Anthropometric Comparison between Classroom Furniture Dimensions and Female Students Body Measurements for Enhanced Health and Productivity.

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ABSTRACT

Anthropometric measures for female secondary school students in Nigeria were sparsely reported in literature. Consequently, Classroom Furniture (CF) are designed without recourse to anthropometric dimensions and ergonomic norms. Poorly designed CF may lead to learning challenges and risk of potential future posture related health problems. Thus, provision of CF with appropriate measures is crucial to encourage proper fit and could help to reduce accidents among students. Therefore, this study was undertaken to evaluate the degree of compatibility between CF dimensions and female students' body measurements in Secondary School, Okitipupa, Nigeria.

232 female students aged from 11 to 18 years partook in the study. They were grouped into Lower Class Female, Middle Class Female and Upper Class Female. Anthropometric data that include Popliteal Heights (P), Buttock-Popliteal Lengths (BPL), Hip Widths (HW), Shoulder Heights (SHH), Elbow Heights (EH), and Knee Heights (KH) were collected and compared with dimensions of CF features: Seat Height (SH), Seat Depth (SD), Seat Width (SW), Backrest Height (B), Desk Height (D) and Underneath Desk Height (UD) using match equations.

Mismatch between students' body dimensions and CF features ranged from 43.750-76.390, 28.750-100.000, 87.500-100.000, 52.500-100.000 and 49.000-78.480% for SH, SD, B, D and UD respectively. Seat width was suitable for all the students. Their ergonomic design values ranged from 47.260-51.770, 15.180-17.630, 38.060-42.580, 43.580-51.160, 41.610-48.470 and 25.170-37.480cm, respectively.

Two types of classroom furniture (suited the anthropometric characteristics of majority of the female students and have the potential of reducing the occurrence of cumulative-trauma disorders) are required in secondary schools.

Keywords: Anthropometric comparison, Classroom furniture, Body measurements, School environments, Ergonomic design.

INTRODUCTION

The school, in term of size, is second to none. It is the biggest workplace of all. The learners represent 'workers' there. School comprises an essential environment for the learners where "productivity" in terms of attainment of expected educational levels is of prime importance to a serious and determined student, the family and the country as a whole. School is well-organized location for the advancement of health among students (World Health Organisation, 1996). Thus, the need for improvement in the design of school environments to benefit learning has already been recognised (Smith, 2007). Classroom furniture is one of the components of such desired school environments.

Classroom furniture is employed widely by learners during a decisive stage (adolescence) of human development. All interactions between classroom furniture and the human body during this stage give rise to a specific postural condition. Various forms of physical deformations are the probable aftermaths of employing classroom furniture that are poorly produced. For instance, poorly produced classroom furniture would likely result in poor sitting habit such as leaning over a table to write or read (Panagiotopoulou, *et al*., 2004). Once this poor sitting habit is formed in adolescent, it is difficult to change later in adulthood (Harreby *et al*., 1995; Siivola *et al*., 2004). This may affect the physical development of the learners (Evans *et al*., 1988)

In addition, wrong alignment of the body as an outcome of classroom furniture mismatch diminishes the capability of antigravity muscles to create torque. The neuromuscular systems of the body, as a result, may not respond optimally to external forces like gravity. Poorly designed and unsuitable sized chairs liable to causing abnormal physiological strain on the neuromuscular systems and this can lead to repetitive strain and lower back pain (Bernard *et al*., 1994; Mandal, 1997; Tittiranonda *et al*., 1999; Trousier *et al*., 1999; Ariens *et al*., 2001).

Parcells, *et al* ., (1999) pointed out that musculoskeletal stress resulting from effort to maintain stability and comfort of seating, due to the use of poorly designed classroom furniture, may make for a fidgety individual, a condition not conducive to focused learning. This impaired learning interest; discomfort and bad posture associated with poorly designed classroom furniture are factors which may affect students' academic performance (Evans *et al*., 1988).

On the other hand, properly designed classroom furniture along with correct posture, is necessary to aid in reducing or averting back stress, restricted circulation, irritation and fatigue, cumulative-trauma disorders and other distractions occasioned by the discomfort of an unsuitable posture. This, in turn, has the tendency to promote the health of students (Knight and Noyes, 1999; Cranz, 2000; Agha, 2010; Dianat *et al*., 2013). Furthermore, properly designed classroom can help the students to achieve improved productivity in terms of academic performance. Thus, this study examined the level of compatibility between classroom furniture dimensions and female students' body measurements in Secondary School, Okitipupa, Nigeria with a view to improving its match for enhanced academic performance by the users.

METHODOLOGY

In order to select an appropriate sample size (for optimum utilisation of resources in terms of fund and time) for the studied population, GPower version 3.1 software was employed for the selections. A priori analysis was carried out. A power of 80.00% was used and the analysis reported a sample size of 207, hence, a sample size of 231 is reasonable. The analysis is reported below:

Analysis: A priori: Compute required sample size			
Input:	Tail(s)	=	Two
	Effect size f^2	=	0.1
	α err prob	=	0.05
	Power (1-β err prob)	=	0.80

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	Number of predictors	=	5
Output:	Critical t	=	1.6533
	Df	=	344
	Total sample size	=	207
	Actual power	=	0.8001

Selection of Participants

According to Jeong and Park (1990), sex disparity in anthropometry is momentous for classroom furniture fabrication. Furthermore, the phenomenon of variations in body proportions among genders, ages and requirement of suitable classroom furniture was also reported by Chung and Wong (2007). Therefore, a total of 231 female students were randomly chosen from those who offered to take part in the study from Junior Secondary School One to Senior Secondary School Three (Table 1). Their ages range between 11 and 18 years. They had not participated in any such study, and have no physical disabilities.

Measurements of Classroom Furniture Dimensions

The dimensions of classroom furniture designs which were considered are defined thus:

Seat Height (SH): Measured as the vertical distance between the floor and the highest point on the front edge of the seat (Dianat *et al*., 2013; Oladapo and Akanbi, 2015)

Seat depth (SD): Measured as the horizontal distance between the back and the front edge of the sitting surface (Dianat *et al*., 2013; Akanbi and Oladapo, 2016).

Seat Width (SW): Measured as the horizontal distance between the lateral edges of the seat (Dianat *et al*., 2013; Oladapo and Akanbi, 2016a).

Back rest Height (BH): Measured as the vertical distance between the sitting surface and the top edge of backrest (Dianat *et al*., 2013; Oladapo and Akanbi, 2016b).

Desk height (DH): Measured as the vertical distance between the floor and the top of front edge of the desk (Panagiotopoulou *et al*., 2004; Oladapo and Akanbi, 2023).

Underneath Desk Height (UD): Measured as the vertical distance between the floor and the bottom of the front edge of the shelf under the writing surface (Panagiotopoulou *et al*., 2004; Oladapo and Akanbi, 2023).

Table 3.1: Classification of Participants

Division	**Lower class (J.S.S.1-J.S.S.2)**	**Middle class (J.S.S.3-S.S.S.1)**	**Upper class (S.S.S.2-S.S.S.3)**	**Total**
Female	80	80	71	231

Where J.S.S. stands for Junior Secondary School and S.S.S. stands for Senior Secondary School.

Process of Collection of Anthropometric Data of the studied Population

A survey was conducted between January and February, 2024 to measure students' anthropometry in eight selected high schools in Okitipupa, Ondo State, Nigeria. The instruments used for this study included

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anthropometer (Model 01290. Lafayette Instrument Company, Lafayette Indiana), a tape measure, students' usual chairs at school, flat wooden pieces (20 × 10 × 10), which was used as footrest, and a perpendicular wooden angle (60 × 15 × 50). The perpendicular wooden angle was used to position the elbow at 90^0 during the measurements processes.

Six anthropometric data of the subjects (stature, waist height, shoulder-arm length, lower-arm length, shoulder breadth, knee height, elbow height, popliteal height, shoulder height, buttock-popliteal length and hip width) and their shoe height were collected and collated.

Acquisition and Description of Anthropometric Measures

The measurements were performed on the right-hand side of the partaking students. The subjects wore their school uniform and were barefooted. The following measurements were taken: knee height, elbow height, popliteal height, shoulder height, buttock-popliteal length, and hip width.

Knee Height (KH): Defined as the vertical distance from the floor/footrest to the top of the knee cap with knee flexed at 90° (Agha, 2010; Oladapo and Akanbi, 2016b).

Elbow Height (EH): Defined with the elbow flexed at 90°, as the vertical distance from the seat pan to the bottom of the tip of the elbow (olecranon) (Dianat *et al*., 2013; Oladapo and Akanbi, 2016a).

Popliteal Height (PH): Defined as the vertical distance between the floor/footrest surface and the popliteal space (which is the posterior surface of the knee) at 90° Knee flexion (Agha, 2010; Akanbi and Oladapo, 2016).

Shoulder Height (SR): Defined as the vertical distance from the seat pan to the top of the shoulder, that is, at the acromion process (Panagiotopoulou *et al*., 2004; Oladapo and Akanbi, 2015).

Buttock-Popliteal Length (BL): Defined with the knee flexed at 90°, as the distance between the posterior surface of the buttock and the posterior surface of the knee or popliteal surface (Panagiotopoulou, *et al.*, 2004; Oladapo and Akanbi, 2023).

Hip Width (HW): Measured as the highest horizontal expanse across the hips in the sitting position (Tunay and Melemez, 2008; Oladapo and Akanbi, 2023).

Determination of Potential Mismatch

Match is considered as compatibility between the classroom furniture dimensions and anthropometric measures of students while mismatch is seen as incompatibility between the dimensions of classroom furniture and anthropometric measures of students. In essence, a mismatch/match denotes that the students' dimensions are outside/within the lower and upper limits set by the researchers for the suitability of the dimensions of existing classroom furniture (Agha, 2010). In order to evaluate a potential match or otherwise in the present arrangement between female students in secondary schools and classroom furniture provided for them, anthropometric measures of the studied population were compared with dimensions of classroom furniture. The match criteria (product dimensions against the users' measures) which were used in this study are presented in table 2.

Table 2. Classroom Furniture Dimensions versus Relevant User Dimensions

S/N	CF dimensions	User dimensions
1	Seat height (SH)	Popliteal height (P)

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2	Seat depth (SD)	Buttock-popliteal length (BPL)
3	Seat width (SW)	Hip width (HW)
4	Backrest height (B)	Shoulder height (SHH)
5	Desk height (D)	Elbow Height (Sitting) (EH)
6	Underneath desk height (UD)	Knee height

Also, the match equations employed for the present study are presented below.

Seat height (SH): This has been considered as the greatest component in the production of classroom furniture (Molenbroek *et al*., 2003; Castellucci *et al*., 2010; Oladapo and Akanbi, 12016b). Furthermore, it is the greatest component if the development of a mismatch criterion is considered (Qutubuddin *et al*., 2013; Castellucci *et al*., 2014). The inequality below is such that seat height is lower than popliteal height in such a manner that (1) the lower leg is at a 5-30^0 angle relative to the vertical and (2) the shin-thigh angle is between 95 and 120^0 (Evans *et al*., 1988; Occhipinti *et al*., 1993; Sanders and McCormick, 1993).

Therefore, to assess possible mismatch/match of SH, an equation reported by Agha (2010) was adopted with slight modification as follows:

$$(PH + Sh) \cos 30^0 \leq SH \leq (PH + Sh) \cos 5^0 \quad (1)$$

Where PH is popliteal height, Sh is shoe height and SH is seat height.

Seat Depth (SD): This is the next to the greatest component (Castellucci *et al*., 2014). Most scholars suggested that seat depth should be designated for the fifth percentile of popliteal-buttock length distribution, including even the shorter users (Pheasant, 1991; Khali *et al*., 1993; Sanders and McCormick, 1993; Occhipinti *et al*., 1993; Orborne, 1996; Helander, 1997; Milanese and Grimmer, 2004). Therefore, to assess possible mismatch/match of SD, an equation reported by Chung and Wong (2007) was adopted as follows:

$$0.800\ BL \leq SD \leq 0.950BL \quad (2)$$

Where BL is buttock-popliteal length and SD is seat depth.

Seat Width (SW): SW should be enough to aid ischial tuberosites in order to provide stability and allow space for lateral movements (Khali *et al*., 1993; Corlett and Clark, 1995). It should be convenient to suit the users with the largest hip width (Evan *et al*., 1988; Occhipinti *et al*., 1993; Sanders and McCormick, 1993; Orborne, 1996; Helander, 1997). Therefore, to assess possible mismatch/match of SW, an equation reported by Dianat *et al*., (2013) was adopted as follows:

$$HW < SW \quad (3)$$

Where HW is hip width and SW is seat width.

Backrest height (BH): BH is considered appropriate when it is below scapula (Evans *et al*., 1988; Orborne, 1996) to bring about movement of the trunk and arms (Khali *et al*., 1993). In order to assess possible mismatch/match of BH, an equation reported by Gouvali and Boudolos, (2006) was adopted as follows:

$$0.600\ SR \leq BH \leq 0.800\ SR \quad (4)$$

Where SR is shoulder height and BH is backrest height.

Desk height (DH): Most scholars consider elbow rest height as the main component needed for evaluation of desk height (Sanders and McCormick, 1993; Dul and Weerdmeester, 1998; Milanese and Grimmer, 2004) because there is a significant reduction in the load on the spine when arms can be aided on the desk (Occhipintie *et al*., 1985). In order to assess the possible mismatch/match of DH, an equation reported by Ramadan (2011) was adopted as follows:

$$SH + EH \leq DH \leq SH + (EH\ 0.852) + (SR\ 0.148) \quad (5)$$

Where SH is seat height, EH is elbow height, DH is desk height and SR is shoulder height.

Underneath desk height (UD): UD should be enough so that there is space between the knees and the underneath surface of the desk (Evans *et al*., 1988; Sanders and McCormick, 1993; Helander, 1997; Dul and Weerdmeester, 1998). This space should also allow for knee crossing (Corlett and Clark, 1995; Helander, 1997). In order to assess the possible mismatch/match of UD, an equation reported by Gouvali and Boudolos, (2006) was adopted with slight modification as follows:

$$(KH + Sh) + 2 \leq UD \leq [(PH + Sh)\cos 5^0 + (EH\ 0.852) + (SR\ 0.148)] - 4 \quad (6)$$

Where KH is knee height, Sh is shoe height, UD is underneath desk height, PH is popliteal height, EH is elbow height and SR is shoulder height.

RESULT AND DISCUSSION.

Anthropometric dimensions of students that participated in this study are presented (Tables 3-5) in percentiles for simplicity and applicability of use; and availability to classroom furniture manufacturers (Mokdad and Ansari, 2009; Oladapo and Akanbi, 2016b).

Table 3: The Anthropometric Data and Statistical Features of Lower Class Female Group (cm)

	Average	Lowest	Highest	Std. dev.	5^{th} Percentile	50^{th} Percentile	95th Percentile
KH	49.860	43.000	55.500	2.733	46.000	49.800	54.030
EH	17.100	12.000	22.000	2.094	13.100	17.000	20.110
PH	40.100	34.000	45.100	2.422	36.450	40.000	44.250
SR	47.790	42.000	57.000	3.139	42.600	47.500	53.500
BL	45.980	39.800	51.600	2.599	42.070	45.600	50.210
HW	28.460	23.000	34.600	2.398	24.610	28.600	31.820
Sh	1.670	0.200	3.000	0.592	0.490	1.800	2.710

Table 4: The Anthropometric Data and Statistical Features of Middle Class Female Group (cm)

	Average	Lowest	Highest	Std. dev	95th Percentile	50th Percentile	5th Percentile
KH	50.820	47.100	58.000	2.032	53.810	50.950	47.300
EH	17.710	9.700	25.000	2.839	22.000	17.500	13.630
PH	40.470	31.000	45.500	2.293	43.400	40.850	36.480
SR	49.990	40.300	56.500	3.057	54.020	50.150	44.860

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BL	48.740	41.000	87.000	5.182	52.620	48.500	43.960
HW	30.920	23.900	37.400	2.749	35.410	31.050	26.400
Sh	1.410	0.300	3.000	0.679	2.510	1.250	0.500

Table 5: The Anthropometric Data and Statistical Features of Upper Class Female Group (cm)

	Average	**Lowest**	**Highest**	**Std. dev.**	**95th Percentile**	**50th Percentile**	**5th Percentile**
KH	51.970	48.600	57.600	2.041	55.780	51.500	49.110
EH	18.560	10.600	25.000	2.956	23.000	18.650	14.220
PH	41.450	36.400	47.800	2.570	46.180	41.100	37.620
SR	51.740	45.600	59.000	2.892	56.890	51.500	47.360
BL	49.230	41.200	56.500	2.722	53.000	49.350	44.570
HW	32.780	27.200	43.600	3.032	37.590	32.750	28.730
Sh	1.630	0.200	4.600	0.759	2.700	1.500	0.660

Match/Mismatch Analysis

The match (in percentages) between the dimensions of classroom furniture designs and anthropometric measures of the students are as shown in Figures 1-2 and table 6.

Compatibility Analysis between Seat Height and Popliteal Height

As seen in Figure 1, seat height was appropriate for 43.040% of lower class female; 56.250% of middle class female; and 23.610% of upper class female in that order. In essence, many of the learners were using seats that are either too low or too high for their body build. Learners that uses seats that are too low may be subjected to potentially high risk of low back pain because such seats have the possibility of raising the angles of lumbar flexion while the learner sits on it (Pheasant, 1996; Milanese and Grimmer, 2004). A high seat has the possibility of subjecting its user to experiencing high amount of stresses on the popliteal arc that runs through the underside of the thigh and this may result to increase in tissue pressure on the posterior surface of the knee (Milanese and Grimmer, 2004). This situation may cause serious discomfort and possible risk of injury (Agha, 2010).

Compatibility Analysis between Seat Depth and Buttock Popliteal Length

As observed from table 6, seat depth was appropriate for 45.570% of lower class, 71.250% of middle class; and 0.000% of upper class female accordingly. Other learners were sitting on seats that are either shorter or larger for them. The high mismatch (100 %) experienced by upper class learners indicated that their buttock-popliteal length is larger than the seat depth and because of this, their thigh are likely to be compressed and blood circulation may not be possible (Milanese and Grimmer, 2004; Gouvali and Boudlos, 2006). The possibility of effective use of the back rest is not guaranteed if seat depth is not up to buttock-popliteal length (Pheasant, 2003; Niekerk *et al*., 2013). Learners' thighs would be unaided, while in the sitting posture, if the seat depth that is too short for them. This circumstance may bring about loss of stability and discomfort (Pheasant 1996, 2003; Castellucci *et al*., 2010; Dianat *et al*., 2013).

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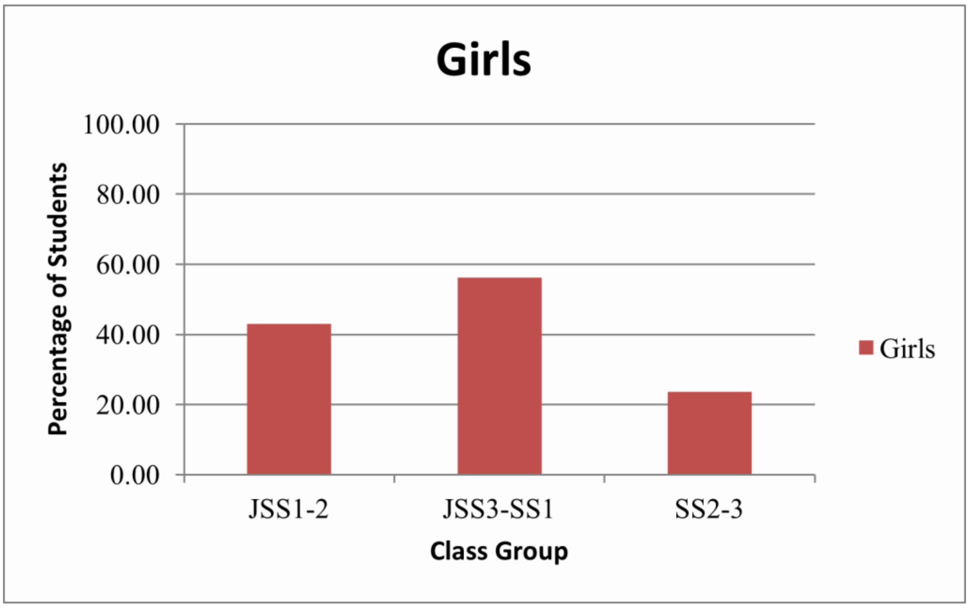


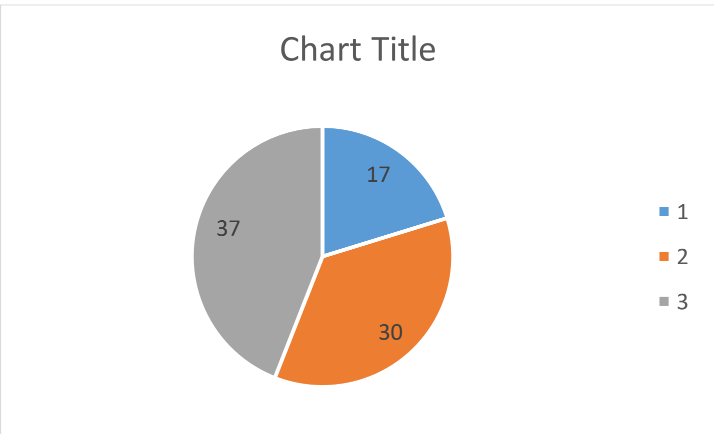
Figure 1: Compatibility Analysis of seat height for all students

Table 6: Compatibility Analysis of students that fit with SD

	LCF	MCF	UCF
Number of Students that find fit	36.000	57.000	0.000
Total number of students	79.000	80.000	72.000
Percentages	45.570	71.250	0.000

Compatibility Analysis between Seat Width and Hip Width

As observed from Figure 2, seat width was compatible for learners across the board. This finding differs totally from previous study by Guovali and Boudolos (2006) who reported that seat width was too narrow for 9.500% of the learners and too wide for about 90.500% of the learners. Dianat *et al.*, (2013) reported that seat width was too narrow for more than half of the learners and too wide for 7% of them. Narrow seats have the tendency of causing discomfort, unsteadiness and restriction of movement (Evans *et al.*, 1988; Khalil *et al.*, 1993; Orborne, 1996; Helander, 1997) but wide seats occupy more space and cannot be said to be unsuitable (Gouvali and Boudolos, 2006; Castellucci *et al.*, 2014).



Legend	
1, 80	LCF, 80 stds
2, 80	MCF, 80 stds
3, 71	UCF, 71 stds

Figure 2: Compatibility Analysis of seat width for all students

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Compatibility Analysis between Backrest Height and Shoulder Height

As presented in Figure 3, there is 100% mismatch between backrest and the learners in the lower and middle classes. However, 12.500% of upper class female are comfortable with the backrest of the classroom furniture available to them. The findings of the present study are in contrast to those of Parcells et al., (1999) who reported that 12.200% of the learners did not find fit as regarded backrest height and Guovali and Boudolos (2006) who submitted that mismatch existed for 60.100% of the learners in relation to backrest height. If learners' scapular is lower than backrest, arm mobility will likely be restricted (Evans *et al*., 1988; Orborne, 1996). A situation not favourable for learning arises when the learners are requested to abduct their elbows them more than 20^0 and flex them more than 25^0 so as to rest their elbows on the desk (Parcells *et al* ., 1999; Milanese and Grimmer, 2004) as the case is in this study.

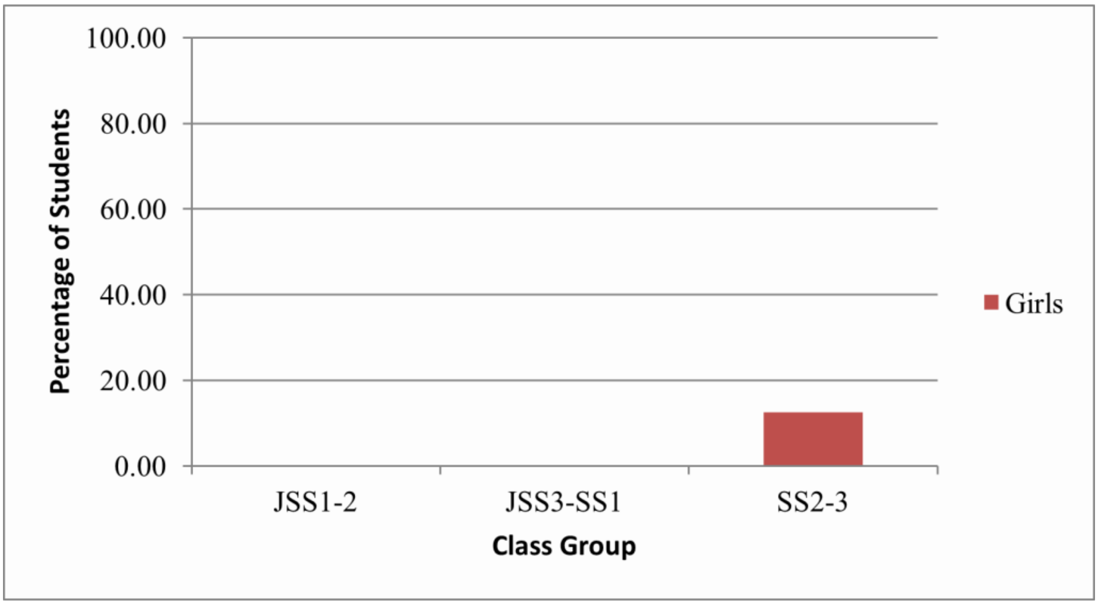

Figure 3: Compatibility Analysis of backrest height for all students

Compatibility Analysis between Desk Height and Elbow Height

Table 7 displayed compatibility analysis between the desk height and elbow height. About two third (64.560%) of the female in the lower class were using desk that were either too high or too low. A little more than one half (52.500%) of the female in the middle class were using desk that were either too high or too low. The situation is worst in upper class as none of the learner is comfortable with desk height. If desks available for learners' use are essentially high, the users would be forced to raise their arms. This action may result to excessive muscular load, discomfort and pain in the shoulder area (Parcells *et al*., 1999; Szeto *et al* ., 2002). On the other hand, learners that were using desk that were too low would be required to bend their trunk forward which may lead to increase in spinal load (Wilke *et al*. 1999, 2001). This finding agrees with that of Dianat *et al*. (2013) but in contrast to those of Parcells *et al*. (1999), Guouvali and Boudolos (2006), Chung and Wong (2007), Savanur *et al*. (2007), Saarni *et al*. (2007) and Castellucci *et al*. (2010).

Table 7: Match percentage of students that fit with DH

	LCF	MCF	UCF
Number of Students that find fit	28.000	38.000	0.000
Total number of students	79.000	80.000	72.000
Percentages	35.440	47.500	0.000

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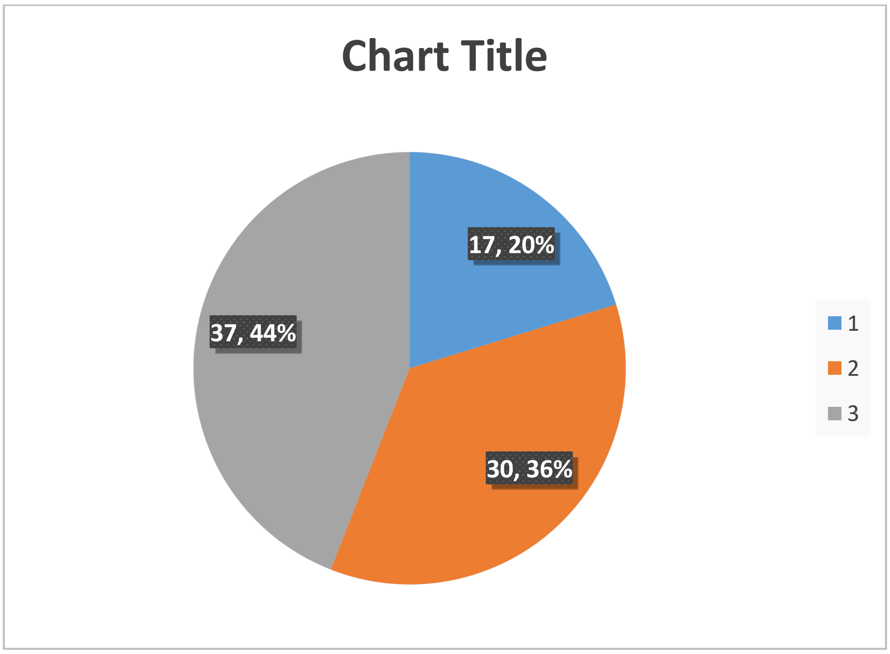
Compatibility Analysis between Underneath Desk Height and Knee Height

Figure 4 showed the compatibility analysis between the underneath desk height and knee height. As seen, 21.520% of lower class female found fit. For females in the middle class, 37.500% found underneath desk height compatible. Underneath desk height was suitable for 51% of female in the upper class. The incompatibility experienced by learners in the lower and middle classes is that of the underneath desk height being too high. This finding is in line with that of Guovali and Boudolos (2006). Furthermore, for the upper class, the knee height of the majority of the learners is higher than underneath desk height. Consequently, their thighs were in contact with the desk such that legs' mobility is denied (Evans *et al*. 1988; Dul and Weerdmeester, 1998; Parcells *et al*. 1999).



Legend	
1, 17	LCF, 17 stds
2, 30	MCF, 30 stds
3, 37	UCF, 37 stds

Figure 4: Match percentage of underneath desk height for all students

Proffered Dimensions for the Fabrication of Ergonomic Compliant Classroom Furniture (cm)

In order to produced ergonomically suitable classroom furniture for the learners, design for average individuals is considered. This is cost effective. However, according to Okunribido (2000), anthropometric dimensions is the foundation upon which all ergonomic design of products is based. Thus, the data required for the fabrication of ergonomic compliant classroom furniture are presented in table 8. These values were gotten by substituting average values of the anthropometric measurements of the learners (Tables 3-5) into the match equations presented in section 2.5. The classroom furniture features for lower class male are unique. However, those of the middle class female and upper class female are very close (table 9a and b). Hence, two types of classroom furniture (table 10) are needed by the studied population and are thus fabricated.

Table 8: Values of Anthropometric Data Required for Ergonomic Compliant Classroom Furniture (cm)

Groups	KH	EH	PH	SR	BL	HW	Sh
Lower class Female	47.660	14.340	34.720	44.490	44.250	28.760	1.500
Middle class Female	51.770	17.630	40.580	50.430	49.470	35.930	2.280
Upper class Female	52.440	17.810	40.260	51.160	50.980	37.480	2.300

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Table 9 a: Dimensions for Ergonomic Compliant Classroom Furniture (cm)

		SH			SD			B	
Groupings	**LOL**	**AV**	**UP**	**LOL**	**AV**	**UP**	**LOL**	**AV**	**UP**
J.S.S.1-J.S.S.2 FEMALE	34.40	36.99	39.57	35.40	38.72	42.04	26.69	31.14	35.59
J.S.S.3-S.S.S.1 FEMALE	40.13	43.15	46.16	40.78	44.61	48.43	30.26	35.30	40.34
S.S.S.2-S.S.S. 3 FEMALE	38.87	42.85	44.83	38.78	42.64	46.05	30.70	35.82	40.93

Table 9b: Dimensions for Ergonomic Compliant Classroom Furniture Redesign (cm)

		D			UD	
Groupings	**LOL**	**AV**	**UP**	**LOL**	**AV**	**UP**
J.S.S.1-J.S.S.2 FEMALE	54.33	56.35	58.36	51.66	54.30	56.94
J.S.S.3-S.S.S.1 FEMALE	75.96	78.38	80.80	56.52	60.57	64.81
S.S.S.2-S.S.S. 3 FEMALE	74.48	76.97	79.45	56.07	59.67	63.31

Table 10: Re-classification of Learners Based on the Dimensions of Ergonomic Compliant Classroom Furniture (cm).

	AV for LCF	**AV for MCF**	**AV for UCF**	**AV_t**
SH	36.993	43.152	41.855	42.650
SD	38.727	44.621	42.463	43.993
BH	31.144	35.373	35.072	35.264
DH	56.375	78.389	76.027	77.365
UD	54.289	60.675	59.596	60.181

Where **AV** = average value, **AV_t** = true average value for MCF and UCF.

Learners evaluated the ergonomic compliant classroom furniture provided for them (FORM A). The proportion of learners that expressed satiety with the standard of fit/comfort afforded by the ergonomic compliant classroom furniture over the existing one jumped for lower class learners from 64.660-82.480 and

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that of J.S.S.3 to S.S.S.3 female learners jumped from 66.250-83.330% (tables 11 and 12).

Table 11: Learners' Ratings of Existing Classroom Furniture and Ergonomic Compliant Classroom Furniture

	LCF		MCF-UCF	
	EDS (TOTAL)		EDS (TOTAL)	
N	OLD	NEW	OLD	NEW
1	16	19	14	21
2	15	20	15	21
3	15	22	14	21
4	13	24	14	21
5	17	18	15	20
6	15	20	16	20
7	16	21	17	20
8	16	20	16	19
9	15	16	16	18
10	16	20	16	23
11	14	23	19	21
12	16	17	16	20
13	16	22	17	20
14	15	20	15	18
15	11	20	14	18
16	15	18	18	21
17	17	17	16	21
18	16	20	16	20
19	16	19	18	19
20	14	17	16	18

Table 12: Comparison between Existing Classroom Furniture and Ergonomic Compliant Classroom Furniture.

	EDS MEAN		% EDS MEAN	
	OLD	NEW	OLD	NEW
Lower Class Female	0.6466	0.8248	64.66	82.48
J.S.S.3-S.S.S.3 Female Learners	0.6625	0.8333	66.25	83.33

Form A	Classroom Furniture Evaluation Opinionnaire Form
Department of Mechanical Engineering,	
Olusegun Agagu University of Science and Technology, Okitipupa.	
Evaluator's Name……………………………………………	
Period of use…………………..	
Class…………………………………………………… Gender…………………………	

Section A: Existing Classroom Furniture (both type)					
CF' features	Strongly fit (4 points)	Fit (3 points)	Averagely fit (2 points)	Poorly fit (1 point)	No fit (0 point)
Seat height (SH)					
Seat depth (SD)					
Seat width (SW)					
Backrest height (B)					
Desk height (D)					
Underneath desk height (UD)					
Total %, Ergonomic Design Score (%EDS) = (SH+SD+SW+B+D+UD/24)*100 =					
Section B: Ergonomic Compliant Classroom Furniture (both type)					
CF' features	Strongly fit (4 points)	Fit (3 points)	Averagely fit (2 points)	Poorly fit (1 point)	No fit (0 point)
Seat height (SH)					
Seat depth (SD)					
Seat width (SW)					
Backrest height (B)					
Desk height (D)					
Underneath desk height (UD)					
Total %, Ergonomic Design Score (%EDS) = (SH+SD+SW+B+D+UD/24)*100 =					

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CONCLUSION

This study established that there is a mismatch between secondary school female learners' anthropometry and the classroom furniture dimensions of the studied population. The mismatched ranged from about 43.750-76.390%, 28.750-100.000%, 87.500-100.000%, 52.500-100.000% and 49.000–78.480% for seat height, seat depth, backrest height, desk height and underneath desk height respectively. From the foregoing, it is observed that principles of ergonomics are not followed for the fabrication of classroom furniture for female secondary school learners in the geographical area covered by this work.

Thus, fabrication and allocation of classroom furniture for learners should be based on ergonomic norms and anthropometric dimensions. Two types of classroom furniture of different dimensions should be urgently made available for usage by female secondary learners. There is nothing like one-size-fits-all philosophy.

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