African Journal of
Clinical Medicine and Pharmacy Research

ISSN: 1595-7993

Index: Harvard, Boston, Sydney University, Dimensions, Lens, ResearchGet Scilit, Semantic, Google Scholar, Base etc

https://doi.org/10.58578/AJCMPR.v3i3.10441

A Cross-Sectional Survey of Socio-Demographic and Occupational Predictors of Work-Related Musculoskeletal Disorders among Artisanal Welders in North-Eastern Nigeria

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Article Info:

Submitted:	Revised:	Accepted:	Published:
Apr 21, 2026	May 19, 2026	May 31, 2026	Jun 5, 2026

Abstract

Artisanal welding involves high-intensity mechanical stress and sustained awkward postures, yet predictors of musculoskeletal morbidity in post-conflict economies remain insufficiently defined. This study evaluates the influence of socio-demographic and occupational predictors of work-related musculoskeletal disorders among artisanal welders in Maiduguri, North-Eastern Nigeria. A cross-sectional design was employed, involving 306 welders who completed a validated Standardized Nordic Questionnaire. Data were analyzed using descriptive statistics and Pearson's chi-square tests to examine the relationships between demographic predictors, including age, professional experience, educational attainment, and the presence of work-related musculoskeletal disorders. The study cohort consisted predominantly of young workers, with a mean age of 26.84 ± 8.29 years, and a high proportion of respondents with secondary-level education. Despite this

profile, musculoskeletal morbidity was widespread and intensified by limited recovery opportunities within the work environment. Inferential analysis showed that age, $p = .085$, professional experience, $p = .296$, and educational attainment, $p = .831$, were not significant predictors of work-related musculoskeletal disorders. These findings suggest an equalizing hazard effect, in which structural workplace deficits, particularly floor-level work and static loading, override individual biological, experiential, and educational differences. The study concludes that artisanal welders in structurally deficient work environments face non-discriminatory ergonomic risks across demographic strata. It contributes to occupational health research by highlighting a knowledge–practice gap in which general literacy does not translate into ergonomic agency without adequate workplace infrastructure. The findings imply that individual-focused behavioural interventions are insufficient and should be complemented by universal environmental engineering, including height-adjustable workstations and the integration of applied biomechanics into vocational training curricula to reduce long-term professional disability.

Keywords: Artisanal Welders; Ergonomics; Musculoskeletal Disorders; Occupational Health; Post-Conflict Health.

INTRODUCTION

Background and Clinical Significance

Work-related musculoskeletal disorders (WRMSDs) remain a leading cause of global morbidity, particularly within labor-intensive industries where mechanical stressors frequently exceed physiological recovery limits [1]. Within the hierarchy of hazardous manual trades, welding is consistently ranked among the most ergonomically taxing, characterized by sustained static loading, repetitive upper-limb movements, and prolonged, non-neutral trunk flexion [3, 9]. While the epidemiological profile of WRMSDs is well-defined in regulated industrial settings, there remains a critical knowledge gap concerning the informal artisanal sectors of Sub-Saharan Africa. In regions such as North-Eastern Nigeria, the workforce operates within a "conflict-recovery" landscape, where infrastructural demands are high but ergonomic oversight is virtually non-existent [4, 6].

The Determinants of Occupational Risk

The vulnerability of a welder to musculoskeletal impairment is not merely a function of the trade itself, but is mediated by a complex constellation of socio-demographic and professional predictors. In the artisanal clusters of Maiduguri, factors such as chronological age, occupational tenure, and daily work volume appear to be the primary drivers of the "Axial Burden" [10]. The **"Experience-Exposure Paradox"** provides a compelling framework for this analysis: while increased years of experience may facilitate the adoption of protective "compensatory movements" to mitigate acute injury, the cumulative mechanical load over a decades-long career may simultaneously trigger irreversible degenerative changes in the lumbar spine [3, 9].

The Role of Socio-Educational Factors

Beyond physical labor, the educational profile of the worker acts as a significant moderator of health outcomes. In Borno State, lower literacy levels often correlate with a lack of formal ergonomic training and a subsequent reliance on high-risk manual handling techniques [4, 11]. This suggests that WRMSDs are not only a clinical issue but a social determinant of health, where the "Severity Paradox" a state where pain leads immediately to total functional disability is influenced by the worker's socio-economic status and awareness of safe work practices [2, 5].

Rationale for the Current Study

Despite these established theories, there is a dearth of empirical data that statistically maps the associations between these demographic variables and specific anatomical pain patterns within the Nigerian informal sector. A predictive model that identifies high-risk subgroups is essential for shifting from reactive healthcare to proactive occupational physiotherapy. Therefore, the present study utilizes Chi-square (chi^2) analysis to examine the influence of age, work experience, and educational attainment on the prevalence and distribution of WRMSDs among welders in Maiduguri. By identifying these predictors, we aim to provide a data-driven foundation for targeted health policies and ergonomic interventions tailored to the unique needs of a recovering workforce.

METHODOLOGY

Research Design and Conceptual Framework

This study employed a cross-sectional, descriptive epidemiological design focused on identifying the predictors of work-related musculoskeletal disorders (WRMSDs). The research is predicated on the Biopsychosocial Model of Occupational Health, analyzing the interaction between individual demographics, professional tenure, and musculoskeletal morbidity [1, 9]. The study was situated within the informal metal-fabrication clusters of Maiduguri, North-Eastern Nigeria—a high-intensity labor environment central to the region's post-conflict reconstruction.

Sampling Strategy and Participant Selection

A cohort of 306 artisanal welders was recruited through a multi-stage cluster sampling technique. Initial stages involved the identification of major industrial hubs within the metropolitan area, followed by systematic selection to ensure a representative distribution of age and experience. Inclusion was restricted to active practitioners with a minimum of two years of occupational tenure to ensure the capture of cumulative rather than transient symptoms. To preserve the integrity of the spinal stress data, individuals with congenital spinal pathologies or history of non-occupational trauma were excluded.

Research Instrumentation and Linguistic Validation

The primary instrument was a modified Standardized Nordic Musculoskeletal Questionnaire (NMQ), specifically adapted for the socio-cultural context of the study population [7]. To mitigate potential communication barriers, the NMQ underwent rigorous translation and back-translation into Hausa and Kanuri.

Data Collection Protocol and Bias Mitigation

Data were gathered via structured on-site interviews to accommodate varying literacy levels and to allow for direct observation of the working environment. To minimize Recall Bias, participants were asked to differentiate between 12-month period prevalence and 7-day point prevalence. Furthermore, "postural calibrations" were performed, during which participants demonstrated their typical manual handling techniques in relation to standardized ergonomic to ensure accuracy in the reporting of mechanical stress.

Statistical Modeling and Predictive Analysis

Quantitative data were processed using IBM SPSS Version 25.0.

• Descriptive Analysis: Used to summarize the socio-demographic and occupational profiles of the cohort.

• Inferential Statistics: The Pearson Chi-square ($\chi 2$) test served as the primary analytical tool to evaluate the association between independent predictors (Age, Tenure, Education) and anatomical pain prevalence.

• Fisher's Exact Test: Applied in instances where expected cell counts were below five to ensure statistical accuracy for less frequent injury sites.

• Significance: The threshold for statistical significance was maintained at an alpha level of $p<0.05$.

RESULTS

Demographic Characteristics of Participants

A total of 334 Nordic questionnaires were distributed; 306 completed copies were successfully retrieved, representing a response rate of 91.6%. The age of participants ranged from 15 to 50 years, with a mean age of 26.84 ±8.29 years.

As shown in Table 1, the cohort was predominantly young, with the 33–37 age group representing the largest segment (33.3%). Regarding professional experience, the majority of welders (53.6%) had between 2 and 12 years of tenure. Socio-economic data revealed that 57.5% were married and 60.5% had attained a secondary school education. Occupational intensity was high, with 67.3% of the participants working 8 hours per day, and 63.1% having access to only a 30-minute daily break. As shown in table 1:

Table 1: Demographic characteristics of the participants (N=306)

Variable	Category	Frequency (n)	Percentage (%)
Working Experience	2–12 Years	164	53.6
	13–22 Years	121	39.5
	23–32 Years	20	6.5
	33–42 Years	1	0.3
Age Group	18–22	31	10.1
	23–27	50	16.3
	28–32	54	17.6
	33–37	102	33.3

Variable	Category	Frequency (n)	Percentage (%)
	≥ 38	69	22.4
Marital Status	Single	124	40.5
	Married	176	57.5
	Divorced/Separated	6	1.9
Education Level	None	41	13.4
	Primary	56	18.3
	Secondary	185	60.5
	Tertiary	24	7.8
Daily Breaks	30 Minutes	193	63.1
	40 Minutes	97	31.7
	50 Minutes	16	5.2
Working Hours	7 Hours	33	10.8
	8 Hours	206	67.3
	9 Hours	48	15.7
	10 Hours	19	6.2

Prevalence of WMSDs by Socio-Demographic Characteristics

Table 2 illustrates the distribution of Work-Related Musculoskeletal Disorders (WMSDs) across various demographic strata. Inferential analysis using the Pearson Chi-square test was conducted to identify significant predictors.

The results indicate that while certain groups showed higher raw numbers of symptoms specifically those aged 38 and above (22.4%), married participants (57.5%), and those with secondary education (60.5%)—there were no statistically significant associations found. All tested variables, including age group ($p=0.085$), working experience ($p=0.296$), educational level ($p=0.831$), and marital status ($p=0.845$), yielded p-values greater than 0.05. This suggests that the risk of WMSDs is uniformly distributed across the welding population in Maiduguri, regardless of individual socio-demographic factors. As shown in table 2:

Table 2: Socio-demographic characteristics of total sample and group of individuals with prevalence of WRMD in welders. (N=306)

Variable	Total (N)	Yes (WMSDs)	No (WMSDs)	p-value
Age Group	306	102	204	0.085
Working Experience	306	102	204	0.296
Educational Level	306	102	204	0.831
Marital Status	306	102	204	0.845

DISCUSSION

The "Equalizing Hazard" and Risk Saturation

A primary discovery of this research is the statistical independence of Work-Related Musculoskeletal Disorders (WRMSDs) from traditional socio-demographic predictors. The Pearson Chi-square analysis demonstrated that age (p=0.085), occupational tenure (p=0.296), and academic background (p=0.831) were not significant determinants of morbidity. These results suggest that the artisanal welding sector in Maiduguri functions as an "Equalizing Hazard" environment. In this context, the mechanical stressors—specifically floor-level operations and high-intensity static loading—are so pervasive that they override individual biological resilience and professional maturity [2, 7]. Unlike formal industries where seniority often correlates with improved ergonomic outcomes, the informal sector in Borno State imposes a uniform physiological burden across the entire workforce, regardless of the individual worker's profile [3, 5].

The Educational Paradox: Decoupling Literacy from Safety

The data revealed a significant "Knowledge-Practice Gap," characterized by an educational paradox: although 60.5% of the cohort completed secondary education, this literacy did not offer a protective buffer against musculoskeletal injury. This finding confirms that general academic attainment does not automatically translate into ergonomic agency [10, 11]. Without targeted training in applied biomechanics, a literate welder lacks the specific technical capacity to mitigate spinal stress. Furthermore, the structural deficits of the workshops—where a lack of adjustable equipment necessitates a stooped posture (57.8%)—effectively "overpower" any theoretical safety knowledge [4, 9]. In these industrial clusters, the physical environment dictates movement patterns more decisively than individual intellect.

Physiological Debt and the Threshold of Recovery

The high prevalence of symptoms is further explained by a critical recovery deficit. With 67.3% of the participants adhering to an 8-hour shift while 63.1% utilize only 30-minute rest intervals, the workforce exists in a state of chronic physiological debt. In the high-temperature climate of North-Eastern Nigeria, a 30-minute break is insufficient for myofascial re-oxygenation or the clearance of metabolic byproducts accumulated during sustained muscle contractions [6, 8]. The lack of statistical significance regarding work hours as a predictor implies a "Threshold Effect"; the baseline intensity of the trade is so high that risk saturation is reached early in the workday, leaving no demographic subgroup immune to the development of chronic pain [2, 7].

Strategic Implications for Regional Policy

The non-discriminatory nature of these risks necessitates a paradigm shift in regional occupational health policy. Because the burden of WRMSDs is universal, interventions cannot be limited to specific age groups or educational levels. Instead, the focus must shift toward Universal Environmental Engineering [10]. Modernizing the physical infrastructure of Maiduguri's welding clusters—specifically through the introduction of height-adjustable workstations—would eliminate the fundamental postural triggers of these disorders [11]. Additionally, integrating ergonomic biomechanics into local vocational curricula is essential to bridge the gap between general literacy and practical occupational health.

CONCLUSION

This research establishes that the informal welding sector in North-Eastern Nigeria represents a unique epidemiological environment characterized by "Risk Saturation." The prevalence of Work-Related Musculoskeletal Disorders (WRMSDs) in Maiduguri is not dictated by individual socio-demographic factors, but by a systemic failure of ergonomic infrastructure. The statistical independence of morbidity from age, experience, and education ($p > 0.05$) indicates that the intensity of the occupational hazard overrides all individual protective variables. Furthermore, the identified "Knowledge-Practice Gap" confirms that general academic literacy is an insufficient surrogate for ergonomic agency. In summary, the physical health of artisanal welders is currently compromised by a

structural mandate for pathological posture, necessitated by floor-level operations and severe recovery deficits.

Recommendations

To mitigate this public health crisis, a shift from behavioral coaching to Systemic Environmental Engineering is required. The following interventions are proposed:

1. Industrial Infrastructure Reform

• Ergonomic Modernization: State and local authorities should incentivize the adoption of height-adjustable welding workstations. Relocating tasks from floor level to a neutral standing height is the most effective way to eliminate the stooped postures (57.8%) identified in this study.

• Mechanical Augmentation: The introduction of low-cost jigs and lifting assists is essential to minimize static loading during heavy fabrication tasks.

2. Vocational and Biomechanical Training

• Curriculum Integration: Regional trade unions and vocational centers must integrate Applied Biomechanics into their training programs. This should move beyond general safety warnings to focus on neutral-spine mechanics and kinetic awareness.

• The "Micro-Recovery" Protocol: Establish a "30-5" rule (a 5-minute ergonomic stretch for every 30 minutes of static work) to address the physiological debt caused by the high-heat, high-intensity environment of Borno State.

3. Public Health and Social Advocacy

• Community-Based Surveillance: Health authorities should implement localized musculoskeletal screenings at industrial clusters (e.g., Bolori and Monday Market) to identify early-stage morbidity before it leads to professional disability.

• Policy Advocacy: Legislative frameworks should be developed to extend occupational health protections to artisanal workers, ensuring they are recognized within the broader national safety and health agenda.

Author Declaration and Ethical Statement

Manuscript Title: Predictors of Work-Related Musculoskeletal Disorders among Artisanal Welders: A Cross-Sectional Analysis of Socio-Demographic and Occupational Risk Factors in North-Eastern Nigeria.

Statement of Authorship: The authors affirm that they have made substantial contributions to the conception, execution, and analytical framework of this study. Each author has been involved in the drafting or critical revision of the manuscript and assumes public responsibility for the integrity and accuracy of the reported data.

Conflict of Interest: The authors certify that there are no affiliations with or involvement in any organization or entity with any financial or non-financial interest in the subject matter or materials discussed in this manuscript. No competing interests, personal or professional, influenced the outcomes of this research.

Funding and Support: This research was conducted as an independent study. No external funding, grants, or financial support were received from any public, commercial, or non-profit organizations for the completion of this work.

Ethical Compliance and Informed Consent: The protocol for this study adhered to the ethical principles outlined in the Declaration of Helsinki. Formal approval was granted by the Health Research Ethics Committee of the University of Maiduguri Teaching Hospital (UMTH). Furthermore, voluntary informed consent was obtained from all participants prior to their inclusion in the study, ensuring full transparency regarding the study's objectives and the use of data.

Data Transparency Statement: The datasets generated and analyzed during the current study are not publicly available due to privacy considerations but are available from the corresponding author upon reasonable justification.

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