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Anthropometric Assessment of Classroom Furniture for Ghanaian School Children From Two Socio-Economic Areas

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Abstract

Children spend over 80% of their school time in a seated position yet, ergonomic principles are conservatively applied in adult workplaces without consideration for the school environment. This study assessed the compatibility of the school furniture of kindergarten and class one pupil in the Asokore Mampong and Oforikrom Municipalities, Ghana.

A cross-sectional analytic study was used. The research covered four selected basic schools from two socioeconomic suburbs (relatively high and relatively low socioeconomic areas).

The participants were chosen using stratified sampling. Anthropometric data were collected from 395 healthy pupils during regular class lessons. The student furniture dimensions were taken and compared with their anthropometry to identify potential matches or mismatches. For all sitting anthropometric parameters, students were seated in an upright position with 90º knees and elbow flexion.

The findings revealed a considerable level of discordancy between the measured furniture and the anthropometrics of the learners due to the negligence of user anthropometry during the construction of educational furniture. The seat depth was too deep for 80.51% of participants, only 15.19% had appropriate seat depth. The seat-to-desk height had a 25.06% match, 69.11% low mismatch, and 5.82% high mismatch. The match percentages of seat desk clearance, seat width, and desk depth were 72.91%, 66.08%, and 36.46% respectively. The match percentages of seat height were 24.61% for low socio-economic area schools and 12.25% for high socio-economic area schools. The seat height was too low for 45.55% of pupils from low socio-economic area schools and 62.25% of those from high socio-economic area schools. The seat depth was too deep for 91.62% of pupils from low socio-economic area schools and 70.10% of pupils from high socio-economic area schools.

The study revealed considerable incompatibility between the classroom furniture and the body dimensions of the pupils. Thus, the classroom furniture requires ergonomic improvements.

Keywords: anthropometry; furniture dimensions; ergonomic problems; school children.

Introduction

The musculoskeletal health of schoolchildren is a major concern around the world **[28]**. Children dedicate a considerable amount of time to school in a seated position **[29,6,7]**. The classroom is the work setting for students in kindergarten, elementary, high schools, and tertiary institutions. Children are repeatedly exposed to the hazards of uncomfortable postures as a result of unsuitable classroom furniture **[32,19]** emphasized that maintenance of good posture while seated is imperative among children. Many considerations, such as the anthropometric measurements, tasks performed in the classroom, and the designs of the furniture features **[32,23,4]**, can influence the postures of school children **[15]**. The anthropometry of children varies widely across different age groups, within the same age groups, between genders, and different cultures as well **[18]**. Considering these variations, it is not likely that school furniture intended for use by children with fixed dimensions will fit them all, yet students are mostly exposed to furniture with no opportunities for adjustments. Musculoskeletal strain caused by discomfort from furniture and attempts to create stability, especially in schoolkids, can result in fidgetiness, which discourages concentrated learning **[26]**. Prolonged sitting on unsuitable classroom furniture and defective postures such as flexed postures adopted by learners results in the manifestation of different musculoskeletal disorders. **[31]** investigated the prevalence of non-specific low back pain (LBP) amongst 10-18 year-old school children and found that the prevalence of LBP in the 10-14 year-olds was 21.5% while that of the 15-18 year-old was 38.2%. **[1]** highlighted a 57.5% prevalence of musculoskeletal pain among 255 Ghanaian junior high school students. They

revealed that the shoulder, neck, and wrist were the commonly affected parts of the body, as reported by the students. Children develop sitting habits at an early age, making it vital to inculcate good posture as early as possible **[14]**. Abysmal sitting habits developed during childhood are challenging to rectify during old age **[32,16]**. Several researches have been carried out in numerous countries to investigate the anthropometric parameters of learners and to assess the ergonomic suitability of their classroom desks. **[22]** conveyed that 60% of Dutch schoolchildren aged 4 to 12 used chairs that were too high for them. **[25]** measured the relevant body dimensions of 180 (90 boys and 90 girls) Greek learners aged 7 to 12 years from three basic educational institutions in Thessaloniki. They reported that schoolchildren's seats were too deep. **[17]** carried out an anthropometric study for 274 Greek students in the age range 6 to 18 years. They reported mismatches of 71.5% and 81.8% for chair height and table height respectively. **[21]** presented anthropometric data for one thousand one hundred and seventy-four pupils aged six to twelve years from public schools in Bahrain. They suggested that the design of educational furniture should take into consideration the variation in the body dimensions of schoolchildren. **[11]** examined the incompatibility between furniture measurements and anthropometrics of 195 Chilean 8th-grade students. Agha, (2010) reported significant mismatches between the anthropometrics of students and the measured furniture among 600 schoolboys aged between six and eleven years from classes one to six from 5 basic educational institutions in the Gaza Strip, Palestine.

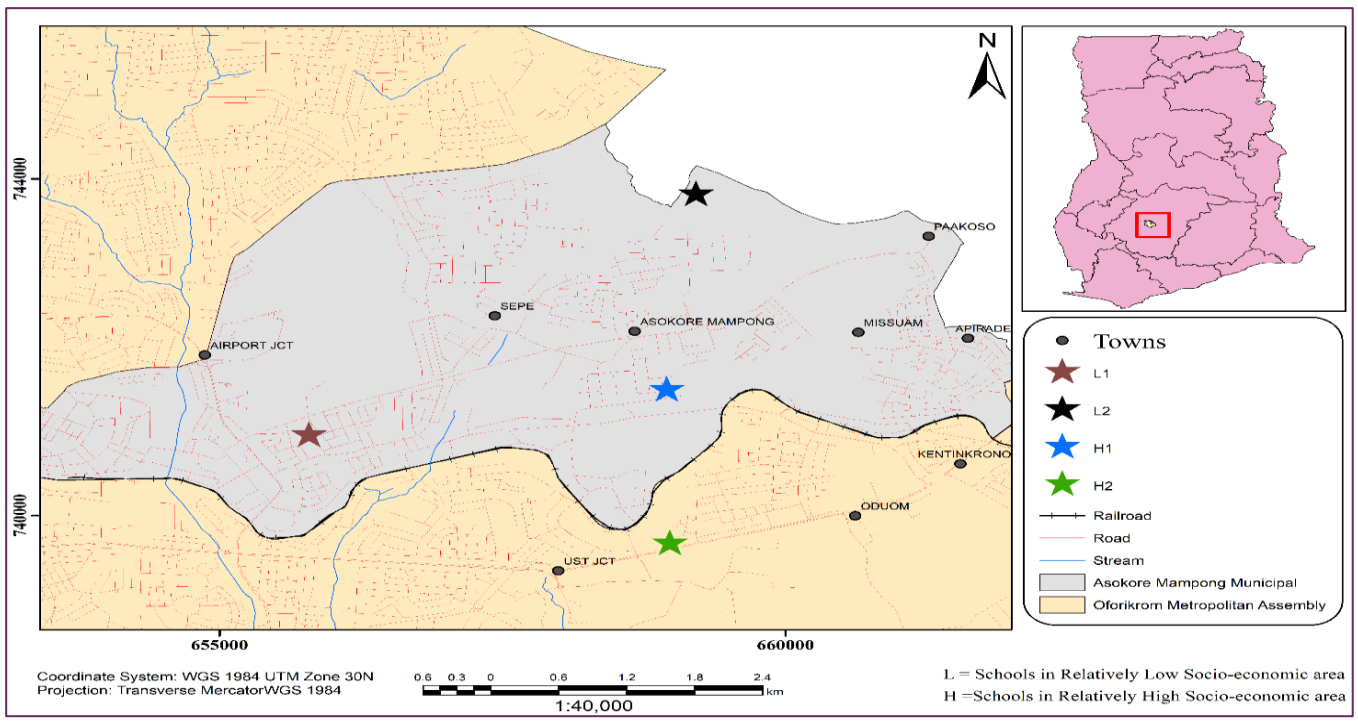
[2] carried out an anthropometric survey for 91 Malaysian pupils aged 8 to 11 years. In another study carried out by **[6]** for 300 first to fifth-grade learners aged 5 to 10 years across 3 primary schools in Jessore, Bangladesh. They revealed that the average height of the chair was suited only to 18.67% of males and 24.67% of females. A systematic review of the influence of school furniture on students' performance and physical responses by **[10]** revealed that performance was improved when students were seated in better fit or matched conditions. **[30]** carried out an exhaustive survey to gather the body dimensions of 584 schoolboys and 562 schoolgirls aged six to twelve years. Another study by **[13]** focused on the anthropometric measurements of three hundred Nigerian pupils aged five to twelve and their classroom furniture. They reported that chair height matched only 27.97% of boys and 20.38% of girls. Ergonomic principles have been conservatively applied in adult workplaces. Research on ergonomics in the school environment has been mostly targeted at 6-18 year-olds with a dearth of consideration for the younger school children. There is a paucity of anthropometric data on schoolchildren in Ghana. Our research offers evidence from four schools in the Asokore Mampong and Oforikrom Municipalities in the Ashanti Region of Ghana. This study was therefore carried out to assess the compatibility of classroom furniture and anthropometry of kindergarten and class one pupils.

Methodology

Research Design and Setting

This cross-sectional study was conducted between July and September 2019 in the Asokore Mampong and Oforikrom Municipalities, Ghana **(Figure 1)**. This site was chosen because it is comprised of children from different socio-economic backgrounds. The research covered four selected basic schools (two private schools and two public schools) from two socioeconomic suburbs (relatively high and relatively low socioeconomic areas). The Asokore Mampong Municipality is one of the 260 Metropolitan, Municipal, and District Assemblies (MMDAs) in Ghana. It was carved out of the Kumasi Metropolitan Assembly in 2012. It was established by the Legislative Instrument, L.I 2112. The Oforikrom Municipal Assembly on the other hand was carved out of the Kumasi Metropolitan Assembly by LI 2291 in 2018. The municipalities have over one hundred registered schools with the Ghana Education Service. The Municipalities according to the 2010 Population and Housing Census has a combined population of 304,815 (PHC, 2010) (www.ghanadistricts.com).

Figure 1: Map of Ghana Showing the Study Locations



Study Population and Sampling

A stratified sampling followed by a simple random sampling technique was employed in the selection of the 395 subjects. The subjects were stratified based on the socioeconomic area of their enrolled school, type of school (private/public), and grade level. The participants were chosen using stratified sampling, which ensured that the samples were representative of subgroups **[30]**. The sample involved kindergarten and class one school children in four selected schools with two located in a relatively high

socioeconomic area[1] (coded as High SEA) and two schools also from a relatively low socioeconomic area[2] (coded as Low SEA). At the selected schools, pupils whose parents consented were the ones used in the study. The pupils of the high socioeconomic area schools have good academic development and are more expressive in communication. They have strong language skills and there is the use of open-ended questions during teacher-student communication, unlike the low socioeconomic area schools where imperatives and yes/no questions are used in communication between teachers and students which in turn impede child responses and speech development.

A total of three hundred and ninety-five (196 schoolboys and 199 schoolgirls) kindergarten through class one pupils from four (4) selected schools participated in the study. The children involved in this study were aged four to thirteen years. The mean age of respondents (SD =15.21) was 6.58 years.

Table 1 presents the sample distribution based on the socioeconomic classification and stage of pupils. The sample size was estimated using Cochran's formula (Cochran, 1977) indicated as Equation 1.

$$n = \frac{Z^2 P(1-P)}{d^2} \qquad \textbf{(1)}$$

where n = sample size, Z = z–statistic for a level of confidence (z=1.96), P = expected proportion (p = 0.05 in a proportion of one for 5% for a 95% confidence interval, and d, the level of precision/error margin desired. From Cochran's standard table, a population of 250,000 to 300,000,000 at a 95% confidence interval requires a sample size of 384. This was used in the estimation of the sample size.

Ethical approval to conduct the study was obtained from the Committee on Human Research Publication and Ethics (CHRPE) at the College of Health, Kwame Nkrumah University of Science and Technology, Kumasi Ghana (Ref number CHRPE/AP/539/19). The principals of the schools were duly briefed about the nature and importance of the study, and their consent to conduct the survey was received. Moreover, since the study involved minors, informed written consent, signed or thumbprint, was obtained from the parents or legal guardians of all the study participants. Participation in the study was entirely voluntary. There were no risks and no direct benefits associated with taking part in the study.

Table 1. Sample Distribution Based on Class And School Classification

	Class Level			
School	**KG 1**	**KG 2**	**Class 1**	**Total**
Low SEA Schools	50	57	84	191
High SEA Schools	89	38	77	204
Total	139	95	161	395

High SEA – Schools in High Socioeconomic Areas

Low SEA – Schools in Low Socioeconomic Areas

Data Collection Tools and Techniques

Anthropometric data were collected from 395 healthy pupils in these basic primary schools during their regular class lessons. The student's furniture dimensions were taken. Measurements were compared to identify potential matches or mismatches. Each participant was measured from the right to the left side of their body. They were measured while barefoot and dressed in light school uniforms with empty pockets. During the measurements, the students sat or stood in standard positions. For all sitting anthropometric parameters, students were seated in an upright position with 90º knees and elbow flexion. Healthy postures were strictly observed. The hair of participants was leveled during the measurement of standing height to prevent reading interference and ensure accuracy. The data was collected using standard tape measures, a calibrated weighing scale of capacity of 180 kg, and a data sheet for record-keeping. Some of the tape measures were mounted on walls on leveled surfaces to serve as stadiometers while others were used as improvised anthropometers. The weight of each school child was taken with a calibrated Silvercrest IAN 103967 talking scale of capacity 180 kg. The age of the pupils was recorded in months due to their young ages and for ease of interpretation of growth. The anthropometric measurements taken in standard sitting and standing positions and recorded in centimeters with the measuring tape are presented in **Table 2**

Table 2. Description of Anthropometric Measurements Used (Castellucci *et al.*, 2014)

Measure	**Description**
Height/Stature	Vertical distance between the floor and the top of the head, and measured with the subject erect and looking straight ahead (Frankfort plane)
Popliteal Height	Measured with 90° knee flexion, as the vertical distance from the floor or footrest and the underside of the thigh at the knee (popliteal surface).

[1] Parents of students have regular jobs & income; Their occupations are in prestigious and semi-prestigious categories; Some parents are skilled manual labourers.

[2] Parents of students do not usually have regular income and are mostly unskilled labourers.

Popliteal Length	Horizontal distance from the back of the uncompressed buttocks to the popliteal angle, at the back of the knee where the lower legs meet the underside of the thigh.
Sitting Shoulder Height	Vertical distance from subject's seated surface to the acromion
Sitting Elbow Height	Taken with a 90° angle elbow flexion, as the vertical distance from the bottom of the tip of the elbow (olecranon) to the subject's seated surface
Buttock Knee Length	Taken with a 90° angle knee flexion as the horizontal distance from the back of the uncompressed buttocks to the front of the kneecap.
Knee Height	Vertical distance from the floor to the upper surface of the knee.
Thigh Thickness	The vertical distance from the highest uncompressed point of the thigh to the subject's seated surface.
Hip Breadth	Distance between the right side of the pelvic and the left side, measured when seated.
Arm Length	Measured with a 90° arm flexion, as the distance measured vertically from the acromion down to the posterior surface of the arm.
Reaching Height	Vertical distance from the floor to the tip of the middle finger when arms are stretched.

The following dimensions were taken from the classroom furniture in use in the various classes and at the different schools to identify potential mismatches to the anthropometric dimensions of the pupils **(see Table 3).**

Table 3. Description of Furniture Dimensions (Castellucci *et al.*, 2014)

Measure	Description
Seat Dimensions	
Seat Height	Vertical distance from the floor to the middle point of the front edge of the seat.
Seat Width	Horizontal distance between the lateral edges of the seat.
Seat Depth	Distance from the back to the front of the sitting surface.
Backrest Height	Vertical distance from the seat surface to the edge of the back support.
Seat-To-Desk Clearance	The vertical distance from the middle point of the front edge of the seat to the lowest structure point below the table.
Seat To Desk Height	The vertical distance from the top of the front edge of the seat to the top of the front edge of the desk.
Table/Desk Dimensions	
Table/Desk Height	The vertical distance from the floor to the top of the front edge of the table.
Table/Desk Width	Horizontal distance between the lateral edges of the desk/table.
Table Depth	Distance from the back to the front of the top surface of the desk/table.

Data Analysis

STATA Statistical Software Version 14.1 was used to calculate the mean values, standard deviation, 5^{th}, $50^{th,}$ and 95^{th} percentile values for the anthropometric data collected and the furniture dimensions measured. The ergonomic analysis was done to estimate the degree of match between the measured body dimensions of the schoolchildren and the dimensions of their furniture using standard equations. Ordered logistic regression was also used in the mismatch investigations. Adjusted odds ratios (aOR), crude odds ratios (cOR), and 95% confidence intervals were calculated. Variables included in the model were socio-economic area of school, gender, class, weight, stature, and classroom furniture mismatches.

Mismatch Equations between the Dimensions of Classroom and Body Measurements

The anthropometric values were measured against the furniture dimensions for the classification of match or mismatch using standard equations by **[8,27]** as follows;

1. **Popliteal height (PH) & Seat height (SH)**
   $0.88PH \leq SH \leq 0.95PH$
2. **Buttock-popliteal length (BPL) & Seat depth (SD)**
   $PL \leq SD \leq 0.95\ BPL$
3. **Hip width (HW) & Seat width (SW)**

HW < SW

4. **Thigh thickness (TT) & Seat-desk clearance (SDC)**
   TT + 2 < SDC
5. **Elbow Height Sitting (EHS) & Seat-desk height (SDH)**
   EHS ≤ SDH ≤ EHS +5
6. **Buttock-Knee Length (BKL) &Desk Depth (DD)**
   DD ≥ BKL

Results

Table 4 highlights the descriptive information of the anthropometric measurements of all participants across the four schools. From the table, the mean stature of the participants was 119.13 cm (SD 8.28). The minimum height recorded was 98.00 cm while the maximum height was 145.00 cm. The 5th, 50th, 95th percentile values of stature were 106.00, 119.00, and 133.00 cm. The mean popliteal height was 32.53 ± 3.00cm. The mean buttock-popliteal length was 34.34 ± 3.37cm. The mean hip width was 31.55 ± 3.29cm. The mean sitting shoulder height was 39.44 ± 3.55cm. The mean sitting elbow height was 14.47 ± 2.02cm. The mean buttock-knee length was 41.25 ± 4.11cm. The mean knee height is 38.47 ± 3.64cm. The mean elbow fingertip length was 31.36 ± 3.04cm. The mean thigh thickness was 7.86 ± 0.85cm. The mean body weight was 21.49 ± 4.16kg.

Results and Discussion

Anthropometry of students

Table 4: Anthropometric Measurements of All Study Participants

Percentile Values							
Anthropometric Measures	**Mini**	**Max**	**Mean**	**SD**	**5th**	**50th**	**95th**
Stature	98.00	145.00	119.13	8.28	106.00	119.00	133.00
Popliteal Height	25.00	44.00	32.53	3.00	28.00	32.50	37.00
Buttock-Popliteal Length	26.00	47.00	34.34	3.37	29.00	34.00	40.00
Hip Width	22.00	47.00	31.55	3.29	27.00	31.00	38.00
Sitting Shoulder Height	27.00	50.00	39.44	3.55	34.00	40.00	45.00
Sitting Elbow Height	9.00	20.00	14.47	2.02	11.00	14.00	18.00
Buttock-Knee Length	28.00	57.00	41.25	4.11	35.00	41.00	48.00
Knee Height	24.00	50.00	38.47	3.64	33.00	38.00	44.00
Elbow Fingertip Length	23.00	47.00	31.36	3.04	27.00	31.00	36.50
Thigh Thickness	5.50	11.50	7.86	0.85	6.80	7.80	9.30
Body Weight	13.40	41.30	21.49	4.16	15.80	21.10	28.80

All dimensions are in centimeters (cm) except body weight measured in kilograms (kg).

From Table 4, the 5th, 50th, 95th percentile values of stature (height) were 106.00, 119.00, and 133.00 cm. This shows that 95% of the population have a height below 133.00 cm and 95% of the population have a height above 106.00 cm. However, the 50th percentile value of stature is almost equivalent to the mean which explains that 50% of the participants have a standing height that is nearly the same as the mean stature.

Table 5: Anthropometric Measurements by Socio-Economic Area Of Schools

Percentile Values							
Anthropometrics	**Mini**	**Max**	**Mean**	**SD**	**5th**	**50th**	**95th**
Stature							
Low SEA Schools	98.00	145.00	119.23	9.33	105.00	119.00	135.00
High SEA Schools	104.00	144.00	119.04	7.18	107.00	119.00	131.00
Popliteal Height							
Low SEA Schools	25.00	41.00	32.54	3.00	28.00	32.00	37.00
High SEA Schools	26.00	44.00	32.52	3.00	28.00	33.00	37.00
Buttock-Popliteal Length							

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Low SEA Schools	26.00	47.00	34.04	3.74	29.00	34.00	41.00
High SEA Schools	26.00	46.00	34.63	2.97	30.00	35.00	39.00
Hip Width							
Low SEA Schools	22.00	39.50	30.62	2.73	27.00	30.00	36.00
High SEA Schools	26.00	47.00	32.43	3.52	28.00	32.00	39.00
Sitting Shoulder Height							
Low SEA Schools	27.00	50.00	39.74	3.79	33.50	40.00	46.00
High SEA Schools	28.00	50.00	39.16	3.30	34.00	39.75	44.00
Sitting Elbow Height							
Low SEA Schools	9.00	19.50	13.91	1.84	11.00	14.00	17.00
High SEA Schools	10.00	20.00	15.00	2.05	12.00	15.00	19.00
Buttock-Knee Length							
Low SEA Schools	28.00	57.00	41.29	4.76	34.00	41.00	50.00
High SEA Schools	32.00	55.00	41.21	3.42	36.00	41.00	47.00
Knee Height							
Low SEA Schools	24.00	50.00	38.88	3.90	33.00	39.00	46.00
High SEA Schools	30.00	47.00	38.10	3.35	33.00	38.00	43.00
Elbow Fingertip Length							
Low SEA Schools	23.00	47.00	31.03	3.26	27.00	31.00	37.00
High SEA Schools	25.00	44.00	31.67	2.80	28.00	31.00	36.00
Thigh Thickness							
Low SEA Schools	5.50	10.80	7.60	0.79	6.30	7.50	9.00
High SEA Schools	6.80	11.50	8.11	0.83	7.00	8.00	9.50
Body Weight							
Low SEA Schools	13.80	35.30	21.07	3.91	15.40	20.70	28.50
High SEA Schools	13.40	41.30	21.88	4.36	16.40	21.30	29.50

High SEA – Schools in High Socioeconomic Areas

Low SEA – Schools in Low Socioeconomic Areas

Table 5 shows the descriptive anthropometry according to the socioeconomic area of the participating schools.

Table 5 shows some socio-economic differences in the anthropometric measurements of schoolchildren. In this study, generally, participants from relatively higher socioeconomic area schools had slightly greater body dimensions than those from relatively low socioeconomic area schools except for five variables. These five dimensions are; stature, popliteal height, sitting shoulder height, buttock-knee length, and knee height. The literature has reported that socioeconomic factors are determinants of children's growth. **[10]** established that children from higher socio-economical backgrounds are taller as compared to those from lower socio-economical backgrounds. However, in this study, children from lower socioeconomic backgrounds were on average 0.19 cm taller than their counterparts from higher socioeconomic backgrounds. During fieldwork, it was observed that most of the students in the relatively low socioeconomic area schools were enrolled at a relatively advanced age than their counterparts in the relatively high socioeconomic area schools. **[12]** stated that student growth differs with age and their legs also grow rapidly before puberty**.** This could have been attributed to the observed trend in the standing height, popliteal height, buttock-knee length, and knee height of the participants from lower socio-economic backgrounds. Moreover, not only were some of the children from the relatively low socioeconomic area schools overaged, they were not punctual to school.

Table 6: Anthropometric Measurements of All Participants In Kindergarten To Class 1

Percentile Values							
Anthropometrics	**Mini**	**Max**	**Mean**	**SD**	**5th**	**50th**	**95th**
Stature							
KG 1	98.00	129.00	113.22	5.79	104.00	113.00	122.00
KG 2	98.00	145.00	117.28	6.75	105.50	117.00	127.00
Class 1	110.00	145.00	125.34	6.48	115.00	125.00	136.00
Popliteal Height							
KG 1	25.00	37.00	30.32	2.07	27.00	30.00	33.00
KG 2	26.00	44.00	32.08	2.74	28.00	32.00	36.00
Class 1	30.00	44.00	34.70	2.23	32.00	35.00	38.00
Buttock-Popliteal Length							
KG 1	26.00	40.00	32.35	2.71	28.00	32.00	37.50
KG 2	26.00	42.00	33.84	2.73	29.00	34.00	38.00
Class 1	29.00	47.00	36.36	3.10	32.00	36.00	42.00
Hip Width							
KG 1	22.00	41.00	31.44	3.48	27.00	31.00	38.00
KG 2	24.00	38.00	30.10	2.37	27.00	30.00	35.00
Class 1	27.00	47.00	32.51	3.27	28.00	32.00	39.00
Sitting Shoulder Height							
KG 1	29.00	48.00	37.18	2.89	33.00	37.00	42.00
KG 2	27.00	50.00	39.46	3.20	33.00	40.00	43.00
Class 1	31.00	50.00	41.39	3.09	37.00	41.50	47.00
Sitting Elbow Height							
KG 1	10.00	20.00	14.73	1.82	12.00	15.00	18.00
KG 2	10.00	19.50	13.32	1.72	11.00	13.00	17.00
Class 1	9.00	20.00	14.92	2.11	11.50	15.00	18.00
Buttock-Knee Length							
KG 1	28.00	47.00	38.32	3.19	33.00	38.00	44.00
KG 2	33.00	53.00	41.35	3.07	37.00	41.00	46.00
Class 1	35.00	57.00	43.70	3.72	38.00	43.00	50.00
Knee Height							
KG 1	30.00	43.00	35.61	2.43	31.00	36.00	39.00
KG 2	24.00	47.00	38.41	3.12	33.00	39.00	43.00
Class 1	34.00	50.00	40.98	2.91	37.00	41.00	46.00
Elbow Fingertip Length							

KG 1	25.00	39.00	29.87	2.14	27.00	30.00	33.50
KG 2	23.00	43.00	30.89	3.40	27.00	30.00	37.00
Class 1	27.00	47.00	32.91	2.75	29.00	33.00	37.00
Thigh Thickness							
KG 1	5.50	10.50	7.63	0.79	6.30	7.50	9.00
KG 2	5.80	10.10	7.56	0.81	6.50	7.30	9.00
Class 1	6.80	11.50	8.24	0.79	7.00	8.10	9.50
Body Weight							
KG 1	13.40	27.80	18.85	2.51	15.30	18.40	22.70
KG 2	13.80	35.30	20.82	3.78	15.70	20.10	28.40
Class 1	15.20	41.30	24.15	3.92	18.60	23.60	30.50

Table 6 shows the descriptive anthropometry according to classes

Table 6 revealed observable differences in the measured anthropometric parameters of children from various classes. For example, the mean values of stature for class one, kindergarten two, and one, are 125.34, 117.28, and 113.22 cm respectively. This finding is reinforced by **[32]** who communicated that learners differ greatly in body dimensions, cross the different age groups, and within the same age groups thus not all learners match their classroom seats and tables. Moreover, this finding confirms the study by **[25]** who conveyed that anthropometric measures can vary for school children in different classes as well as for those in the same class. The mean values of popliteal height for class one, kindergarten two, and one, are 34.70, 32.08, and 30.32cm. This trend is in line with the study by **[5]** who conveyed that the legs grow faster than the trunk before adolescence and the growth of an individual is primarily truncal in adolescence. The results revealed that, in all measured body dimensions, the mean values of pupils in class one showed the largest body dimensions, followed by kindergarten two and one, except for hip width, thigh thickness, and sitting elbow height. For these three dimensions, the largest body dimensions were observed in class one pupils followed by kindergarten one and two. **[3]** conveyed that the body measurements of pupils increase with age which is in agreement with the findings of this study.

Table 7: Anthropometric Measurements by Gender

Percentile Values							
Anthropometrics	**Mini**	**Max**	**Mean**	**SD**	**5th**	**50th**	**95th**
Stature							
Male	98.00	141.00	118.80	7.51	106.00	118.50	132.00
Female	98.00	145.00	119.46	8.99	105.00	119.00	135.00
Popliteal Height							
Male	25.00	44.00	32.46	2.92	28.00	32.00	37.00
Female	26.00	41.50	32.60	3.08	28.00	32.50	37.00
Buttock-Popliteal Length							
Male	27.00	43.00	34.00	3.11	29.00	34.00	39.00
Female	26.00	47.00	34.68	3.59	29.00	35.00	41.00
Hip Width							
Male	22.00	41.00	31.41	3.07	28.00	31.00	38.00
Female	24.00	47.00	31.70	3.49	27.00	31.00	38.00
Sitting Shoulder Height							
Male	31.00	50.00	39.29	3.27	34.00	40.00	44.00

Citation: Claudia A. Mensah, Afia Agyemang-Beniako, Sam Newton, Alhassan Sulemana, Moses Djimatey, Jonathan N. Hogarh, Sabastian Samuel Kwesi. Anthropometric Assessment of Classroom Furniture for Ghanaian School Children From Two Socio-Economic Areas. Journal of Medicine Care and Health Review 2(1). https://doi.org/10.61615/JMCHR/2025/JAN027140116

Female	27.00	50.00	39.59	3.81	33.00	40.00	46.00
Sitting Elbow Height							
Male	9.00	20.00	14.45	2.02	11.00	14.00	18.00
Female	10.00	20.00	14.49	2.03	11.00	14.00	18.00
Buttock-Knee Length							
Male	31.50	52.00	40.87	3.81	35.00	40.00	47.00
Female	28.00	57.00	41.61	4.38	35.00	41.00	49.00
Knee Height							
Male	30.00	47.00	38.18	3.32	32.00	38.00	44.00
Female	24.00	50.00	38.76	3.92	33.00	39.00	46.00
Elbow Fingertip Length							
Male	23.00	44.00	31.39	2.92	27.00	31.00	37.00
Female	25.00	47.00	31.33	3.17	27.00	31.00	36.50
Thigh Thickness							
Male	5.80	10.80	7.88	0.87	6.70	7.80	9.30
Female	5.50	11.50	7.85	0.84	6.80	7.80	9.30
Body Weight							
Male	13.80	38.90	21.63	3.93	16.40	21.15	28.80
Female	13.40	41.30	21.34	4.38	15.40	21.00	29.00

Table 7 shows the descriptive anthropometry according to male and female

Table 7 presents the different measured body dimensions of boys and girls. The results suggest that there are no significant variations in the mean values of the measured anthropometrics for both sexes in this study. The mean standing height for males is 118.80 cm and 119.46 cm for girls. It is observed that the girls were on average 0.66 cm taller than the males. For both males and females, the mean popliteal height, hip width, sitting shoulder height and body weight were, correspondingly, 32.46 and 32.60 cm, 31.41 and 31.70cm, 39.29 and 39.59 cm, and 21.63 and 21.34 kg. This finding supports the study by **[7]** who conveyed that, in terms of gender differences, it can be seen that, boys and girls grow at a comparable rate until puberty. They also found out that, with the exception of certain variables such as hip breadth, boys usually have larger body dimensions than girls after puberty.

Dimensions of students' classroom furniture

From **Table 8**, it is noteworthy that the classroom furniture in all four schools differed in their dimensions. Communication with administrators of the various schools indicated that the furniture was procured without any considerations for the anthropometrics of the schoolchildren.

Table 8: Chair And Table Dimensions in The Four Surveyed Schools

	School A			**School B**			**School C**			**School D**		
Dimensions	**KG1**	**KG2**	**CLASS 1**	**KG1**	**KG2**	**CLASS 1**	**KG1**	**KG2**	**CLASS 1**	**KG1**	**KG2**	**CLASS 1**
SH	23.46	29.83	33.37	33.33	34.33	30.67	33.00	33.00	36.33	29.90	27.40	28.00
SW	26.50	27.83	92.83	94.83	34.00	91.53	34.00	34.00	32.33	27.73	80.27	80.17
SD	24.16	26.17	17.33	20.17	29.50	16.70	29.50	29.50	33.00	26.63	22.77	23.33
BR	22.13	27.00	29.33	21.67	20.73	22.33	29.00	29.00	37.50	27.10	23.43	24.90

Citation: Claudia A. Mensah, Afia Agyemang-Beniako, Sam Newton, Alhassan Sulemana, Moses Djimatey, Jonathan N. Hogarh, Sabastian Samuel Kwesi. Anthropometric Assessment of Classroom Furniture for Ghanaian School Children From Two Socio-Economic Areas. Journal of Medicine Care and Health Review 2(1). https://doi.org/10.61615/JMCHR/2025/JAN027140116

SDC	9.50	8.83	11.00	23.67	23.47	26.83	11.00	17.67	13.93	12.00	9.00	10.03
SDH	14.67	14.67	29.67	19.50	15.90	19.90	25.00	23.00	26.00	19.33	24.97	31.60
DH	41.33	44.27	59.00	55.83	51.07	51.67	57.00	57.00	61.97	46.43	46.00	47.10
DD	77.33	39.00	23.33	24.83	24.97	24.67	45.50	60.67	46.17	37.67	22.77	23.33
DW	103.00	66.00	84.43	97.33	96.17	91.17	61.00	138.00	61.83	102.67	80.67	80.67
SDC	34.53	38.33	44.17	44.17	46.05	45.33	43.00	50.67	13.93	36.67	37.67	37.70

All dimensions are in centimeters (cm)

The Compatibility Between Anthropometric Indices of The Children And Furniture

The findings revealed a considerable level of discordancy between the measured furniture and the anthropometrics of the learners. This is due to the negligence of user anthropometry during the construction of educational furniture.

Table 9 presents the ergonomic suitability of the furniture for all participants. It gives the degree of match and incompatibilities for the furniture. For example, only 18.23% of the children had chair height that suited their popliteal height. Chair height was low for 54.18% of the children and too high for 27.59% of them. The seat depth was too deep for 80.51% of participants, only 15.19% had appropriate seat depth. The seat-to-desk height also revealed a 25.06% match, 69.11% low mismatch, and only 5.82% high mismatch. The match percentages of seat desk clearance, seat width, and desk depth are 72.91%, 66.08%, and 36.46% respectively.

Anthropometry

Compatibility Between Anthropometrics Measurements and Furniture Dimensions

Table 9: Percentages of Match and Mismatch Tables and Chairs For All Subjects

Furniture Dimensions	**All Participants No. (%)**
Seat Height	Match: 72 (18.23%)
	Low Mismatch: 214 (54.18%)
	High Mismatch: 109 (27.59%)
Seat Depth	Match: 60 (15.19%)
	Low Mismatch: 17 (4.30%)
	High Mismatch: 318 (80.51%)
Seat Width	Match: 261 (66.08%)
	Mismatch: 134 (33.92%)
Seat to Desk Clearance	Match: 288 (72.91%)
	Mismatch: 107 (27.09%)
Seat to Desk Height	Match: 99 (25.06%)
	Low Mismatch: 273 (69.11%)
	High Mismatch: 23 (5.82%)
Desk Depth	Match: 144 (36.46%)
	Mismatch: 251 (63.54%)

Table 10 shows the match and mismatch percentages according to the socio-economic area of schools. The match percentages of seat height are 24.61% for low socio-economic areas of schools and 12.25% for high socio-economic areas of schools. The seat height was too low for 45.55% of children from low socio-economic areas of schools and 62.25% of children from high socio-economic areas of schools. The seat depth was too deep for 91.62% of children from low socio-economic areas of schools and 70.10%of children from high socio-economic areas of schools. Chair-to-table clearance presented the maximum match of at least 72% of children from both socio-economic backgrounds. Seat width was appropriate for at least 65% of participants from both socio-economic backgrounds.

Table 10: Ergonomic Analysis of Table And Chair By Socio-Economic Area of Schools

Furniture Dimensions	Low SEA Schools	High SEA Schools
Seat Height	Match: 47 (24.61%)	Match: 25 (12.25%)
	Low Mismatch: 87 (45.55%)	Low Mismatch: 127 (62.25%)
	High Mismatch: 57 (29.84%)	High Mismatch: 52 (25.49%)
Seat Depth	Match: 11 (5.76%)	Match: 49 (24.02%)
	Low Mismatch: 5 (2.62%)	Low Mismatch: 12 (5.88%)
	High Mismatch:175 (91.62%)	High Mismatch: 143 (70.10%)
Seat Width	Match: 128 (67.02%)	Match: 133 (65.20%)
	Mismatch: 63 (32.98%)	Mismatch: 71 (34.80%)
Seat to Desk Clearance	Match: 140 (73.30%)	Match: 148 (72.55%)
	Mismatch: 51 (26.70%)	Mismatch: 56 (27.45%)
Seat to Desk Height	Match: 73 (38.22%)	Match: 26 (12.75%)
	Low Mismatch: 97 (50.79%)	Low Mismatch: 176 (86.27%)
	High Mismatch: 21 (10.99%)	High Mismatch: 2 (0.98%)
Desk Depth	Match: 35 (18.32%)	Match: 109 (53.43%)
	Mismatch: 156 (81.68%)	Mismatch: 95 (46.57%)

Table 11 shows the match and mismatch percentages across all classes. The seat height fitted 21.74% of class one pupils, 21.05% of kindergarten two pupils, and 12.23% of kindergarten one pupils. It was noteworthy that seat width suited 90.06% of class one pupils. Seat-to-desk clearance showed the highest degree of compatibility for the measured dimensions of furniture across all classes. The matched percentages were 84.47% of class one pupils, 62.11% of kindergarten two pupils, and 66.91% of kindergarten one pupils.

Table 11: Ergonomic Analysis of Table And Chair By Classes

Furniture Dimensions	KG1	KG2	CLASS 1
Seat Height	Match: 17 (12.23%)	Match: 20 (21.05%)	Match: 35 (21.74%)
	Low Mismatch: 81 (58.27%)	Low Mismatch: 63 (66.32%)	Low Mismatch: 70 (43.48%)
	High Mismatch: 41 (29.50%)	High Mismatch: 12 (12.63%)	High Mismatch: 56 (34.78%)
Seat Depth	Match: 17 (12.23%)	Match: 20 (21.05%)	Match: 23 (14.29%)
	Low Mismatch: 2 (1.44%)	Low Mismatch: 9 (9.47%)	Low Mismatch: 6 (3.73%)
	High Mismatch: 120 (86.33%)	High Mismatch: 66 (69.47%)	High Mismatch: 132 (81.99%)

Seat Width	Match: 68 (48.92%)	Match: 48 (50.53%)	Match: 145 (90.06%)
	Mismatch: 71 (51.08%)	Mismatch: 47 (49.47%)	Mismatch: 16 (9.94%)
Seat to Desk Clearance	Match: 93 (66.91%)	Match: 59 (62.11%)	Match: 136 (84.47%)
	Mismatch: 46 (33.09%)	Mismatch: 36 (37.89%)	Mismatch: 25 (15.53%)
Seat to Desk Height	Match: 45 (32.37%)	Match: 45 (47.37%)	Match: 9 (5.59%)
	Low Mismatch: 83 (58.71%)	Low Mismatch: 38 (40.00%)	Low Mismatch: 152 (94.41%)
	High Mismatch: 11 (7.91%)	High Mismatch: 12 (12.63%)	High Mismatch: 0%
Desk Depth	Match: 63 (45.32%)	Match: 46 (48.42%)	Match: 35 (21.74%)
	Mismatch: 76 (54.36%)	Mismatch: 49 (51.58%)	Mismatch: 126 (78.26%)

Table 12: Ergonomic Analysis of Table And Chair By Socio-Economic Area of Schools

Dimensions	**SEA**	**KG 1**	**KG 2**	**Class 1**
SH	Low SEA	Match: 3/50	Match: 14/57	Match: 30/84
		Low MM: 24/50	Low MM: 33/57	Low MM: 30/84
		High MM: 23/50	High MM: 10/57	High MM: 24/84
	High SEA	Match: 14/89	Match: 6/38	Match: 5/77
		Low MM: 57/89	Low MM: 30/38	Low MM: 40/77
		High MM: 18/89	High MM: 2/38	High MM: 32/77
SD	Low SEA	Match: 1/50	Match: 10/57	Match: 00
		Low MM: 00	Low MM: 5/57	Low MM: 00
		High MM: 49/50	High MM: 42/57	High MM: 84/84
	High SEA	Match: 16/89	Match: 10/38	Match: 23/77
		Low MM: 2/89	Low MM: 4/38	Low MM: 6/77
		High MM: 71/89	High MM: 24/38	High MM: 48/77
SW	Low SEA	Match: 28/50	Match: 16/57	Match: 84/84
		Mismatch: 22/50	Mismatch: 41/57	Mismatch: 00
	High SEA	Match: 40/89	Match: 32/38	Match: 61/77
		Mismatch: 49/89	Mismatch: 6/38	Mismatch: 16/77
SDC	Low SEA	Match: 41/50	Match: 21/57	Match: 78/84
		Mismatch: 9/50	Mismatch: 36/57	Mismatch: 6/84
	High SEA	Match: 52/89	Match: 38/38	Match: 58/77
		Mismatch: 37/89	Mismatch: 00	Mismatch: 19/77

SDH	Low SEA	Match: 20/50	Match: 44/57	Match: 9/84
		Low MM: 21/50	Low MM: 1/57	Low MM: 75/84
		High MM: 9/50	High MM: 12/57	High MM: 00
	High SEA	Match: 25/89	Match: 1/38	Match: 00
		Low MM: 62/89	Low MM: 37/38	Low MM: 77/77
		High MM: 2/89	High MM: 0/38	High MM: 00
DD	Low SEA	Match: 26/50	Match: 9/57	Match: 00
		Mismatch: 24/50	Mismatch: 48/57	Mismatch: 84/84
	High SEA	Match: 37/89	Match: 37/38	Match: 35/77
		Mismatch: 52/89	Mismatch: 1/38	Mismatch: 42/77

i. Low MM in the table implies Low Mismatch

ii. High MM in the table implies High Mismatch

Table 13 presents the match and mismatch percentages by gender. The seat height matched only 15.82% of boys and 20.60% of girls. The seat width suited 66.84% of boys and 65.33% of girls. The seat deck clearance elicited matched percentages of at least 72% for both boys and girls. The desk depth was inappropriate for the majority of the children.

Table 13: Ergonomic Analysis of Table And Chair By Sex

Furniture Dimensions	Male	Female
Seat Height	Match: 31 (15.82%)	Match: 41 (20.60%)
	Low Mismatch: 112 (57.14%)	Low Mismatch: 102 (51.26%)
	High Mismatch: 53 (27.04%)	High Mismatch: 56 (28.14%)
Seat Depth	Match: 37 (18.88%)	Match: 23 (11.56%)
	Low Mismatch: 8 (4.08%)	Low Mismatch: 9 (4.52%)
	High Mismatch: 151 (77.04%)	High Mismatch: 167 (83.92%)
Seat Width	Match: 131 (66.84%)	Match: 130 (65.33%)
	Mismatch: 65 (33.16%)	Mismatch: 69 (34.67%)
Seat to Desk Clearance	Match: 144 (73.47%)	Match: 144 (72.36%)
	Mismatch: 52 (26.53%)	Mismatch: 55 (27.64%)
Seat to Desk Height	Match: 48 (24.49%)	Match: 51 (25.63%)
	Low Mismatch: 141 (71.94%)	Low Mismatch: 132 (66.33%)
	High Mismatch: 7 (3.57%)	High Mismatch: 16 (8.04%)
Desk Depth	Match: 80 (40.82%)	Match: 64 (32.16%)
	Mismatch: 116 (59.18%)	Mismatch: 135 (67.84%)

Health Implications of Incompatibility

The incompatibility between measured furniture dimensions and the anthropometry of the school children stimulates implications on health. Musculoskeletal disorders (MSDs) may occur in an educational setting as a result of continued flexion instigated by incompatibility between schoolchildren and their classroom furniture or heavyweight schoolbags. Children are vulnerable to musculoskeletal disorders because they remain seated on ill-fitted furniture in the classroom for long hours. Prolonged hours of sitting can result in the slow movement of the blood which may subsequently form clots within a vein and trigger deep venous thrombosis. Awkward sitting posture by students is a key negative effect of poorly designed furniture. Mismatched heights of chairs and desks instigate poor body posture and pain which eventually interrupts learning. **[23]** argued that seats with very high backrests are associated with pain in the lower back. They reported that seats that are too low are associated with pain in the neck,

upper back, and lower back. Unsuitable postures can result in repetitive strain injuries that affect tertiary students, teens, and pupils **[3]**. Assuming unhealthy postures for deskbound activities such as scribbling, or reading can result in pain in the shoulders, neck, and feet **[20,24]**. Children will find it difficult to rest their feet correctly on the floor when seated on elevated chairs. It is established that a chair that suits learners with short legs can also accommodate learners with long legs **[21].** Seats with extreme heights cause compression of the underside of the thighs leading to awkwardness and improper movement of blood around the legs. Chairs with intense seats press firmly against the popliteal opposing the supply of blood to parts of the thigh. High-swallowed seats affect the lower thigh and result in an unsuitable sitting position. High table surfaces result in forward bending for deskbound tasks. Children are likely to experience kyphotic postures from chairs that are too deep.

Conclusion

The study revealed considerable incompatibility between the classroom furniture and the body dimensions of the pupils. The classroom furniture in use by children requires ergonomic improvements. Adjustable classroom chairs and tables are strongly recommended to minimize mismatch and subsequently reduce musculoskeletal discomfort in school children.

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Conflict of Interest

The authors declare that there is no conflict of interest.

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