is free from conflicting ideas from others.
- Has tasks that are often interrupted before they can be completed.
- Is characterized by repeated laying off and recruitment of workers.

My job requires

- Working very fast.
- Working very hard.
- Intense concentration.
- Enough time to get the work done.

A2 Physical demand items

My job requires

- Much physical effort.
- Lifting heavy loads.
- Rapid physical activity.
- Awkward body posture.
- Awkward positioning of the head and arms.

Notes. Original items from the job content questionnaire [39].