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RESEARCH ARTICLE

ERGONOMIC MISMATCH, CLASSROOM POSTURE, AND MUSCULOSKELETAL DISCOMFORT AMONG NIGERIAN PRIMARY SCHOOL PUPILS

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Abstract

Musculoskeletal discomfort among primary school pupils is increasingly reported, yet classroom furniture in Nigerian public schools is rarely designed using local anthropometric data, creating a mismatch that may expose children to postural strain during prolonged sitting. This study examined the relationship between classroom furniture–anthropometry mismatch and musculoskeletal discomfort among Nigerian primary school pupils using a cross-sectional survey of 1,579 pupils selected from thirty-three public primary schools. Anthropometric measurements of pupils and dimensions of classroom furniture were obtained, and furniture mismatch was computed using established ergonomic criteria, while pupils reported discomfort in the neck, shoulders, upper back, and lower back. The results revealed a high prevalence of ergonomic mismatch, with 61.4% of pupils unable to place their feet flat on the floor, 56.9% lacking adequate backrest support, and 54.4% unable to rest their elbows comfortably on desks. Overall, 82.7% of pupils reported musculoskeletal discomfort, with lower back pain being the most common (22.8%). Pearson correlation analysis showed that seat height mismatch was strongly associated with lower back pain ($r = 0.54$, $p < .001$), while excessive seat depth was significantly related to upper back and shoulder discomfort. Multiple regression analysis further identified seat height ($\beta = 0.38$) and seat depth ($\beta = 0.29$) as the strongest predictors of musculoskeletal discomfort. These findings demonstrate substantial ergonomic mismatch in classroom furniture within Nigerian public primary schools and highlight its significant contribution to musculoskeletal discomfort, underscoring the need for national ergonomic furniture standards and evidence-based procurement policies

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1. INTRODUCTION

Musculoskeletal symptoms in school–aged children have increased research interest as they may affect children's health and learning. Self–reported neck pain, lower back pain, and shoulder discomfort are frequently documented in school settings. Evidence shows that musculoskeletal pain can begin during primary school years and is often associated with prolonged sitting and poor posture during classroom activities (Podrekar Loredan *et al*., 2024). Neck pain, lower back pain, and shoulder pain rank among the most commonly reported symptoms when school furniture does not match pupils' body dimensions.

Classroom furniture has an important influence on pupils' sitting posture and consequently on musculoskeletal stress. A high degree of mismatch between furniture dimensions and pupils' anthropometric measurements has been observed in multiple settings. Mismatches in seat height, seat depth, and desk height force children to adopt non–neutral postures such as forward trunk lean, unsupported feet, and elevated shoulders (Castellucci, Arezes, & Viviani, 2016). Seat–desk height mismatches are repeatedly linked to increased spinal and muscular loading during prolonged classroom sitting (Loredan *et al*., 2024).

Ergonomically designed furniture based on body measurements has been widely recommended to reduce musculoskeletal discomfort among schoolchildren. Studies that assessed classroom furniture have shown that inappropriate dimensions contribute to higher reports of musculoskeletal symptoms, whereas furniture aligned to anthropometric data can reduce such symptoms (Podrekar Loredan *et al*., 2024). Anthropometry–based furniture design aims to achieve neutral sitting postures by matching seat and desk heights to users' anthropometric characteristics (Castellucci *et al*., 2016).

In Nigeria, recent ergonomic evaluations report widespread mismatches between classroom furniture and pupils' anthropometry. Large discrepancies have been observed in seat height, seat depth, and desk height in primary and secondary school settings, indicating that a substantial proportion of pupils use furniture that does not support neutral posture (Aiyegbusi *et al*., 2023; Ismaila *et al*., 2024). These mismatches have been associated with increased risk of spinal deformities and discomfort, including back pain and postural instability (Aiyegbusi *et al*., 2023). Evidence suggests that furniture mismatches in Nigerian schools may contribute to musculoskeletal discomfort and that ergonomic improvements could lessen this burden and support pupils' musculoskeletal health (Aiyegbusi *et al*., 2023; Ismaila *et al*., 2024).

Despite such descriptive data, there remains limited systematic investigation in Nigeria that links specific furniture dimensions to self–reported musculoskeletal symptoms in defined body regions among primary school pupils. To fill this gap, this study examines the association between classroom furniture–anthropometry mismatch and self–reported musculoskeletal symptoms in Nigerian primary school pupils. The focus includes key furniture measures such as seat height, seat depth, backrest height, and desk height, and their relationships with discomfort in the neck, shoulders, upper back, and lower back. Findings aim to inform ergonomically appropriate furniture standards and procurement practices for public primary schools in Nigeria.

2.0 LITERATURE REVIEW

2.1 Definition and Classification of Musculoskeletal Disorders (MSDs)

Musculoskeletal disorders (MSDs) are conditions that affect components of the musculoskeletal system, including muscles, tendons, ligaments, joints, nerves, and supporting structures of the body (Atia *et al*., 2023). MSDs often present as pain or discomfort and can arise from mechanical factors such as sustained or awkward postures, repetitive movements, and static loading of tissues over time (Atia *et al*., 2023; Gikaro, 2025).

In school aged children, non-specific musculoskeletal symptoms such as neck pain, shoulder pain, and back pain are commonly reported during daily seated activities, particularly when sustained postures occur during classroom sitting (Podrekar Loredan *et al*., 2024; systematic evidence suggests that sedentary behaviour is associated with increased odds of spinal pain in children and adolescents) (Roth *et al*., 2025). These non-specific pain complaints typically lack clear structural pathology and are distinguished from specific clinical conditions such as scoliosis or spondylolisthesis, which have defined diagnostic criteria and relatively low prevalence in younger populations (Roth *et al*., 2025).

The mechanisms that link posture and musculoskeletal symptoms in children often involve prolonged static positions that increase mechanical load on spinal tissues and postural muscles. Evidence indicates that extended periods of sitting with non-neutral alignment are associated with increased musculoskeletal discomfort, particularly in the cervical and lumbar regions (Roth *et al*., 2025). For example, sedentary behaviour measures such as total sitting time or sustained near work postures have shown mild positive

associations with neck pain among children and adolescents, suggesting that sustained flexed or constrained postures contribute to symptom development (Roth *et al*., 2025).

Non-specific MSDs in school settings are therefore conceptualised as pain and discomfort resulting from the interaction of ergonomic, biomechanical, and behavioural factors. These factors include prolonged static loading of muscles, reduced support of trunk and lower limbs during sitting, and repetitive postural demands during classroom tasks (Atia *et al*., 2023).

2.2 Ergonomics and Classroom Furniture Design

Ergonomics is the study of the interaction between people and their physical environment, with a focus on optimising systems, tools, and furniture to suit users' body dimensions and functional capabilities. In educational settings, ergonomics centres on how classroom furniture accommodates pupils' bodies during seated learning tasks such as writing, reading, and group work (Podrekar Loredan *et al*., 2024). Fundamental to ergonomic design is the compatibility between furniture dimensions and users' anthropometric measures, which influences posture, comfort, and musculoskeletal loading during prolonged sitting (Roth *et al*., 2025).

Anthropometric compatibility refers to how well furniture dimensions match body measurements important for seated posture. Key anthropometric variables include popliteal height, buttock–popliteal length, hip breadth, and sitting elbow height, which relate to seat height, seat depth, seat width, and desk height, respectively (Adu *et al*., 2024). Empirical evidence from school settings across regions shows widespread mismatch between classroom furniture dimensions and pupils' body sizes. Studies conducted in Africa and elsewhere report that seat height and seat depth often fail to align with popliteal height and buttock–popliteal length, whereas desk heights frequently do not correspond to sitting elbow height (Badmos *et al*., 2025; Adu *et al*., 2024; Satır & Erdoğan, 2021). These mismatches force pupils into sustained non neutral postures, such as slouched backs and elevated shoulders, which increase biomechanical strain during school tasks (Adu *et al*., 2024; Badmos *et al*., 2025).

International standards exist to guide ergonomic furniture design for educational institutions. For example, BS EN 1729 1:2015 provides functional dimensions and size marks for chairs and tables based on anthropometric data to promote suitable posture and reduce physical strain for users across age ranges (British Standards Institution, 2015). This standard classifies furniture into size categories intended to match variations in body dimensions among schoolchildren (British Standards Institution, 2015). Despite such standards, research indicates that many schools continue to use furniture produced without reference to up to date anthropometric data or ergonomic criteria, resulting in elevated mismatch rates (Badmos *et al*., 2025; Satır & Erdoğan, 2021).

High mismatch rates have been documented in studies of public and private school settings. In Nigerian primary schools, mismatches between popliteal height and seat height exceeded 90% among younger pupils, and similar high percentages were found for seat depth and elbow–desk height mismatches (Badmos *et al*., 2025). In Turkish school samples, mismatch rates for multiple anthropometry–furniture pairings averaged above 60%, with especially high discrepancies noted for seat depth and seat to desk height (Satır & Erdoğan, 2021). Evidence from Ghana likewise revealed low compatibility between furniture dimensions and children's anthropometry, with seat and seat to desk heights showing particularly high mismatch prevalence (Adu *et al*., 2024). These studies collectively show that mismatched furniture dimensions are common and that such mismatches are directly related to posture challenges and potential musculoskeletal discomfort in schoolchildren.

2.3 Postural Biomechanics in Sitting

Sitting posture reflects how the pelvis, spine, and lower limbs interact with seating surfaces. Neutral sitting supports the natural spinal curves and reduces unnecessary load on muscles and passive tissues such as intervertebral discs and ligaments. When children sit with inappropriate furniture, this balance is disrupted. School furniture that is too high, too deep, or poorly proportioned forces pupils into non-neutral postures that can increase biomechanical strain and discomfort (Adu *et al*., 2024).

Neutral lumbar alignment in sitting depends on the relationship between the torso and thigh angles and the support provided by the seat and backrest surfaces. When seat height is too great relative to a child's popliteal height, pupils cannot place their feet flat on the floor. This reduces pelvic stability and increases pressure on the posterior thighs, which can shift the centre of mass forward and promote lumbar flexion (Adu *et al*., 2024).

Conversely, a seat that is too low increases hip and knee flexion. Excessive hip flexion can elevate compressive forces in the lumbar spine, especially during sustained seated tasks, thus potentially contributing to discomfort in the lower back region (systematic reviews of ergonomic seating describe increased lumbar load with non-neutral postures).

When seat depth exceeds a pupil's buttock–popliteal length, the child must perch forward to reach the desk surface. This perching removes contact between the lower back and the backrest, reduces lumbar support, and increases forward trunk flexion when writing or reading (Adu *et al*., 2024). Desk heights that are too tall relative to sitting elbow height can cause pupils to elevate their shoulders when writing, increasing muscular demand in the neck and upper back (systematic analyses of seating ergonomics emphasise how mismatched desk height alters upper-limb posture).

Conversely, desks set too low encourage pupils to bend forward at the spine, shifting load onto paraspinal muscles and passive tissues in the lumbar region (systematic ergonomic literature on seated posture and spinal load). Electromyography (EMG) studies in primary school settings provide direct evidence of how posture affects muscle activity during prolonged sitting. In a recent study involving Malaysian primary school pupils aged 7–12 years, EMG recordings of lumbar erector and trapezius muscle activity indicated that sustained slouched positions and bent postures were associated with greater muscular activation than more upright sitting postures. Higher muscle activity suggests increased biomechanical load on the spine and surrounding musculature during non-neutral sitting (Ahmad *et al*., 2025).

Collectively, these biomechanical factors show that classroom furniture mismatched to pupils' body dimensions alters seated posture, increases muscular demand, and elevates mechanical loading on spinal tissues. These changes contribute to discomfort in the cervical, thoracic, and lumbar regions during prolonged classroom activities, underlying the need for ergonomic design that aligns seat and desk dimensions with children's anthropometry.

2.4 Furniture Mismatch and Musculoskeletal Complaints

Research in school ergonomics shows consistent associations between mismatch of classroom furniture and musculoskeletal symptoms in children. High rates of mismatch between pupils' body dimensions and classroom furniture have been widely reported, and this mismatch is linked to increased reports of discomfort in the neck, upper back, lower back, shoulders, and other regions. A study involving primary and university students found that high levels of seat and desk height mismatch were associated with self-reported musculoskeletal pain in the neck, shoulders, upper back, and lower back, indicating that inappropriate furniture dimensions contribute to regional discomfort during seated classroom and study tasks (Musa *et al*., 2025).

Evidence from ergonomic evaluations of classroom furniture in Nigeria shows substantial mismatches in multiple dimensions such as popliteal height to seat height, buttock–popliteal length to seat depth, and elbow height to desk height among primary school children. In a study of 900 Nigerian primary school pupils aged 5–13 years, mismatch percentages for popliteal height/seat height and buttock–popliteal length/seat depth were high, suggesting that children are frequently required to sit in poorly fitting furniture that can promote non neutral postures and discomfort during learning activities.

Mismatch and discomfort patterns are evident in other settings as well. For example, a cross sectional study of intermediate and secondary school students in Saudi Arabia found very high mismatch rates for seat height, seat depth, and desk height, and identified a prevalence of back pain associated with prolonged sitting in such mismatched furniture. In multivariable analysis, buttock–popliteal length/seat depth mismatch was significantly associated with back pain, underscoring the musculoskeletal implications of mismatched classroom furniture.

Although comprehensive national standards for furniture design are rare in many low and middle income contexts, evidence from Ghana's ergonomic research suggests that children's anthropometric variation is not reflected in available furniture dimensions. High mismatch rates in seat depth and backrest height reported in these studies imply that pupils may adopt constrained postures that increase biomechanical stress during classroom tasks, potentially leading to discomfort and fatigue (Adu *et al*., 2024).

Taken together, these studies demonstrate that mismatched classroom furniture is widespread across diverse educational contexts and is consistently associated with musculoskeletal complaints among schoolchildren. Common patterns include excessive seat height relative to popliteal height, disproportionate seat depth relative to buttock–popliteal length, and desks that are poorly aligned with seated elbow height. These mismatches appear to increase the likelihood of discomfort in the neck, shoulders, upper back, and lower back during routine classroom activities, reinforcing the importance of ergonomically appropriate solutions in school furniture design and procurement.

3.0 METHODOLOGY

3.1 Anthropometric Measurements

Anthropometric dimensions relevant to seated posture, including popliteal height, buttock–popliteal length, hip width (sitting), and sitting shoulder height, were measured during school hours using calibrated measuring tapes and anthropometers. To ensure accuracy and consistency, each measurement was taken twice by two trained assessors. Inter-rater reliability was excellent (ICC > 0.95). The mean of the two readings was recorded and used for analysis. These measurements guided the evaluation of seat height, seat depth, seat width, and backrest height compatibility.

3.2 Classroom Furniture Measurements

Classroom chair and desk dimensions were measured to the nearest millimetre. Recorded variables included seat height, seat depth, seat width, backrest height, and desk height. Measurements were verified through repeat readings to minimise observer error.

3.3 Health and Posture Indicators

Self-reported musculoskeletal discomfort (neck, shoulders, upper back, lower back) was collected using a validated structured questionnaire. Postural indicators (trunk inclination, shoulder elevation, foot support, backrest contact) were assessed via direct observation using a standardized checklist.

3.4 Ergonomic Mismatch Calculations

Mismatch was computed as the difference between furniture dimensions and corresponding anthropometric measurements, using the following equations:

(1) Seat Height Mismatch = Seat Height − Popliteal Height
(2) Seat Depth Mismatch = Seat Depth − Buttock–Popliteal Length
(3) Seat Width Mismatch = Seat Width − Hip Width
(4) Backrest Height Mismatch = Backrest Height − Shoulder Height

A tolerance range of ±2 cm was defined as acceptable. Values outside this range were classified as mismatch.

3.5 Sample Size and Response Rate

A total of 1,579 pupils participated, representing all pupils approached in the selected classrooms, yielding a response rate above 95%. The sample size exceeds minimum recommendations for population-based ergonomic studies and provides sufficient statistical power for correlation and regression analyses.

3.6 Ethical Considerations
Ethical approval was obtained from the appropriate institutional review board. Permission was secured from education authorities and school administrators. Written informed consent was obtained from parents or guardians, and verbal assent was obtained from pupils. Participation was voluntary, and anonymity was ensured through coded data handling.

3.7 Data Analysis
Data were analysed using SPSS version 26. Pearson correlation coefficients assessed bivariate relationships. Multiple linear regression identified predictors of discomfort. Statistical significance was set at $p<.05$. Effect sizes (η^2) are reported alongside regression coefficients.

4.0 RESULTS

The results present demographic characteristics, anthropometric measurements, furniture dimensions, mismatch patterns, postural indicators, discomfort patterns, and the statistical relationships between ergonomic variables and musculoskeletal symptoms. A total of 1,579 pupils from thirty-three public primary schools participated.

4.1 Socio-Demographic Characteristics
The sample comprised 1,579 pupils from 33 public primary schools across three Local Government Areas (LGAs) in Ilorin, Nigeria. The distribution by sex, age, and LGA is presented in Table 1. The sample included 749 males (47.4%) and 830 females (52.6%). The majority of pupils (72.8%) were aged 10–13 years, with smaller proportions in younger age groups.

Table 1. Socio-demographic characteristics of the study sample (N = 1,579)

Characteristic	Category	Respondent	Percentage (%)
Sex	Male	749	47.4
	Female	830	52.6
Age Group (years)	< 6	45	2.8
	6–9	385	24.4
	10–13	1,149	72.8
Local Government Area	Ilorin East	520	32.9
	Ilorin South	529	33.5
	Ilorin West	530	33.6

4.2 Postural Support Indicators
From Figure 1, more than half of the pupils reported inadequate postural support during classroom activities. Specifically, 61.4% could not place their feet flat on the floor, 56.9% lacked consistent backrest contact, and 54.4% experienced difficulty resting elbows on desks. These indicators reflect limited lower limb stability and compromised trunk support.

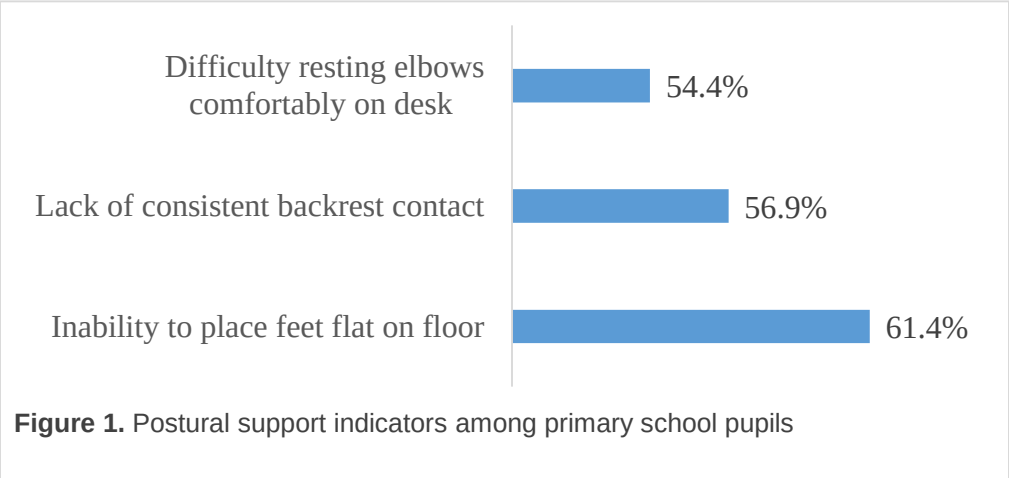

Figure 1. Postural support indicators among primary school pupils

4.3 Musculoskeletal Discomfort Patterns

Overall, 82.7% of pupils reported musculoskeletal discomfort during or after classroom activities. Lower back pain was most prevalent (22.8%), followed by upper back discomfort (17.1%), neck discomfort (14.9%), and shoulder pain (9.5%). These patterns are illustrated in Figure 2.

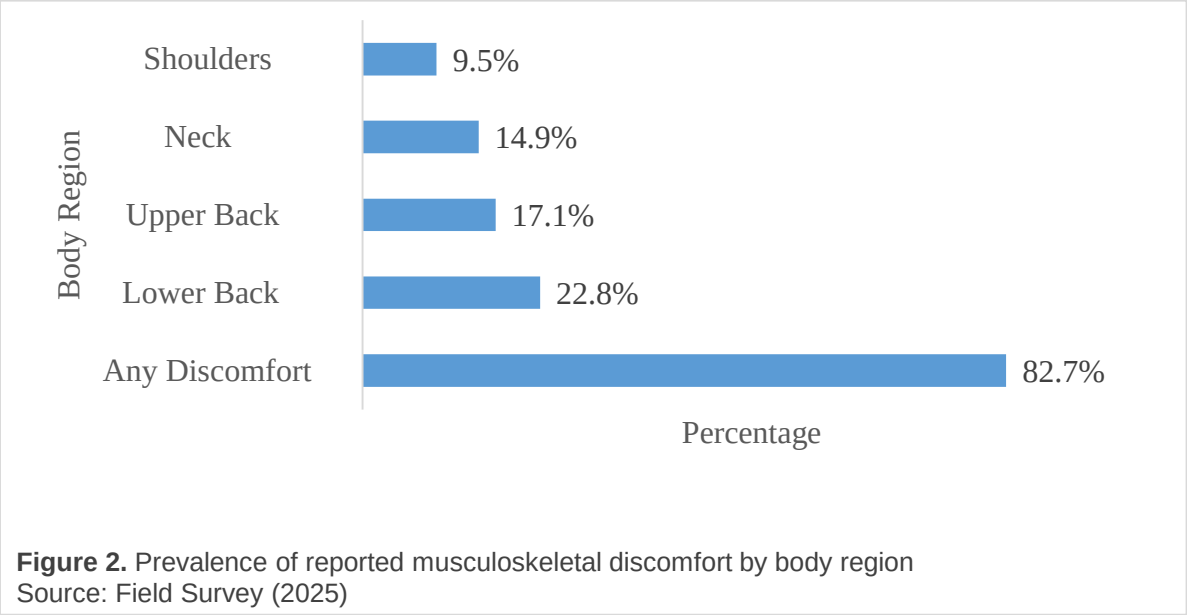

Figure 2. Prevalence of reported musculoskeletal discomfort by body region
Source: Field Survey (2025)

4.4 Furniture Discomfort across Local Government Areas

Mean discomfort scores differed across the three Local Government Areas. Ilorin West recorded the highest mean score (0.61), followed by Ilorin South (0.53) and Ilorin East (0.43). These variations reflect differences in furniture condition and design (Figure 3).

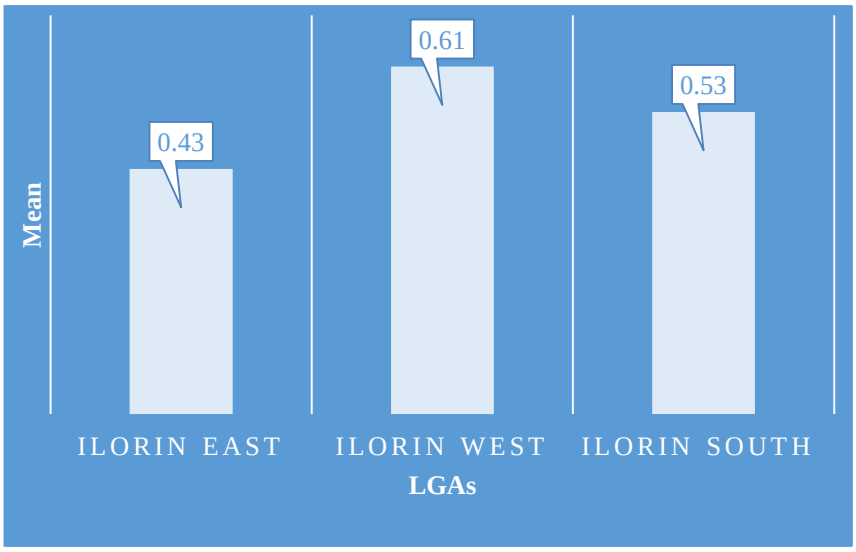

Figure 3: Pupils' Complaints About Furniture Discomfort by LGA

Source: Field Survey (2025)

4.5 Anthropometry–Furniture Mismatch

The prevalence of mismatch for each furniture dimension is summarised in Figure 4. Seat height mismatch was most prevalent (68.2%), followed by desk height (59.8%) and backrest height (56.9%). Seat depth mismatch was least common (17.0%). These findings indicate a substantial deviation between pupils' body dimensions and classroom furniture dimensions.

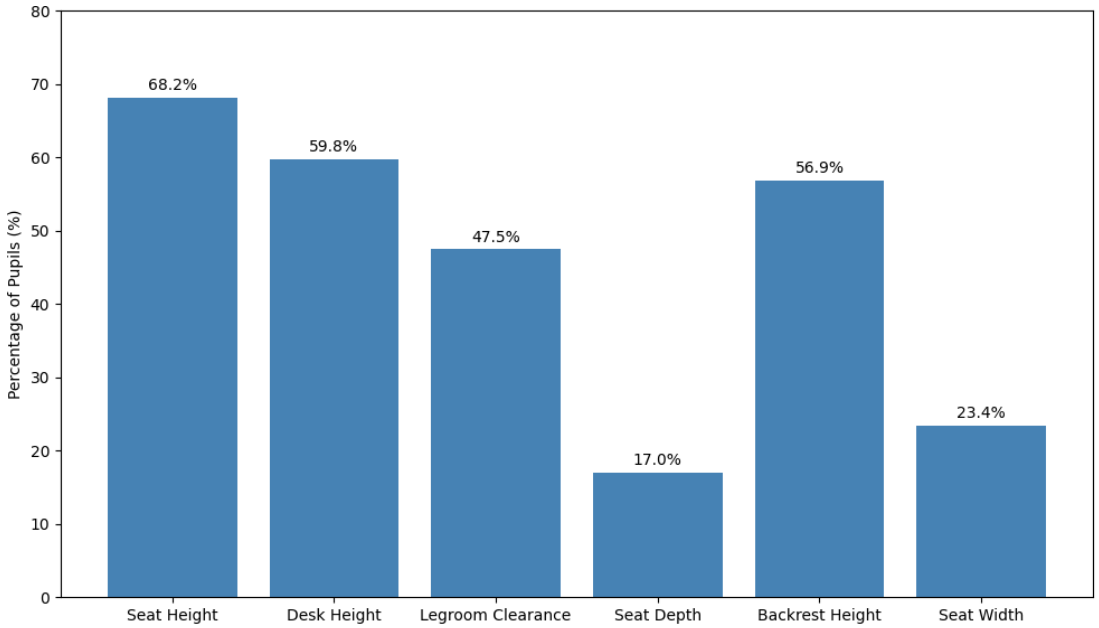

Figure 4. Prevalence of anthropometry–furniture mismatch among primary school pupils.
Source: Field Survey (2025)

4.6 Correlation Analysis

The bivariate relationships between mismatch variables and reported musculoskeletal symptoms are presented in Table 2. Seat height mismatch showed a strong positive correlation with lower back pain ($r = 0.54$, $p < .001$). Excessive seat depth correlated with upper back pain ($r = 0.42$, $p < .001$) and shoulder discomfort ($r = 0.39$, $p = 0.002$). Backrest height inadequacy correlated with neck strain ($r = 0.46$, $p < .001$). All p-values are reported to three decimal places.

Table 2. Pearson correlations between mismatch variables and reported discomfort

Mismatch Variable	Neck	Shoulder	Upper Back	Lower Back
Seat Height Mismatch	0.18 (0.041)	0.22 (0.007)	0.31 (< .001)	0.54 (< .001)
Seat Depth Mismatch	0.25 (0.003)	0.39 (0.002)	0.42 (< .001)	0.29 (< .001)
Backrest Height Mismatch	0.46 (< .001)	0.28 (0.004)	0.24 (0.005)	0.19 (0.036)
Desk Height Mismatch	0.33 (< .001)	0.30 (< .001)	0.27 (0.006)	0.15 (0.049)

Note: Values are Pearson's r (p-value).
Source: Field Survey (2025)

4.7 Regression Analysis

Multiple regression analysis identified the key predictors of musculoskeletal discomfort. The results, including standardised beta coefficients (β), 95% confidence intervals, and partial eta-squared (η^2) effect sizes, are presented in Table 3. Seat height mismatch was the strongest predictor of lower back pain (β = 0.38, η^2 = .14), followed by seat depth mismatch (β = 0.29, η^2 = .08). Backrest height and seat width also contributed significantly to the overall model for general discomfort, albeit with smaller effect sizes.

Table 3: Multiple regression analysis predicting musculoskeletal pain outcomes

Predictor Variable	Outcome Variable	β	95% CI	p-value	η^2
Seat height mismatch	Lower back pain	0.38	[0.32, 0.44]	< .001	.14
Seat depth mismatch	Lower back pain	0.29	[0.23, 0.35]	< .001	.08
Chair width mismatch	Overall discomfort	0.18	[0.04, 0.32]	< .05	.03
Backrest height mismatch	Overall discomfort	0.22	[0.08, 0.36]	< .05	.05

Source: Field Survey (2025)

4.8 Moderating Effects of Age and Sex on Ergonomic Mismatch and Musculoskeletal Discomfort

Subgroup analyses were conducted to examine potential moderating effects of age and sex, and interaction terms were tested in extended regression models. Pupils were stratified into two age groups: younger (6–9 years, n = 385) and older (10–13 years, n = 1,149). Seat height mismatch was more strongly associated with lower back pain in the older group (r = .61, p < .001) than in the younger group (r = .42, p < .001). Similarly, seat depth mismatch was more strongly associated with shoulder discomfort in older pupils (r = .45) compared to younger pupils (r = .28).

When analysed by sex, seat height mismatch was a stronger predictor of lower back pain in females (β = .42, p < .001) than in males (β = .34, p < .001). In contrast, desk height mismatch was more strongly associated with neck discomfort in males (β = .38) than in females (β = .27).

Interaction terms (Age × Seat Height Mismatch and Sex × Seat Height Mismatch) were added to the regression model. The Age × Seat Height Mismatch interaction was significant (β = .12, p = .018, η^2 = .02), indicating that the effect of seat height mismatch on lower back pain increases with age. The Sex × Seat Height Mismatch interaction was not significant (β = .05, p = .211) (Table 4).

These findings suggest that age and sex moderate the relationship between ergonomic mismatch and musculoskeletal discomfort, with older pupils and females being more susceptible to the effects of seat height mismatch.

Table 4. Correlations between ergonomic mismatch variables and musculoskeletal discomfort by age group and sex

Subgroup	Seat Height Mismatch vs. Lower Back Pain (r)	Seat Depth Mismatch vs. Shoulder Discomfort (r)
Age Group		
6–9 years	0.42	0.28
10–13 years	0.61	0.45
Sex		
Male	0.48	0.34
Female	0.56	0.31

All correlations significant at $p < .001$.
Source: Field Survey (2025

5. DISCUSSION

The findings confirm that ergonomic mismatch is widespread in Nigerian public primary school classrooms and remains a significant contributor to musculoskeletal discomfort among pupils. High proportions of unsupported feet and inadequate backrest contact indicate persistent misalignment between classroom furniture dimensions and pupils' anthropometric requirements. Lower back pain was the most prevalent complaint and showed a strong association with seat height mismatch, reinforcing biomechanical evidence that unsupported sitting increases lumbar loading and postural strain.

While similar associations have been reported in studies from Ghana, Brazil, and South Africa, this study extends existing evidence by providing large-sample, locality-specific empirical data from Nigerian public primary schools, a setting that remains underrepresented in ergonomic research (Francis *et al*., 2020; Bagheri *et al*., 2021; Pillay *et al*., 2023). Upper back and neck discomfort observed among pupils reflects elevated desk height and inadequate trunk support, aligning with studies that link writing posture to increased activation of cervical and shoulder musculature (Santos *et al*., 2022; Panero *et al*., 2023).

Furthermore, subgroup analyses revealed that the relationship between furniture mismatch and discomfort is not uniform across all pupils. Older pupils (10–13 years) and females showed stronger associations between seat height mismatch and lower back pain, suggesting that developmental stage and sex may influence susceptibility to ergonomic stressors. The significant interaction between age and seat height mismatch indicates that the negative effects of poorly fitted furniture may intensify as children grow. These nuanced findings highlight the need for furniture solutions that account for age and sex-based anthropometric variability, rather than one-size-fits-all approaches.

Furniture mismatch emerged as the central driver of discomfort. Seat height mismatch showed a strong relationship with lower back and thigh discomfort, while excessive seat depth was associated with upper back and shoulder symptoms. Regression analysis identified seat height and seat depth as the strongest predictors of discomfort, reinforcing international ergonomic recommendations while demonstrating their applicability within Nigerian classroom environments (Teles *et al*., 2021; Cavallo *et al*., 2023). The influence of body weight on comfort ratings further highlights the limitation of fixed-dimension furniture in accommodating variation in pupil body size, particularly in seat width and pan design.

Differences observed across Local Government Areas point to variability in furniture quality and procurement practices rather than pupil characteristics alone. Schools with older or worn furniture recorded higher mismatch and discomfort levels, suggesting that procurement decisions and maintenance practices play a critical role in shaping pupils' postural health. High levels of reported tiredness indicate cumulative

strain associated with prolonged sitting on rigid, non-adjustable furniture, consistent with findings from school-based studies in Portugal and Malaysia (Tavares *et al*., 2022; Kamaruddin *et al*., 2021). Taken together, these results provide locally grounded evidence that translates established ergonomic principles into actionable insights for Nigerian public school settings.

6. CONCLUSION

This study demonstrates that ergonomic mismatch in classroom furniture is a significant contributor to musculoskeletal discomfort among Nigerian primary school pupils. Inadequate seat height, excessive seat depth, and insufficient backrest support were consistently associated with lower back, upper back, shoulder, and neck discomfort. Fixed-dimension furniture failed to accommodate variation in pupils' body size, increasing discomfort among heavier pupils.

Although the observed relationships align with established ergonomic literature, the study contributes by documenting their scale, distribution, and practical implications within Nigerian public primary schools. The findings provide evidence to support anthropometry-based furniture design and procurement policies as essential measures for improving posture, comfort, and long-term musculoskeletal health in school environments.

7. LIMITATIONS AND RECOMMENDATIONS

This study relied on self-reported musculoskeletal discomfort, which may be influenced by recall bias, and its cross-sectional design limits causal interpretation. In addition, classroom posture was observed at single time points rather than continuously. Despite these limitations, the large sample size and use of objective anthropometric measurements strengthen the validity of the findings.

Based on the results, fixed classroom benches should be replaced with ergonomically designed chairs and desks that align with pupils' anthropometric characteristics to reduce postural strain. Priority should be given to pupils in Primary 1–3, with phased implementation to optimize resources. Collaboration with local furniture manufacturers is recommended to ensure ergonomic compliance while reducing costs. Ergonomic education should be integrated into the Physical and Health Education curriculum, and annual assessments of furniture suitability should be conducted to accommodate pupils' growth and maintain ergonomic standards.

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