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Ergonomic Exposure and Musculoskeletal Disorders among Vulcanizers in Ethiope West, Delta State, Nigeria

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Background: Vulcanizing is physically demanding and involves prolonged standing, repetitive movements, awkward postures, and manual handling of heavy tires. Informal workers may face substantial work-related musculoskeletal disorder (WRMSD) risks because of limited ergonomic awareness and preventive measures. Objective: This study assessed ergonomic exposure and the prevalence of musculoskeletal disorders (MSDs) among vulcanizers in Ethiope West Local Government Area, Delta State, Nigeria.
Methodology: A descriptive cross-sectional study was conducted among 210 vulcanizers selected through multistage sampling. Data were collected using a structured questionnaire incorporating the Modified Nordic Musculoskeletal Questionnaire and an observational ergonomic checklist. Anthropometric measurements and workplace observations were also undertaken. Data were analyzed using descriptive statistics, chi-square tests, and multivariate logistic regression at $p<0.05$.
Results: Mean age was 38.4±9.7 years and mean work experience was 12.6±7.3 years. The 12-month prevalence of self-reported musculoskeletal symptoms in anybody region was 87.1% (95% CI: 81.7–91.3), with lower back (71.4%), neck (58.6%), and shoulder (49.0%) symptoms most prevalent. Prolonged standing (87.6%), awkward postures (84.3%), repetitive motions (79.5%), and manual lifting (75.2%) were common exposures. Only 28.6% could identify at least one ergonomic risk factor and 12.4% reported using any PPE. self-reported musculoskeletal symptom prevalence was associated with work experience, daily working hours, weekly rest, heavy lifting, and awkward posture. In multivariate analysis, awkward posture was the strongest independent predictor (adjusted OR=9.42, 95% CI: 2.87–30.91, $p<0.001$).
Conclusion: Vulcanizers in Ethiope West experience a high burden of musculoskeletal symptoms alongside substantial ergonomic exposure and inadequate preventive practices. Workplace ergonomic modification, structured rest periods, mechanical lifting aids, appropriate PPE, and occupational health education are recommended.

Keywords: Ergonomics; musculoskeletal disorders; vulcanizers; occupational health; Nigeria

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Introduction

The informal sector is an important component of Nigeria's workforce, and automobile artisans commonly perform physically demanding tasks under resource-constrained conditions. Vulcanizers repair and service tires using prolonged standing, repetitive upper-limb movements, manual handling, awkward body positions, and exposure to heat and other workplace hazards. Among Nigerian informal automobile artisans, heavy manual work, prolonged standing, long working hours, and other adverse physical conditions have been associated with work-related illness and injury (Afolabi et al., 2021).

Musculoskeletal disorders (MSDs) are a major global health problem; the World Health Organization estimates that about 1.71 billion people live with musculoskeletal conditions worldwide (World Health Organization, 2022), with low back pain a major contributor to the burden. In automobile repair work, awkward posture, manual handling, repetitive tasks, and sustained physical effort are plausible pathways to musculoskeletal symptoms. Studies of Nigerian automotive mechanics have reported substantial back-pain burdens and associations with sustained postures, manual handling, work duration, and inadequate ergonomic knowledge (Abaraogu et al., 2016).

Vulcanizing has task-specific ergonomic demands. Tire repair may require work at floor level, trunk and neck flexion, kneeling or crouching, reaching into tire cavities, repetitive use of hand tools, and manual lifting. Ergonomic assessments of Nigerian auto-repair activities have similarly identified awkward postures, repetitive motion, high hand force, and lifting as important risk factors, with several tasks presenting high ergonomic risk (Anyaeche & Ishie, 2021). These exposures may particularly affect the lower back, neck, shoulders, and upper limbs.

Ethiope West contains numerous informal enterprises, including vulcanizing workshops. Previous research in the area has documented occupational hazards and limited protective practices among other informal workers (Bamidele, 2015). However, evidence specific to vulcanizers remains limited. This study therefore assessed MSD prevalence and anatomical distribution, ergonomic exposures, ergonomic awareness, preventive practices, and occupational factors associated with MSDs among vulcanizers in Ethiope West.

Study Objectives

1. Determine the prevalence and anatomical distribution of MSDs among vulcanizers.
2. Identify common ergonomic risk factors in vulcanizing workplaces.
3. Assess the level of ergonomic awareness among vulcanizers.
4. Evaluate utilization of personal protective equipment and other preventive practices.
5. Examine associations between MSD prevalence and socio-demographic and occupational factors.

The biomechanical model provides a useful framework for understanding how forceful exertion, repetitive loading, awkward posture, and insufficient recovery can produce cumulative musculoskeletal stress. Vulcanizing includes all of these exposures: lifting and carrying tires require force, floor-level work requires sustained trunk and neck flexion, and sanding, cutting, buffing, patching, and tool use involve repetition. Evidence from automobile artisans supports the relevance of these physical work conditions to occupational illness (Afolabi et al., 2021).

An exposure–response perspective suggests that MSD risk may increase with greater duration or intensity of physical exposure. In the present setting, longer work experience, longer daily working hours, fewer rest periods, and greater manual workload may increase cumulative exposure. Afolabi et al. (2021) similarly found that long work experience and long working hours were associated with illness among Nigerian informal automobile artisans.

Awkward posture, repetitive motion, manual handling, prolonged standing, vibration, and poorly designed workstations are established ergonomic concerns. In Nigerian auto-repair shops, ergonomic assessment has identified high-risk tasks involving stooping, lifting, forceful exertion, and repetitive movements, particularly for the lower back (Anyaeche & Ishie, 2021). A broader assessment of automobile workshops in southwestern Nigeria also identified poor workstation design, poor tool layout, inadequate lighting, awkward posture, repetitive tasks, and inadequate PPE as common hazards (Adesope et al., 2024).

Comparable MSD burdens have been reported in other Nigerian physically demanding occupations. Among bricklayers, Adedoyin et al. (2022) reported 12-month and seven-day WRMSD prevalences of 87.3% and 67.4%, respectively, with the shoulder and low back most affected. Among automotive mechanics in eastern Nigeria, back pain prevalence was 76.02%, with sustained postures, manual handling, heavy workload, and longer work duration among associated factors (Abaraogu et al., 2016). These findings provide a useful context for interpreting the present results while recognizing differences in occupations and measurement approaches.

Awareness and preventive practices are also important. Artisanal workers may have limited access to formal

occupational-health training, and peer networks may become important sources of information. Recent Nigerian evidence among artisanal blacksmiths indicates continuing gaps in MSD knowledge and prevention (Olonade et al., 2026). PPE is relevant to the wider occupational safety environment, although it does not directly remove most ergonomic exposures; engineering and organizational controls remain central to MSD prevention.

Despite this evidence, the combined assessment of ergonomic exposure, MSD burden, awareness, preventive practices, and occupational determinants among vulcanizers in Ethiope West has received limited attention. The present study addresses this gap using both self-reported symptoms and workplace observations.

Methodology

A descriptive cross-sectional study was conducted among vulcanizers in Ethiope West Local Government Area, Delta State, Nigeria, covering rural and semi-urban communities with informal automobile-service enterprises.

The target population comprised vulcanizers engaged in tire repair or retreading. Eligible participants were adults aged ≥18 years, operating in the LGA for at least six months and willing to consent. Those not actively engaged in vulcanizing, with pre-existing non-occupational musculoskeletal conditions, or unwilling to participate were excluded.

Sample Size and Sampling

Sample size was calculated using $n=(Z^2pq)/d^2$, with Z=1.96, p=0.50, q=0.50, and d=0.07, giving a minimum of 196. Allowing 10% for non-response produced a target of 215; 210 vulcanizers completed the study.

Multistage sampling was used. Forty-seven functional workshops were identified and stratified into urban, peri-urban, and rural locations. Workshops were selected using probability proportional to size, followed by systematic recruitment of vulcanizers from workshop rosters.

Data Collection Instruments and Measures

Data were collected using a researcher-administered questionnaire covering socio-demographic and occupational characteristics, ergonomic exposures, the Modified Nordic Musculoskeletal Questionnaire (NMQ), and awareness and preventive practices. The NMQ assessed symptoms during the preceding 12 months and seven days across nine body regions, including pain intensity, activity limitation, and healthcare seeking.

A QEC-based observational checklist was used in 50 workshops to assess workstation dimensions, tools, working posture, and environmental conditions. The QEC is an established method for assessing WRMSD risk factors (David et al., 2008). Height and weight were measured using a stadiometer and weighing scale, respectively, and BMI was calculated as kg/m^2.

Validity and Reliability

Face and content validity were assessed by ergonomics and occupational-health experts. A pilot study of 20 workers in a neighboring LGA assessed clarity and administration time. The Modified Nordic Musculoskeletal Questionnaire was based on the standardized Nordic questionnaire (Kuorinka et al., 1987).

Data Collection Procedure

Data were collected from August to November 2025. Entry was facilitated by local authorities and Vulcanizers Association leaders. Eligible workers gave written informed consent. Trained research assistants conducted face-to-face interviews, while observations were made in 50 workshops and anthropometric measurements obtained using standardized procedures.

Data Analysis

Data were analyzed using IBM SPSS Statistics version 26. Frequencies, percentages, means, and standard deviations summarized the data. Prevalence estimates included 95% confidence intervals. Chi-square tests assessed associations, while multivariate logistic regression identified independent predictors of self-reported musculoskeletal symptoms. Significance was set at $p<0.05$. The regression outcome was the presence or absence of symptoms in at least one body region during the preceding 12 months. Adjusted odds ratios were interpreted as associations, given the cross-sectional design.

Ethical Considerations

Written informed consent was obtained, and study information was provided in an appropriate local language. Participation was voluntary, confidentiality was maintained, and participants with significant pain were referred to local healthcare facilities.

.Results and Discussion

Socio-demographic and Occupational Characteristics

Table 1. Socio-demographic and occupational characteristics of participants

Characteristic	Category	n	%	Mean ± SD
Age (years)				38.4 ± 9.7
	18–29	62	29.5	
	30–39	78	37.1	
	40–49	48	22.9	
	≥50	22	10.5	
Sex	Male	207	98.6	
	Female	3	1.4	
Education	No formal	42	20.0	
	Primary	84	40.0	
	Secondary	71	33.8	
	Tertiary	13	6.2	
Work experience (years)				12.6 ± 7.3
	<5	30	14.3	
	5–9	58	27.6	
	10–14	52	24.8	
	15–19	38	18.1	
	≥20	32	15.2	
Daily working hours				9.8 ± 1.9
	<8	24	11.4	
	8–10	118	56.2	
	>10	68	32.4	
Weekly rest days	None	86	41.0	
	1 day	94	44.8	
	≥2 days	30	14.2	

The study included 210 vulcanizers, most of whom were male (98.6%). The mean age was 38.4±9.7 years, and the largest age group was 30–39 years (37.1%). Sixty percent had either primary education or no formal education. Mean work experience was 12.6±7.3 years. Average daily working time was 9.8±1.9 hours, while 41.0% reported having no weekly rest day.

The predominance of males reflects the gender composition of the trade. The relatively long work experience and extended working hours are relevant because prolonged physical exposure and limited recovery may increase ergonomic burden (Afolabi et al., 2021).

Ergonomic Exposure

Table 2. Self-reported ergonomic risk factors

Risk factor	n	%
Awkward postures	177	84.3
Repetitive motions	167	79.5
Manual lifting of heavy items	158	75.2
Prolonged standing (>4 hours)	184	87.6
Sustained kneeling/crouching	134	63.8
Working in constrained positions	112	53.3
Using vibrating hand tools	89	42.4
Exposure to heat	165	78.6

Prolonged standing was the most frequently reported exposure (87.6%), followed by awkward postures (84.3%), repetitive motions (79.5%), heat exposure (78.6%), and manual lifting of heavy items (75.2%). Thus, workers were commonly exposed to multiple physical stressors rather than a single isolated hazard.

Observations in 50 workshops supported the questionnaire findings: 64% of workstations had surfaces below elbow height, 74% of hand tools lacked ergonomic handles, 68% had inadequate lighting, only 12% had seating, and 82% had no designated rest breaks. These observations are consistent with ergonomic hazards documented in Nigerian auto-repair settings (Anyaeche & Ishie, 2021; Adesope et al., 2024).

Prevalence and Distribution of MSDs

Table 3. Twelve-month prevalence of musculoskeletal disorders by body region

Body region	n	Prevalence (%)	95% CI
Lower back	150	71.4	64.7–77.4
Neck	123	58.6	51.6–65.3
Shoulders	103	49.0	42.1–56.0
Upper back	87	41.4	34.7–48.5
Wrists/hands	72	34.3	28.0–41.0
Knees	65	31.0	24.9–37.6
Elbows	54	25.7	20.0–32.1
Ankles/feet	41	19.5	14.4–25.6
Hips/thighs	28	13.3	9.1–18.7
Any MSD	183	87.1	81.7–91.3

The overall 12-month prevalence of self-reported musculoskeletal symptoms in any body region was 87.1% (95% CI: 81.7–91.3). Lower back pain was most prevalent (71.4%), followed by neck pain (58.6%) and shoulder pain (49.0%). In addition, 63.7% reported symptoms in two or more body regions, indicating that symptoms were frequently multisite.

Table 4. Seven-day prevalence of musculoskeletal disorders

Body region	n	Prevalence (%)
Lower back	98	46.7
Neck	76	36.2
Shoulders	62	29.5
Upper back	45	21.4
Wrists/hands	38	18.1
Knees	32	15.2

Seven-day prevalence remained substantial, particularly for lower back pain (46.7%) and neck pain (36.2%), indicating a considerable recent symptom burden.

Among workers with MSD symptoms, mean pain intensity was 6.3±2.1 on a 0–10 visual analogue scale, and 42.6% reported severe pain (≥7/10). More than half (55.7%) indicated that symptoms limited their work activities, 28.1% had taken time away from work because of MSDs, and only 12.4% had sought medical care.

Ergonomic Awareness, PPE and Preventive Practices

Table 5. Ergonomic awareness

Variable	n	%
Can name at least one ergonomic risk factor	60	28.6
Cannot name any risk factor	150	71.4
Knowledge of MSD prevention: Yes	34	16.2
Knowledge of MSD prevention: No	176	83.8
Source among those aware: Peers/colleagues	38	63.3
Radio/TV	12	20.0
Community health workers	6	10.0
Formal training	4	6.7

Only 28.6% could identify at least one ergonomic risk factor and 16.2% reported knowledge of MSD prevention. Among those with some awareness, peers and colleagues were the leading information source (63.3%), whereas formal training accounted for only 6.7%. Similar knowledge gaps have been reported among Nigerian artisanal workers (Olonade et al., 2026).

Table 6. Personal protective equipment utilization

PPE item	n	%
Any PPE use	26	12.4
Hand gloves	18	8.6
Boots	12	5.7
Eye protection	8	3.8
Protective clothing	6	2.9
Hearing protection	0	0.0

PPE use was minimal: 12.4% reported using any PPE and no respondent reported hearing protection. Other preventive practices were also limited; 6.7% used lifting aids, 89.5% remained in the same posture for more than two hours without changing position, 73.8% did not take regular rest breaks, and only 15.2% reported organizing the work area to reduce excessive reaching.

Factors Associated with MSD Prevalence

Table 7. Association between socio-demographic factors and MSD prevalence

Factor	Category	MSD prevalence (%)	χ^2	p-value
Age	18–29	80.6	4.21	0.239
	30–39	89.7		
	40–49	87.5		
	≥50	90.9		
Education	No formal	90.5	2.87	0.412
	Primary	88.1		
	Secondary	84.5		
	Tertiary	76.9		

Age and educational level were not significantly associated with MSD prevalence ($p>0.05$). The observed differences should therefore be interpreted descriptively rather than as evidence of independent effects.

Table 8. Association between occupational factors and MSD prevalence

Factor	Category	MSD prevalence (%)	χ^2	p-value
Work experience	<5 years	73.3	14.32	0.002
	5–9 years	82.8		
	10–14 years	90.4		
	15–19 years	89.5		
	≥20 years	96.9		
Daily hours	<8 hours	75.0	11.87	0.008
	8–10 hours	85.6		
>10 hours	>10 hours	94.1		
Weekly rest	None	93.0	7.23	0.027
	1 day	84.0		
	≥2 days	80.0		
Lifting heavy items	Yes	91.8	8.34	0.004
	No	73.1		
Awkward postures	Yes	92.7	10.21	0.001
	No	57.1		

MSD prevalence increased from 73.3% among workers with less than five years of experience to 96.9% among those with at least 20 years ($\chi^2=14.32$, $p=0.002$). It also increased with longer daily working hours, from 75.0% among those

working less than eight hours to 94.1% among those working more than 10 hours (χ^2=11.87, p=0.008). Workers without weekly rest had higher prevalence than those with at least two rest days (93.0% vs. 80.0%; χ^2=7.23, p=0.027). Heavy lifting and awkward posture were also significantly associated with MSD prevalence.

Table 9. Multivariate logistic regression of independent predictors of MSD

Predictor	Adjusted OR	95% CI	p-value
Work experience (≥15 years)	4.83	2.01–11.62	<0.001
Daily hours >10	3.21	1.45–7.12	0.004
Awkward postures	9.42	2.87–30.91	<0.001
No weekly rest	2.67	1.12–6.38	0.027

After adjustment, awkward posture was the strongest independent predictor of self-reported musculoskeletal symptoms (adjusted OR=9.42), followed by work experience of at least 15 years (adjusted OR=4.83), working more than 10 hours daily (adjusted OR=3.21), and having no weekly rest (adjusted OR=2.67). These estimates indicate association, not causation.

Discussion

The 12-month prevalence of self-reported musculoskeletal symptoms of 87.1% demonstrates a substantial occupational health burden among the vulcanizers studied. The finding is strikingly similar to the 87.3% 12-month WRMSD prevalence reported among Nigerian bricklayers by Adedoyin et al. (2022), although the anatomical pattern differed: the present study was dominated by the lower back, whereas the bricklayer study reported the shoulder and low back as the most affected regions. The high prevalence across both occupations supports the importance of sustained manual work, awkward postures, and repetitive physical demands in informal employment.

Lower back pain was the leading complaint in this study (71.4%), followed by neck (58.6%) and shoulder (49.0%) symptoms. The lower-back finding is comparable with the 76.02% back-pain prevalence reported among automotive maintenance mechanics in eastern Nigeria (Abaraogu et al., 2016). The similarity is plausible because both occupations involve manual material handling, sustained or constrained postures, and physically demanding tasks. Ergonomic assessment of Nigerian auto-repair shops has also identified stooping and lifting as high-risk activities capable of increasing low-back loading (Anyaeche & Ishie, 2021; Nwanya, S., & Ukoha, 2025).

The observed exposure profile provides a plausible occupational explanation for the symptom distribution. Prolonged standing, awkward postures, repetitive movements, manual lifting, inadequate workstation height, non-ergonomic tools, limited seating, and insufficient rest were common. These findings are consistent with Afolabi et al. (2021), who found that heavy manual work, long working hours, and prolonged standing were important physical work conditions among Nigerian automobile artisans. They also align with Adesope et al. (2024), who identified poor workstation design, awkward posture, repetitive tasks, poor lighting, and inadequate protective practices in Nigerian automobile workshops.

The strong association with work experience and working hours further supports an exposure-related interpretation. Workers with at least 20 years of experience had a prevalence of 96.9%, compared with 73.3% among those with less than five years, while prevalence reached 94.1% among those working more than 10 hours daily. Afolabi et al. (2021) similarly reported associations between long work experience, long working hours, and illness among informal automobile artisans. However, because the present study is cross-sectional, cumulative exposure is a plausible explanation rather than a demonstrated causal pathway.

Awkward posture was the strongest independent predictor, with an adjusted odds ratio of 9.42. This result is particularly important for intervention because postural exposure can potentially be modified through relatively low-cost engineering and organizational measures. The finding is also compatible with the task-based ergonomic assessment of Anyaeche and Ishie (2021; Okafor et al., 2020), which identified high-risk stoop and lifting tasks in auto-repair work. Raising work surfaces, reducing floor-level work, improving tool handles, providing seating where appropriate, and introducing posture-change breaks are therefore reasonable intervention priorities.

Awareness and preventive practices were inadequate. Only 28.6% could identify an ergonomic risk factor and 16.2% knew about MSD prevention, while only 12.4% used any PPE. The predominance of peers as an information source suggests that interventions delivered through the Vulcanizers Association, community health workers, and practical peer education may be more feasible than relying exclusively on formal training. PPE should be strengthened for relevant hazards, but it should not be presented as the primary control for ergonomic exposure; engineering and work-organization controls are more directly relevant to MSD prevention. This finding is also consistent with recent Nigerian evidence identifying gaps in MSD knowledge and prevention among artisanal blacksmiths (Opone, et al.,2024; Olonade et al., 2026).

This study is the combination of self-reported musculoskeletal symptoms with direct workplace observations, allowing the reported ergonomic exposures to be considered alongside observed workstation and environmental conditions. However, the cross-sectional design does not establish temporal sequence or causality between ergonomic exposures and musculoskeletal symptoms. Musculoskeletal symptoms were self-reported and were not confirmed through clinical examination,

Conclusion

Vulcanizers in Ethiope West experienced a high burden of musculoskeletal symptoms, with 87.1% reporting at least one MSD during the preceding 12 months. Lower back, neck, and shoulder symptoms predominated. The work environment involved prolonged standing, awkward postures, repetitive movements, manual lifting, poor workstation design, inadequate seating, non-ergonomic tools, and insufficient rest.

Ergonomic awareness and preventive practices were poor. Work experience, longer daily working hours, absence of weekly rest, heavy lifting, and awkward posture were associated with MSD prevalence, with awkward posture emerging as the strongest independent predictor. The findings support practical ergonomic interventions combined with occupational-health education and improved access to preventive and rehabilitative services.

Recommendations

1. Improve workshop ergonomics by raising work surfaces, providing suitable seating, improving tool handles, and organizing work areas to reduce reaching, trunk flexion, and awkward postures.
2. Reduce physical workload through tire-handling aids, safer lifting, task variation, regular short rest/posture-change periods, and at least one weekly rest day where feasible.
3. Strengthen occupational-health education through Vulcanizers Associations, community health workers, and local media, focusing on ergonomic risks, safe practices, early symptom reporting, and appropriate PPE use.
4. Improve healthcare access and research through occupational-health and physiotherapy referral services and further prospective and intervention studies on feasible ergonomic improvements.

Conflict of Interest

The authors declare no conflict of interest.

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