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MUSCULOSKELETAL IMPLICATIONS OF INAPPROPRIATE CLASSROOM FURNITURE AMONG NIGERIAN STUDENTS: AN ERGONOMIC AND ANTHROPOMETRIC ANALYSIS

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Abstract:

Background: The ergonomic suitability of classroom furniture plays a crucial role in students' comfort, posture, and overall musculoskeletal health. However, in many developing countries like Nigeria, school furniture often does not align with the anthropometric measurements of students, leading to discomfort and potential long-term health risks.

Objectives: This study aims to evaluate the mismatch between the anthropometric measurements of school children and the dimensions of classroom furniture in Lagos State, Nigeria. It also seeks to investigate the potential musculoskeletal implications of this mismatch on students' health.

Methods: A cross-sectional study was conducted among 164 students from public and private schools in Lagos State, aged 10-17 years. Multistage Sampling Technique with Simple Random Sampling used at each stage to select participants. Anthropometric measurements such as weight, stature, popliteal height, and elbow height (sitting) were taken using standard and appropriate instruments and also follow ISAK recommendation. Classroom furniture dimensions, including seat height, seat depth, and desk height were measured. The ergonomic fit of the furniture was assessed by comparing students' body dimensions with furniture dimensions. Pain and discomfort were graded using a Visual Analog Scale (VAS).

Results: The study revealed significant mismatches between the students' anthropometric measurements and the classroom furniture dimensions, particularly in popliteal height vs. seat height, buttock-popliteal length vs. seat depth, and elbow height (sitting) vs. desk height. However, there are some furniture dimension which match the students' anthropometry measurements. Furthermore, the outcome of pain for students' varies across age groups and school category.

Conclusions: The findings highlight the urgent need for ergonomically designed classroom furniture that aligns with the anthropometric characteristics of Nigerian school children. Properly fitted furniture could reduce discomfort and prevent musculoskeletal issues, thereby promoting better health and learning outcomes. Policymakers and school authorities should prioritize adjustable or size-appropriate furniture to cater to the diverse needs of students.

Keywords: Anthropometry, Ergonomics, Classroom Furniture, Musculoskeletal, Discomfort.

INTRODUCTION

Classroom furniture plays a fundamental role in the educational environment, impacting not only students' comfort and posture but also their overall health and academic performance. Ergonomically designed furniture is intended to support students' natural posture, reducing the risk of musculoskeletal strain and injury. However, in many developing countries,

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including Nigeria, the design and implementation of school furniture often fail to meet these ergonomic standards, leading to a host of health issues for students. (Fidelis et al., 2018)(Fidelis et al., 2019)
This mismatch can force students into awkward sitting positions, leading to poor posture. Over time, these suboptimal postures can cause discomfort, strain injuries, and long-term musculoskeletal problems such as back pain, neck pain, and shoulder issues. (Obinna et al., 2021, Iliev et al., 2023).

The issue of furniture mismatch is particularly pronounced in Nigeria due to a combination of factors. These include the mass production of standard-sized furniture that does not account for the diverse anthropometric characteristics of the student population, limited resources for schools to invest in adjustable or varied furniture sizes, and a lack of awareness or emphasis on ergonomic design in educational settings. (Fidelis & Ogunlade, 2022) As a result, students across different age groups, particularly in primary and secondary schools, are subjected to furniture that is either too large or too small for their bodies. Prolonged use of such furniture can cause discomfort and pain, as well as having direct impact on the spine's posture and physical development during the growth period. (Hashim et al., 2012; Wami et al., 2023)

Ergonomic design principles advocate for furniture that is tailored to the specific needs of the user, taking into account factors such as height, weight, and body proportions. In the context of school environments, this means creating desks and chairs that support proper posture, allowing students to maintain a neutral spine position, feet flat on the floor, and arms at a comfortable angle for writing and other activities. When furniture is not ergonomically designed or mismatched to the user, the consequences can be significant, leading to discomfort, increased physical strain, and the development of chronic pain conditions.

This study focuses on Lagos State, Nigeria, and aims to evaluate the current standards of classroom furniture design, assess the extent of mismatch between children's body measurements and the furniture provided, and explore the potential musculoskeletal implications of this mismatch among Nigerian school children. Thus, it provides recommendations for improving classroom furniture design in Nigerian schools.

MATERIALS AND METHODS

The study participants were students from selected Secondary Schools in Lagos, State, Nigeria. A total of 164 students participated in the study from both private and public secondary schools. Representation across different socio-economic backgrounds was also ensured. Multistage sampling techniques and simple random sampling at each stage was adopted for the selection of schools and students.

The participants were drawn from age 10 to 17 with both gender, ensuring a representative sample of Nigerian school children. The sample size was determined using the formula presented by Parcells *et al*. (1999), Odunaiya *et al*. (2014), and Taifa and Desai (2017), which considers the population size and level of precision.
Applying the formula, the sample size was calculated as

$$n=\frac{(Z_\alpha + Z_\beta)(p_1q_1 + p_2q_2)}{(p_1-p_2)^2}$$

Where,
n= minimum sample size per group Z_α= % pt. normal distr. →5% confidence level= 1.96
Z_β = one-sided % pt. normal distr. – power = 0.84
Previous study by Fidelis *et. al*. (2022)
p_1 = prevalence of furniture mismatch in public school q_1= 1- p_1
p_2 = prevalence of furniture mismatch in private school q_2= 1- p_2
Sample >30 ok
(Araoye, 2004)

Anthropometric Measurements: In taking the anthropometric measurements, the procedure follow International Society for Anthropometric Analysis of Kinanthropometry (ISAK) recommendation.
The following anthropometric measurements were taken:

- Stature (body height)
- -Body Mass (Weight)
- Shoulder height (sitting)
- Elbow height (sitting)
- Popliteal height:
- Thigh thickness (thigh clearance).
- Hip width
- Buttock-popliteal length

These measurements were taken using Lufkin tape, measuring tape, a skinfold caliper, and a ruler. The tools were calibrated before use to ensure accuracy. Each measurement was taken three times, and the average was recorded to minimize errors.

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Furniture Dimension

The following furniture dimensions were taken as well;

Seat height	Seat depth	Seat width
Back rest height	Desk height	Seat-desk clearance

These dimensions were compared against the students' anthropometric data to assess the level of mismatch.

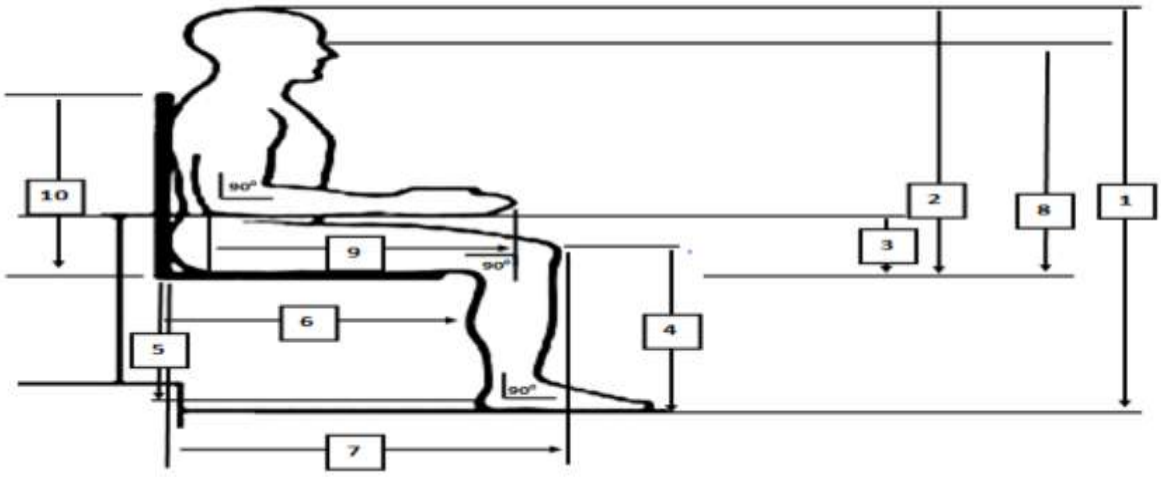

Fig 5: Some of the Measured Anthropometry Data in the Frankfurt Plane

1 – Sitting Stature 2 – Sitting Height3 – Sitting Elbow Height 4 – Sitting Knee Height 5 – Popliteal Height 6 – Buttock Popliteal Height 7 – Buttock Knee Length 8 – Sitting Eye Height 9 – Forearm Hand Length 10 – Sitting Shoulder Height

Ergonomic Suitability Assessment:

The ergonomic suitability of the classroom furniture was assessed by comparing the students' anthropometric data with the dimensions of the classroom furniture. This comparison aimed to identify any discrepancies that could lead to discomfort or musculoskeletal strain. The specific criteria for ergonomic suitability were based on established guidelines and ergonomic principles tailored to the students' anthropometric characteristics.

Pain Grading

To assess the impact of furniture mismatch on musculoskeletal discomfort, students were asked to report any pain or discomfort experienced while using the furniture. The pain was graded using a visual analog scale (VAS), where:

- 0 indicates no pain,
- 1-3 indicates mild, noticeable, non-interfering pain,
- 4-6 indicates moderate, interfering pain,
- 7-10 indicates severe, intense pain.

The VAS is a widely used tool for pain assessment and provides a subjective, measure of pain intensity (Hawker et al., 2011, chen et al., 2018).

Statistical Analysis

The data were analyzed using SPSS version 25.0 and MS-Excel. Descriptive Statistics were used to summarize the demographic data and anthropometric measurements. Match and Mismatch Analysis along with Pain Outcome carried out.

RESULTS

Table highlighted the composition of the participants. From the table and based on sex, both male and female shared equal percentage (50%), based on school, it was also equal percentage (50%) for both private and public school. In the age groups, the participants were equally distributed among the four age groups (25%)

Table 1: Socio-demographic characterization of the participants

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		Frequency	Percentage (%)
Sex	Male	82	50.0
	Female	82	50.0
Age Group	10-11	41	25.0
	12-13	41	25.0
	14-15	41	25.0
	16-17	41	25.0
School	Public School	82	50.0
	Private School	82	50.0

Table 2 show the summary of descriptive statistics for the variables under study. The mean (±standard deviation), minimum and maximum value of each variable according to gender and based on school were displayed.

Table 2: Descriptive summary of Anthropometry of Participants by School Category

School	**Public School**						**Private School**					
Sex	**Male**			**Female**			**Male**			**Female**		
Statistics / Variables	*Mean ± Std. Dev.*	*Min.*	*Max.*	*Mean ± Std. Dev.*	*Min.*	*Max.*	*Mean ± Std. Dev.*	*Min.*	*Max.*	*Mean ± Std. Dev.*	*Min.*	*Max.*
Weight (kg)	38.76 ±8.01	27.5	58.4	42.48 ± 8.88	27.4	64.7	41.07 ±8.43	26.2	61.4	43.95 ±9.55	27.4	67.2
Height (cm)	155.3 ±12.86	137.7	184.2	154.79 ±9.91	138	176	155.71 ±13.35	131.8	183	156.47 ±8.6	138	170
Students Sitting Height (cm)	76.33 ±9.9	37.4	107.7	81.46 ±5.46	70	93.2	75.73 ±11.12	31.2	90.2	81.06 ±5.99	62.9	90.8
Elbow Height Sitting (cm)	16.94 ±3.19	13	25.3	19.11 ±3.69	12.8	27	17.64 ±3.68	11.21	25.55	19.73 ±6.14	12.7	51.2
Buttock Popliteal Length (cm)	47.63 ±5.38	36	60	51.75 ±7.23	39.2	66.5	47.64 ±6.56	34.9	66	51.88 ±6.59	39.5	68.1
Hip Breadth (cm)	34.8 ±6.46	14.2	44.65	37.81 ±5.53	22.1	48.5	37.72 ±3.28	31.3	43.6	39.59 ±9.42	27	86
Thigh Clearance (mm)	17.75 ±3.17	11	26	18.1 ±2.24	13.6	24	18 ±2.27	14.3	23.15	17.8 ±2.55	12.65	24.4
Popliteal Height (cm)	41.39 ±3.7	35.2	49.5	40.61 ±3.83	33	51	40.74 ±3.31	34.6	47.57	40.35 ±3.18	33	46.8

Table 3 show the frequency of match and mismatches (low and high) of students' participants across age groups. The table highlight the match and mismatches of furniture dimension and body measurements compared. While the results varies from each other based on age groups, there are instances of outright mismatch and match as well.

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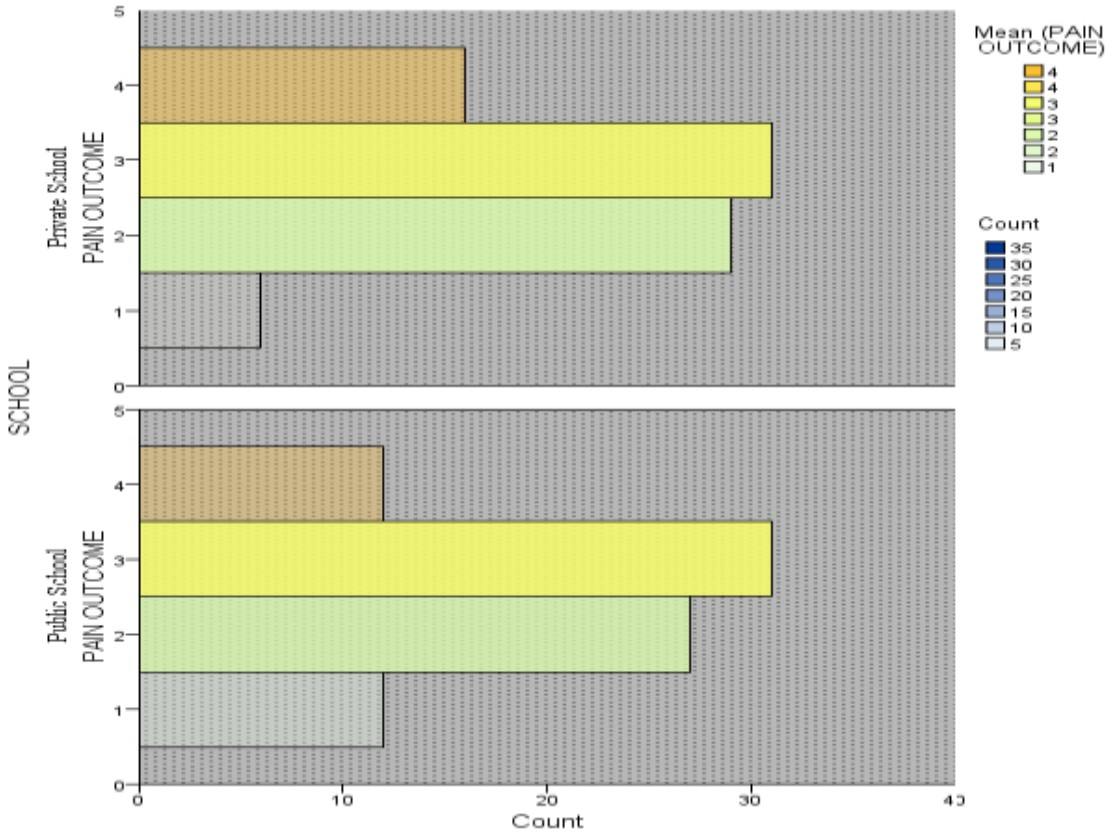
Table 3: Frequency of match and mismatches (low and high) according to age groups.

	PH and SH			**HB and SW**		
Result / Age Group	H.M.	M.	L.M.	H.M.	M.	L.M.
10 - 11	144	16	0	80	30	50
12 – 13	94	66	0	83	26	51
14 - 15	21	137	2	82	0	78
16 - 17	17	142	1	77	0	83
	BPL and SD			**TC and SDC**		
Result / Age Group	H.M.	M.	L.M.	H.M.	M.	L.M.
10 - 11	54	74	32	0	160	0
12 – 13	50	77	33	0	160	0
14 - 15	7	75	78	0	160	0
16 - 17	10	63	87	0	160	0
	EHS and DH			**SHS and BRH**		
Result / Age Group	H.M.	M.	L.M.	H.M.	M.	L.M.
10 - 11	160	0	0	0	160	0
12 – 13	160	0	0	0	160	0
14 - 15	160	0	0	14	139	9
16 - 17	160	0	0	2	110	48



Graph 1. Pain outcome of participants based on school

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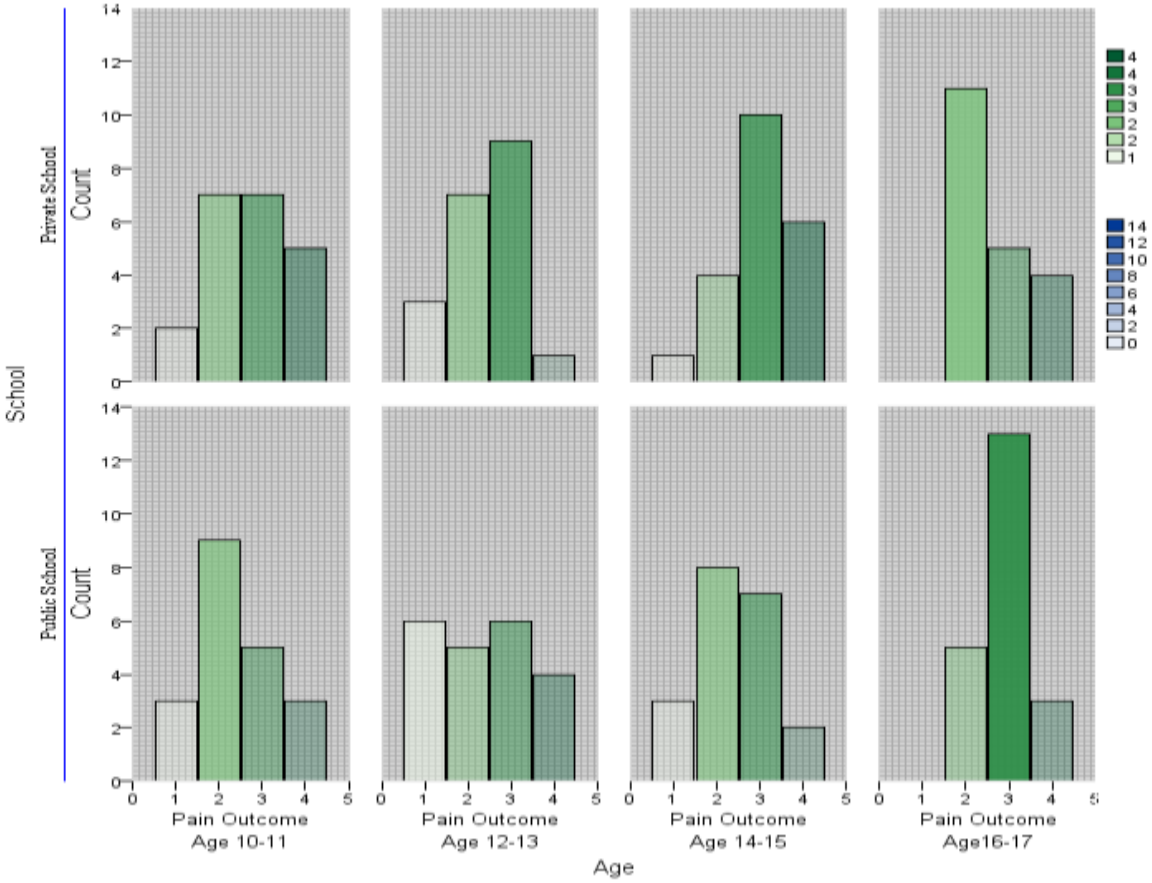

Graph 2. Pain outcome of students based on school and age groups.

Where, 1=No Pain 2=Mild Pain 3=Moderate Pain 4=Severe Pain

DISCUSSION

The findings from this study highlight a significant mismatch between the anthropometric measurements of Nigerian school children and the dimensions of the classroom furniture they use. This mismatch has substantial implications for the health, comfort, and academic performance of students, underscoring the urgent need for ergonomic intervention in the design and provision of classroom furniture in Nigerian schools.

Ergonomic Mismatch and Its Implications

The results show that a considerable number of students are using classroom furniture that is poorly fitted to their body dimensions, leading to discomfort and increasing the risk of musculoskeletal problems. Specifically, the mismatch between popliteal height and seat height was evident in a large proportion of the participants, which is concerning given that inadequate seat height can cause improper leg support. This can lead to increased pressure on the thighs and knees, contributing to discomfort and potential circulatory issues (Milanese & Grimmer, 2004; Murphy et al., 2007).

Similarly, the significant discrepancy between buttock-popliteal length and seat depth suggests that many students are forced to sit in positions that do not support the natural curve of the spine, increasing the likelihood of back pain and discomfort (Castellucci et al., 2010). The inadequacy in hip breadth vs. seat width further exacerbates this issue, as narrow seats can restrict movement and lead to discomfort in the hip region.

The mismatch between elbow height (sitting) and desk height is particularly problematic, as it can lead to strain in the shoulders and upper arms, hindering students' ability to write and perform other desk-based tasks comfortably. This finding is consistent with previous studies that have shown a strong correlation between desk height and shoulder strain, particularly in younger students whose anthropometric dimensions are more variable (Panero & Zelnik, 1979; Pheasant & Haslegrave, 2006; Kahya., 2019; Cadiz et al., 2021 Prasetyo et al., 2021; Wang et al., 2022; Fidelis & Ogunlade, 2022).

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Impact on Musculoskeletal Health

The analysis of pain and discomfort outcomes reinforces the ergonomic challenges identified in the mismatch analysis. A significant number of students reported experiencing moderate to severe pain, particularly in the neck, back, and legs. These findings align with those of previous studies that have documented the relationship between poorly designed classroom furniture and the development of musculoskeletal pain in school-aged children (Agha, 2010; Odunaiya et al., 2014). The frequent reports of back pain, especially among older students, suggest that prolonged exposure to poorly fitted furniture can have cumulative negative effects on musculoskeletal health.

Implications for Policy and Practice

The results of this study underscore the need for policymakers and educational authorities in Nigeria to prioritize the ergonomic design of classroom furniture. Given the significant variations in anthropometric measurements across different age groups, it is imperative that schools provide adjustable or varied furniture sizes to accommodate the diverse needs of students. This approach is supported by ergonomic design principles, which advocate for furniture that is tailored to the user's body dimensions to reduce the risk of discomfort and injury (Zandvliet & Straker, 2001; Bai, 2024).

Furthermore, the implementation of ergonomic furniture in schools could have broader benefits, including improved concentration, reduced absenteeism due to pain-related issues, and overall better academic performance. As educational institutions aim to create conducive learning environments, the importance of ergonomically suitable furniture cannot be overstated.

Limitations and Future Research

While this study provides valuable insights into the ergonomic challenges faced by Nigerian school children, it also has some limitations. The study was conducted in a limited number of schools within Lagos State, which may not fully represent the broader population of Nigerian students. Additionally, the study focused on secondary school students, and further research could explore similar issues in other educational settings, such as primary and tertiary institutions.

Future research should also consider longitudinal studies to assess the long-term impact of furniture mismatch on students' musculoskeletal health. Additionally, interventions aimed at improving furniture design and testing their effectiveness in reducing discomfort and pain could provide practical solutions for schools.

CONCLUSION

The study reveals a significant mismatch between the anthropometric measurements of Nigerian school children and the dimensions of the classroom furniture they use, with potential implications for musculoskeletal health and academic performance. The findings emphasize the need for ergonomic interventions in classroom furniture design to ensure that it meets the diverse needs of students, thereby promoting their health and well-being.

CONFLICT OF INTEREST

The authors declare that they have no competing interests.

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REFERENCES

[1]. Adeyemi, A. J., Lasisi, O. I., Ojile, P., & Abdulkadir, M. (2020). The effect of furniture intervention on the occurrence of musculoskeletal disorders and academic performance of students in North-West Nigeria. Work, 65(1), 195-203.
[2]. Agha, S. (2010). School furniture match to students' anthropometry in the Gaza Strip. Ergonomics 53 (5), 344–354.
[3]. Agha, S. R. (2010). Ergonomics: Standards for classroom furniture. _International Journal of Advanced Manufacturing Technology_, 46, 427–432.
[4]. Aiyegbusi, A.I., Gbiri, C.A., Oyeniran, T.O. (2023). Mismatch between school furniture dimensions and anthropometric parameters is a risk for spinal deformities in secondary school students in Lagos, Nigeria: a cross-sectional study. Bull Fac Phys Ther 28, 34 https://doi.org/10.1186/s43161-023-00145-8
[5]. Araoye,M. O(2004). Research Methodology with statistics for social sciences. Nathadex Publishers. Pg 69
[6]. Bai, Y., Kamarudin, K. M., & Alli, H. (2024). A systematic review of research on sitting and working furniture ergonomic from 2012 to 2022: Analysis of assessment approaches. Heliyon, 10(7), e28384. https://doi.org/10.1016/j.heliyon.2024.e28384
[7]. Bass, S., Delmas, P.D., Pearce, G., Hendrich, E., Tabensky, A., & Seeman, E. (1999). The differing tempo of growth in bone size, mass and density in girls is region-specific. Journal of Clinic Investigation 104 (6), 795–804.

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DOI 10.17148/IMRJR.2025.020103

[8]. Bhadrabati B, Farzana Bintay Z, Rahat A , Parvez M.S., Hogue A.S.M. (2014). Mismatch between classroom furniture and anthropometric measurements of Bangladeshi primary school students. International Conference on Mechanical, Industrial and Energy Engineering.25-26 December, Khulna, BANGLADESH
[9]. Bravo G, Braganca S, Arezes PM, Molenbroek JFM, Castellucci HI. (2018). A literature review of anthropometric studies of school students for ergonomics purposes: Are accuracy, precision and reliability being considered? DOI:10.3233/WOR-182719
[10]. Brewer, J., Davis, K., Dunning, K., & Succop, P. (2009). Does ergonomic mismatch at school impact pain in school children? Work: A Journal of Prevention, Assessment & Rehabilitation 34 (4), 455–464.
[11]. Cadiz R.G.D., Guerrero C.J.J., Gumasing M.J.J. (2021). Proceedings of the International Conference on Industrial Engineering and Operations Management. Ergonomic design of computer workstations of high school students studying at home; pp. 1311–1319.
[12]. Castellucci H.I., Arezes P.M., Molenbroek J.F.M. (2014). Applying different equations to evaluate the level of mismatch between students and school furniture. Appl. Ergon. 45(4):1123–1132. doi: 10.1016/j.apergo.2014.01.012.
[13]. Castellucci, H. I., Arezes, P. M., & Molenbroek, J. F. M. (2010). Analysis of the most relevant anthropometric dimensions for school furniture selection based on a study with students from one Chilean region. _Applied Ergonomics_, 41(4), 563–568.
[14]. Castellucci, H., Arezes, P., & Viviani, C. (2010). Mismatch Between Classroom Furniture and Anthropometric Measures in Chilean Schools. Applied Ergonomics 41 (4), 563–568.
[15]. Castellucci, H.I., Arezes, P.M., & Molenbroek, J.F.M. (2014). Applying different equations to evaluate the level of mismatch between students and school furniture. Applied Ergonomics, DOI: 10.1016/j.apergo.2014.01.012
[16]. Chen X, Yuan R, Chen X , Sun M, Lin S, Ye J, Chen C. (2018). Journal of Pain Research 11 1921–1926
[17]. Cotton, L., O'Connell, D., Palmer, P., & Rutland, M. (2002). Mismatch of school desks and chairs by ethnicity and grade level in middle school. Work: A Journal of Prevention, Assessment & Rehabilitation 18 (3), 269–280.
[18]. Dianat, I., Ali Karimib, M.,AslHashemic, A., & Bahrampour, S. (2013). Classroom furniture and anthropometric characteristics of Iranian high school students: Proposed dimensions based on anthropometric data. Applied Ergonomics 44 (1), 101–108.
[19]. Evans, W.A., Courtney, A.J., & Fok, K.F. (1988). The design of school furniture for Hong Kong school children: an anthropometric case study. Applied Ergonomics 1988 (19), 122–134
[20]. Fallon, E., & Jameson, C. (1996). An ergonomic assessment of the appropriateness of primary school furniture in Ireland. In In A.F. Ozok and G.Salvendy (Eds.), Advances in Applied Ergonomics. pp. 770–773
[21]. Farahani A , Shakib M. (2009)A Survey on Some Skeletal Disorders and Proportionality of Anthropometric Features of School furniture dimensions in primary students. World J Sport Sci. (2) 266-271
[22]. Fidelis OP, Ogunlade B, Adelakun SA, Adukwu O (2018) Ergonomic analysis of classroom furniture in a Nigerian University. Nigerian J Tech 37: 1154-1161
[23]. Fidelis OP, Ogunlade B, Adelakun SA, Adukwu O (2019) Anthropometric measures of young Nigerians for ergonomic furniture design Nigerian J Tech 37: 1154-1161
[24]. Fidelis, O. P., & Ogunlade, B. (2022). Anthropometric perspective to classroom furniture ergonomics and the need for standards in Nigerian schools. Work (Reading, Mass.), 72(1), 279–289. https://doi.org/10.3233/WOR-205317
[25]. Hashim A.M., Dawal S.Z.M., Yusoff N. (2012). Ergonomic evaluation of postural stress in school workshop. Work. 41(SUPPL.1):827–831. doi: 10.3233/WOR-2012-0249-827
[26]. Iliev B., Domljan D., Vlaović Z. (2023). Comparison of anthropometric dimensions of preschool children and chairs in kindergartens in north Macedonia, Bulgaria and Croatia. Heliyon. 9(3) doi: 10.1016/j.heliyon.2023.e14483.
[27]. Kahya E. (2019). Mismatch between classroom furniture and anthropometric measures of university students. Int. J. Ind. Ergon. 74 doi: 10.1016/j.ergon.2019.102864.
[28]. Milanese, S., & Grimmer, K. (2004). School furniture and the user population: An anthropometric perspective. _Ergonomics_, 47(4), 416–426.
[29]. Murphy, S., Buckle, P., & Stubbs, D. (2007). Classroom posture and self-reported back and neck pain in schoolchildren. _Applied Ergonomics_, 38(2), 155–163.
[30]. Noro, K., & Fujita, T., (1994). A fuzzy expert system for allocating chairs to elementary school children. In: Lueder, R., and K. Noro (Eds.), Hard Facts about Soft Machines: The Ergonomics of Seating. London: Taylor & Francis.
[31]. Obinna F.P., Sunday A.A., Babatunde O. (2021). Ergonomic assessment and health implications of classroom furniture designs in secondary schools: a case study. Theor. Issues Ergon. Sci. 22(1):1–14. doi: 10.1080/1463922X.2020.1753259.
[32]. Occhipinti, E., Colombini, O.,Frigo, C.,Pedotti, A., & Grieco, A. (1985). Sitting posture: analysis of lumbar stresses with upper limbs supported. Ergonomics 28 (9), 1333-1346.
[33]. Odunaiya, N. A., Owonuwa, D. A., & Oguntibeju, O. O. (2014). Ergonomic suitability of school furniture and possible health implications in a developing country. _African Health Sciences_, 14(1), 149–156.

International Multidisciplinary Research Journal Reviews (IMRJR)
A Peer-reviewed journal
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DOI 10.17148/IMRJR.2025.020103

[34]. Onawunmi, A. S., Oyawole, F.A., Dunmade, I. S (2016) Ergonomic assessment of School Furniture in Primary Schools in Nigeria. International Journal of Applied Science and Technology. 6 (1) 92-101
[35]. Orborne, D. (1996). Ergonomics at Work: Human Factors in Design and Development. 3rd edition Chihester: John Wiley & Sons
[36]. Oyewole, S. A., Haight, J. M., & Freivalds, A. (2010). The ergonomic design of classroom furniture/computer work station for first graders in the elementary school. International Journal of Industrial Ergonomics, 40 (4), 437–447
[37]. Panagiotopoulou, G., Christoulas, K., Papanickolaou, A., & Mandroukas, K. (2004). Classroom furniture dimensions and anthropometric measures in primary school. Applied Ergonomics 35 (2), 121-128.
[38]. Panero, J., & Zelnik, M. (1979). _Human Dimension & Interior Space: A Source Book of Design Reference Standards_. Whitney Library of Design.
[39]. Parcells, C., Stommel, M., & Hubbard, R. (1999). Mismatch of classroom furniture and student body dimensions. Journal of Adolescent Health 24 (4), 265–273.
[40]. Pheasant, S. (1984). Anthropometrics: An introduction for schools and colleges (PP7310). British Standards Institution, London.
[41]. Pheasant, S. (1991). Ergonomics, Work and Health. Hong Kong: Macmillan.
[42]. Pheasant, S. (2003). Bodyspace (Second.). London: Taylor & Francis.
[43]. Pheasant, S., & Haslegrave, C. M. (2006). _Bodyspace: Anthropometry, Ergonomics and the Design of Work_. CRC Press.
[44]. Prasetyo Y.T., Kumar A., Alyza J.P., Ong K.T.A.M., Siochi M.A., Ong A.K.S. (2021). Proceedings of the International Conference on Industrial Engineering and Operations Management. Evaluation of chair dimensions, anthropometric measurements and subjective comfort among Filipino high school students: a structural equation modelling approach; pp. 1738–1747.
[45]. Ramadan, M. (2011). Does Saudi school furniture meet ergonomics requirements? Work: A Journal of Prevention, Assessment & Rehabilitation 38 (2), 93–101.
[46]. Robertson MM, Huang YH, Lee J. (2017). Improvements in Musculoskeletal Health and Computing Behaviors: Effects of a Macroergonomics OfficeWorkplace and Training Intervention. Applied Ergonomics. 62:182-96.
[47]. Rudolf M, GriffithY. (2009). Evaluating the ergonomics of a student learning environment. WORK: A Journal of Prevention, Assessment & Rehabilitation. 34:475-80.
[48]. Wami S.D., Mekonnen T.H., Yirdaw G., Abere G. (2021). Musculoskeletal problems and associated risk factors among health science students in Ethiopia: a cross-sectional study. Journal of Public Health (Germany) 29(4):943–949. doi: 10.1007/s10389-020-01201-6.
[49]. Wang W.Q., Zhang J., Cai Y.C. (2022). Improvement of chair in ladder classroom based on human data and behavior investigation of college students. Lect. Notes Comput. Sci. 172–184. doi: 10.1007/978-3-031-05890-5_14. 13319 LNCS.
[50]. Zandvliet, D., & Straker, L. (2001). Physical and psychosocial aspects of the learning environment in information technology-rich classrooms. _Ergonomics_, 44(9), 838–857.