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Prevalence of vitamin D deficiency among Northern Muslim women with chronic musculoskeletal pain residing in Port Harcourt, Rivers State, Nigeria: a cross-sectional study

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Abstract

Aim: Vitamin D deficiency is increasingly recognised as a global health concern and is associated with musculoskeletal pain. Women adhering to cultural clothing practices may be at increased risk due to limited sun exposure. This study aimed to determine the prevalence of vitamin D deficiency and identify its predictors among Northern Muslim women with chronic musculoskeletal pain living in Port Harcourt, Nigeria.

Methods: A cross-sectional study of 220 Northern Muslim women aged ≥ 18 years with chronic musculoskeletal pain was conducted in Port Harcourt, Nigeria. Sociodemographic and lifestyle data were collected, and serum 25-hydroxyvitamin D levels were measured using ELISA. Participants with conditions affecting vitamin D absorption or metabolism, or those taking interfering medications, were excluded. Group comparisons (deficient vs. non-deficient) were performed using chi-square tests for categorical variables, independent-samples *t*-tests for continuous variables, and one-way ANOVA for pain scores across vitamin D status categories. Multivariate logistic regression was used to identify predictors of vitamin D deficiency. Analyses were conducted using IBM SPSS Statistics version 25 (IBM Corp., Armonk, NY, USA), with $p < 0.05$ considered significant.

Results: The prevalence of vitamin D deficiency was 65.0%, a rate slightly higher yet comparable to reports from other urban populations. Significant predictors included full-body covering (adjusted OR = 3.1; 95.00% CI: 1.8–5.3), low intake of vitamin D-rich foods (OR = 2.4; 95.00% CI: 1.3–4.1), and outdoor activity < 3 hours per week (OR = 2.7; 95.00% CI: 1.6–4.6). Vitamin D-deficient participants reported higher mean pain scores (7.3 ± 1.4) than vitamin D-insufficient participants (5.9 ± 1.3).

Conclusions: Vitamin D deficiency is highly prevalent among Northern Muslim women with chronic musculoskeletal pain in Port Harcourt, largely influenced by clothing practices, low sun exposure, and inadequate dietary intake. Public health strategies, including targeted education and supplementation programs, are recommended to address this burden.

Keywords

vitamin D deficiency, musculoskeletal pain, Northern Muslim women, sun exposure, dietary intake, Port Harcourt

Introduction

Vitamin D is a crucial secosteroid hormone involved in the regulation of calcium and phosphate homeostasis, thereby maintaining bone mineralisation and musculoskeletal integrity [1]. It is also essential for immune function, mental well-being, reproductive health, and the prevention of chronic diseases [2].

Deficiency of vitamin D has been extensively implicated in the pathophysiology of chronic musculoskeletal pain through mechanisms including impaired calcium absorption and altered muscle function [3–5]. Globally, specific demographic groups, notably women adhering to cultural and religious clothing practices that significantly reduce cutaneous ultraviolet B (UVB) exposure, exhibit a higher prevalence of vitamin D insufficiency and related musculoskeletal disorders [6].

In Nigeria, Northern Muslim women often migrate to southern urban centres such as Port Harcourt, bringing cultural and religious practices, including full-body covering, which may reduce skin exposure to sunlight. This, combined with limited outdoor activity in urban environments, can lead to vitamin D deficiency even in tropical climates [7].

Despite the recognised risk factors, data on vitamin D status among Northern Muslim women living in southern Nigerian cities remain scarce. Understanding the prevalence of deficiency and its associations with lifestyle and cultural practices is important to guide interventions aimed at reducing chronic musculoskeletal pain and improving overall health.

This study aimed to determine the prevalence of vitamin D deficiency among Northern Muslim women with chronic musculoskeletal pain residing in Port Harcourt and to identify socio-demographic and lifestyle factors associated with deficiency.

Materials and methods

Study design and setting

This was a facility-based cross-sectional study designed to determine the prevalence and predictors of vitamin D deficiency among Northern Muslim women presenting with chronic musculoskeletal pain. The study was conducted in Port Harcourt, Rivers State, Nigeria, a metropolitan city located in the Niger Delta region (latitude 4°49′N, longitude 7°2′E), characterized by a tropical monsoon climate with year-round sunlight averaging 12 hours per day.

Data collection occurred from March to August 2024 in five primary health care centres and four outpatient clinics. These facilities were purposefully selected because they serve both local residents and a large population of Northern Nigerian migrants, many of whom are Muslim women adhering to cultural dress codes that reduce sun exposure. This urban setting was chosen to reflect real-world environmental, social, and dietary factors influencing vitamin D status in this population.

Study population and sampling

A total of 220 participants (deficient = 143 and non-deficient = 77) were recruited using a consecutive sampling strategy, in which women presenting to selected outpatient clinics for evaluation of musculoskeletal pain were consecutively approached and screened for eligibility. Participants were included if they were female, aged 18 years or older, self-identified as Muslim women of Northern Nigerian origin, had resided in Port Harcourt for at least one year, and reported chronic musculoskeletal pain lasting a minimum of three months, confirmed by both clinical records and self-report. Exclusion criteria were pregnancy or current breastfeeding, known metabolic bone diseases such as rickets, osteomalacia, or Paget's disease, use of vitamin D supplements exceeding 1,000 IU/day within the previous three months, chronic kidney or liver disease, malignancy, or any other condition affecting vitamin D metabolism, and the use of medications known to interfere with vitamin D metabolism, including anticonvulsants and glucocorticoids. Women who declined or were unable to provide informed consent were also excluded. Written informed consent was obtained from all participants after the study objectives and procedures were explained in either English or Hausa, depending on participant preference.

Ethical approval

This study was reviewed and approved by the Rivers State University Research Ethics Committee (Protocol No: RSU/REC/2025/112) and conducted in accordance with the Declaration of Helsinki (2024 revision).

Data collection procedures

Data collection was carried out by four trained research assistants who were fluent in both English and Hausa to facilitate effective communication with participants. A structured, interviewer-administered questionnaire, which had been pretested among 20 women to ensure reliability and face validity, was used to gather sociodemographic and lifestyle information. Variables collected included age, marital status, education level, occupation, and household income. Anthropometric measurements were obtained using a digital weighing scale (Seca 803, Germany) and a portable stadiometer (Seca 213, Germany), with participants measured in light clothing and without shoes. Body Mass Index (BMI) was calculated as weight in kilograms divided by height in meters squared (kg/m^2). Clothing style was categorized as full-body covering, including face veil or niqab, or partial covering, which left the face and hands exposed. Sun exposure was classified as either less than three hours or three or more hours of direct sunlight per week. Dietary assessment focused on the frequency of consumption of vitamin D-rich foods such as oily fish, eggs, and fortified milk, recorded as daily, weekly, monthly, or rarely.

Pain assessment

Pain severity was assessed using a 10-point Visual Analogue Scale (VAS), where 0 = no pain and 10 = worst possible pain. The VAS was explained to participants, and scores were obtained in a quiet consultation room to minimize bias.

Blood collection and processing

Certified phlebotomists collected 5 mL of venous blood from the antecubital vein using sterile 21-gauge needles and EDTA-containing vacutainer tubes, labeling each sample with a unique participant code for blinding. The samples were allowed to clot at room temperature for 5–10 minutes, then centrifuged at 2,795 × g for 5 minutes using a Hettich EBA 200 centrifuge (Germany). The resulting serum was carefully separated into aliquots and stored in cryovials at −70°C until analysis.

Vitamin D analysis

Vitamin D status was determined by measuring serum 25-hydroxyvitamin D [25(OH)D] concentrations using a solid-phase competitive enzyme-linked immunosorbent assay (ELISA) (DIA Source 25-OH Vitamin D Total ELISA Kit, Bio-Rad Laboratories, Hercules, CA, USA) on a continuous data acquisition (CODA) automated EIA analyzer. Inter-assay coefficients of variation (CV) were 4.900% at 26.3 ng/mL and 4.500% at 42.0 ng/mL. Vitamin D status was categorised based on established guidelines as follows: Deficient: < 20 ng/mL; Insufficient: 20–29 ng/mL, and Sufficient: ≥ 30 ng/mL. All procedures followed the manufacturer's guidelines. Quality control procedures were followed throughout the analysis to ensure the reliability and reproducibility of results.

Statistical analysis

Data were analyzed using IBM SPSS Statistics version 25 (IBM Corp., Armonk, NY, USA). Descriptive statistics (means, standard deviations, frequencies, and percentages) were used to summarize participant characteristics and vitamin D status categories. The prevalence of vitamin D deficiency was calculated with 95% confidence intervals. Associations between categorical variables (marital status, education level, clothing style, outdoor activity, and dietary intake) and vitamin D status were assessed using chi-square tests. Continuous variables such as age and BMI were compared between groups using independent-samples *t*-tests. Baseline characteristics (e.g., demographics, pain scores, sun exposure) were compared between groups (deficient vs. non-deficient) using stratified analysis to control for potential confounders, including prior low-dose vitamin D supplementation (< 1,000 IU/day). Multivariate logistic regression was conducted to identify independent predictors of vitamin D deficiency, adjusting for potential confounders. Differences in mean musculoskeletal pain scores across vitamin D status categories (deficient, insufficient, sufficient) were evaluated using one-way analysis of variance (ANOVA) with post hoc Tukey's tests for pairwise comparisons. Statistical significance was set at $p < 0.05$.

Results

Sociodemographic and clinical characteristics of participants

Table 1: The sociodemographic and clinical characteristics of participants. A total of 220 women were included. The mean age was 36.8 ± 11.2 years.

Table 1. Sociodemographic and clinical characteristics of participants (*N* = 220).

Variable	*N* (%) or mean ± SD
Age (years)	36.8 ± 11.2
Marital status	
• Married	178 (80.91%)
• Single/divorced/widowed	42 (19.09%)
Education level	
• None	128 (58.18%)
• Primary or higher	92 (41.82%)
Clothing style	
• Full-body covering	154 (70.00%)
• Partial covering	66 (30.00%)
Outdoor activity	
< 3 h/week	165 (75.00%)
≥ 3 h/week	55 (25.00%)
BMI (kg/m^2)	28.1 ± 5.3
Vitamin D status	
• Deficient (< 20 ng/mL)	143 (65.00%)
• Insufficient (20–29 ng/mL)	62 (28.18%)
• Sufficient (≥ 30 ng/mL)	15 (6.82%)

BMI: Body Mass Index.

Associations of vitamin D deficiency with full-body covering, low outdoor activity, and low intake of vitamin D-rich foods

Univariate analysis (Table 2) revealed significant associations of vitamin D deficiency with full-body covering, low outdoor activity, and low intake of vitamin D-rich foods.

Independent predictors of vitamin D deficiency

Multivariate logistic regression (Table 3) identified independent predictors.

Table 2. Univariate associations between participant characteristics and Vitamin D deficiency status (*N* = 220).

Variable	Deficient, *n* = 143 (65.00%)	Non-deficient, *n* = 77 (35.00%)	*p*-value*
Age (mean ± SD)	36.4 ± 11.0	37.6 ± 11.5	0.448
Marital status			
• Married	119 (83.22%)	26 (33.80%)	0.235
•Single/divorced/widowed	24 (16.78%)	51 (66.20%)	
Education level			
• None	86 (60.14%)	42 (54.55%)	0.422
• Primary or higher	57 (39.86%)	35 (45.45%)	
Clothing style			
• Full-body covering	114 (79.72%)	40 (51.95%)	< 0.001
• Partial covering	29 (20.28%)	37 (48.05%)	
Outdoor activity			
• < 3 h/week	131 (91.60%)	43 (55.84%)	< 0.001
• ≥ 3 h/week	12 (8.40%)	34 (44.16%)	
BMI (mean ± SD)	28.3 ± 5.4	27.8 ± 5.1	0.505
Dietary vitamin D-rich foods			
Low dietary vitamin D-rich foods	100 (69.93%)	38 (49.35%)	0.003
Adequate intake	43 (30.07%)	39 (50.65%)	

**p*-values: Chi-square tests for categorical variables; Independent-samples *t*-tests for continuous variables.

Table 3. Multivariate logistic regression of predictors of vitamin D deficiency.

Variable	Adjusted OR	95% CI	*p*-value
Full-body covering	3.1	1.8–5.3	< 0.001
Outdoor activity < 3 h/week	2.7	1.6–4.6	< 0.001
Low intake of vitamin D-rich foods	2.4	1.3–4.1	0.003
Age	1.0	0.97–1.03	0.448
BMI	0.98	0.93–1.04	0.505

OR: odds ratio; BMI: Body Mass Index.

Mean serum 25-hydroxyvitamin D levels

Mean serum 25-hydroxyvitamin D [25(OH)D] levels differed significantly across groups (Table 4).

Table 4. Serum [25(OH)D] levels (ng/mL) by selected participant characteristics.

Variable	Mean ± SD	*p*-value
Clothing style		
• Full-body covering	15.9 ± 6.1	< 0.001
• Partial covering	22.4 ± 6.8	
Outdoor activity		
• < 3 hours/week	16.5 ± 6.3	< 0.001
• ≥ 3 hours/week	22.2 ± 6.7	
Dietary vitamin D-rich foods		
• Low intake	16.2 ± 6.0	< 0.001
• Adequate intake	21.5 ± 6.9	

Self-reported musculoskeletal pain severity by vitamin D status

Participants with a deficiency reported higher musculoskeletal pain scores (Table 5).

Frequency of consumption of vitamin D-rich foods among participants

Dietary sources of vitamin D were generally low (Table 6).

Table 5. Self-reported musculoskeletal pain severity by vitamin D status.

Vitamin D status	Mean VAS score ± SD	*p*-value
Deficient (< 20 ng/mL)	7.3 ± 1.4	< 0.001
Insufficient (20–29 ng/mL)	5.9 ± 1.3	
Sufficient (≥ 30 ng/mL)	4.8 ± 1.2	

VAS: Visual Analogue Scale.

Table 6. Frequency of consumption of vitamin D-rich foods among participants (*N* = 220).

Food item	Consumes regularly (≥ 2 × /week) *n* (%)	Rarely/never *n* (%)
Fatty fish	54 (24.55%)	166 (75.45%)
Egg yolk	72 (32.73%)	148 (67.27%)
Fortified dairy products	38 (17.27%)	182 (82.73%)
Fortified cereals	31 (14.09%)	189 (85.91%)
Beef liver	47 (21.36%)	173 (78.64%)
Vitamin D supplements	12 (5.45%)	208 (94.55%)

Discussion

Socio-demographic and clinical characteristics of participants

This study enrolled 220 Northern Muslim women with chronic musculoskeletal pain residing in Port Harcourt, Rivers State. The mean age was approximately 37 years, and a large proportion (80.91%) were married. Over half (58.18%) reported no formal education, and a striking 70.00% practised full-body covering, while 75.00% engaged in outdoor activity for less than three hours per week. In the absence of a direct control group, our findings were compared with existing population-level data on vitamin D deficiency in Nigeria. Previous studies have reported prevalence rates of vitamin D deficiency ([25(OH)D] < 20 ng/mL) ranging from approximately 35% to 65% among urban adults in Nigeria [8]. In comparison, our study population of Northern Muslim women residing in Port Harcourt exhibited a prevalence of 65.0%, suggesting a slightly elevated but broadly similar rate relative to general urban populations. High prevalence of vitamin D deficiency has been reported in women in different regions of Nigeria, which is in line with the findings of our study. In Northern Nigeria, 83.00 to 87.50% of women were reported to be vitamin D deficient [7, 9]. Cultural clothing practices and reduced outdoor exposure may contribute specifically to higher risk in this subgroup, warranting targeted public health interventions [6, 7, 9].

Associations of vitamin D deficiency with full-body covering, low outdoor activity, and low intake of vitamin D-rich foods

Univariate analyses demonstrated significant associations between vitamin D deficiency and full-body covering, reduced outdoor activity, and low dietary intake of vitamin D-rich foods. Participants with full-body covering were significantly more likely to be deficient (79.72% vs. 51.95%, $p < 0.001$), consistent with prior studies linking concealing clothing to reduced UVB-mediated cutaneous vitamin D synthesis [8, 9]. Similarly, limited outdoor activity correlated with higher deficiency rates (91.60% vs. 55.84%, $p < 0.001$), suggesting that behavioural factors limit sun exposure even in equatorial regions [10]. Dietary insufficiency also emerged as a significant correlate, reinforcing the importance of food sources in populations with low sun exposure. These findings suggest multiple modifiable factors contributing to the deficiency in this group [11–13].

Independent predictors of vitamin D deficiency

Multivariate logistic regression identified full-body covering, low outdoor activity, and low dietary intake of vitamin D-rich foods as independent predictors of deficiency. Specifically, full-body covering was associated with a threefold increased odds of deficiency (aOR = 3.1), while low outdoor activity (aOR = 2.7) and inadequate dietary intake (aOR = 2.4) also significantly predicted deficiency. These results suggest that cultural clothing practices and behavioural factors independently contribute to risk, even after controlling for age and BMI [12, 14–16].

Mean serum 25-hydroxyvitamin D levels [25(OH)D]

The mean serum [25(OH)D] concentrations varied significantly by clothing style, outdoor activity, and dietary intake. Women practising full-body covering had markedly lower mean levels (15.9 ng/mL) compared to those with partial covering (22.4 ng/mL, $p < 0.001$). Likewise, participants with < 3 hours of outdoor activity weekly had lower levels (16.5 ng/mL) than those with ≥ 3 hours (22.2 ng/mL). Low intake of vitamin D-rich foods was also associated with lower mean serum levels (16.2 ng/mL vs. 21.5 ng/mL, $p < 0.001$). These differences underscore how behavioural and cultural practices jointly shape vitamin D status, even in sun-rich regions, by limiting effective UVB exposure and dietary intake [12, 14–16].

Self-reported musculoskeletal pain severity by vitamin D status

Participants with vitamin D deficiency reported significantly higher mean musculoskeletal pain severity scores (VAS 7.3) compared to those with insufficient (5.9) or sufficient (4.8) vitamin D status ($p < 0.001$). This aligns with evidence suggesting a role for vitamin D in musculoskeletal health and pain modulation [17, 18]. While causality cannot be inferred from this cross-sectional design, the clear gradient in pain scores by vitamin D status suggests that deficiency may contribute to the severity of chronic pain among these women.

Frequency of consumption of vitamin D-rich foods among participants

Dietary assessment revealed generally low consumption of vitamin D-rich foods among participants. For example, only 24.55% consumed fatty fish ≥ 2 times per week, 32.73% regularly ate egg yolks, and fewer than one in five reported regular intake of fortified dairy products or cereals. Vitamin D supplement use was extremely rare (5.45%). These findings highlight a major dietary gap that likely exacerbates deficiency risk, particularly for individuals with limited sun exposure due to clothing or lifestyle [19–22].

Limitations

This study has several important limitations. First, its cross-sectional design prevents establishing causality between vitamin D deficiency and chronic musculoskeletal pain severity. Second, vitamin D intake was assessed through self-reported dietary frequency without precise quantification, which may introduce recall bias. Third, the sample was limited to Northern Muslim women residing in an urban area of Port Harcourt, potentially limiting generalisability to rural settings or other ethnic and religious groups. Additionally, other potential determinants of vitamin D status, such as skin pigmentation, seasonality, and genetic factors, were not assessed. Despite these limitations, the study provides valuable insights into the high burden of vitamin D deficiency and its correlates in a culturally defined, at-risk population.

Conclusions

This study demonstrates a high prevalence of vitamin D deficiency (65.0%) among Northern Muslim women with chronic musculoskeletal pain residing in Port Harcourt, Rivers State, Nigeria. Independent predictors of deficiency included full-body covering, low outdoor activity, and low dietary intake of vitamin D-rich foods. Furthermore, vitamin D deficiency was associated with significantly higher self-reported pain severity. These findings underscore the multifactorial nature of vitamin D deficiency in this population, shaped by cultural clothing practices, behavioral factors, and limited dietary sources. Addressing this public health issue requires culturally sensitive strategies to improve awareness, promote safe sun exposure, and enhance dietary vitamin D intake.

Recommendations

Based on these findings, the following recommendations are proposed:

1. Healthcare providers should routinely screen at-risk women and offer guidance on sun exposure, diet, and supplements.
2. Public health authorities should run culturally sensitive awareness campaigns and support food fortification.
3. Community and religious leaders should promote safe sun exposure within cultural norms.

4. Nutrition stakeholders should improve access to vitamin D-rich and fortified foods.
5. Researchers should explore long-term outcomes and test targeted interventions.

Abbreviations

BMI: Body Mass Index

ELISA: enzyme-linked immunosorbent assay

UVB: ultraviolet B

VAS: Visual Analogue Scale

Declarations

Acknowledgments

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Author contributions

GJO: Conceptualization, Investigation, Writing—original draft, Writing—review & editing, Formal analysis. RHA: Conceptualization, Investigation, Writing—original draft, Writing—review & editing. KAO: Validation, Writing—review & editing, Supervision. All authors read and approved the submitted version.

Conflicts of interest

The authors declare that they have no conflicts of interest.

Ethical approval

The study was approved by the Research Ethics Committee of Rivers State University, Port Harcourt, Rivers State, Nigeria (Approval No. RSU/REC/2025/112).

Consent to participate

Informed consent to participate in the study was obtained from all participants.

Consent to publication

Informed consent to publication was obtained from relevant participants.

Availability of data and materials

The data supporting the findings of this study will not be shared due to participant confidentiality and ethical restrictions. However, authors are willing to respond to reasonable questions from readers.

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