ANTHROPOMETRIC DESIGN OF FURNITURE FOR USE IN TERTIARY INSTITUTIONS IN ABEOKUTA, SOUTH-WESTERN NIGERIA

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Abstract:

Students sit for most of the time on school furniture in the classroom. However, the design of school furniture in Nigeria using the anthropometric data of the users has yet to be given adequate attention. This study was carried out to obtain anthropometric data of students in higher institutions of learning in Nigeria for the design of ergonomics chairs and tables for use by students in those institutions. Seven hundred and twenty (720) students in three selected institutions participated in the study. Various body dimensions (sitting elbow height, shoulder height, knee height, popliteal height, buttock-popliteal length, stature and body weight) of the students were measured using standard anthropometer and 5^{th}, $50^{th,}$ and 95^{th} percentiles of the data obtained were computed using a SPSS 16.0 statistical package. The existing furniture dimensions in the selected institutions were also measured. Based on the obtained anthropometric data, this paper proposes furniture design dimensions for seat height, seat depth, seat width, backrest height (upper), armrest and desk height for students in the selected tertiary institutions. The present study may be a pointer to the effect that in the design of tables and chairs for use in higher institutions, the anthropometric data of the Nigerian students were not considered. It is hereby recommended that similar study should be carried out in other sections of the country.

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1 Introduction

Anthropometric data is a collection of the dimensions of the human body and is useful for apparel sizing, forensics, physical anthropometry and ergonomic design of the workplace [18, 10, 41, 5]. Similarly, some authors defined anthropometric data as that used in ergonomics to specify the physical dimensions of workplace, equipment, furniture and clothing [21, 19].

Oyewole *et al.* [37] reported that the use of furniture dated back to the Stone Age when chairs and tables were carved from stones and rocks. Similarly, Thariq *et al.* [44] noted that chairs were essential part of any learning environment. Many studies have investigated the ergonomic problem that is associated with the use of school furniture and its design [40, 30, 33, 38, 14]. Studies have confirmed that students spend a greater part of their time in school in the seated posture [25, 24]. Sitting position for a long period of time and static posture in a forward bending manner has been found to be the major cause of low back pain [42, 3, 47]. Mandal [27] in his research noted that 60 percent of students complained of pains in the back, neck or shoulder for which they blamed the furniture. Salminen *et al*. [43] also noted that low back pain was at least, to some extent, due to an unsuitable school table. In addition, Evans *et al*. [13] stated that a mismatch between thigh length and seat depth was significantly related to seating discomfort, and that a mismatch in the seated elbow height and the table height was significantly related to pain in the shoulders and neck. Furthermore, improper design of school furniture is one of the contributing factors to back pain between students as indicated in some studies [1]. A surprising number of students had regular bouts of back, neck and head pains [36].

Linton *et al*. [25, 24] had shown that students spend a substantial part of their time in schools in the sitting posture. Sitting for a long time in a static position by leaning forward have been confirmed to be a major cause of backache [47] which is not limited to adults [36]. A mismatch between the length of thigh and seat depth has been shown to be related to discomfort while a mismatch in seated elbow height and desk height is related to neck and shoulder pain [15]. Helander *et al*. [17] observed that anthropometric dimensions of the user population are essential in the design of workstations for a healthy and comfortable posture. The study of the mechanics of the relevant body parts and external systems while sitting have shown that seventy –five percent (75%) of the body weight is supported by only 26cm^2 of sitting surface resulting in high compressive stress [45]. Therefore, there is the need for leg support to distribute the loads in the buttock and thigh [35]. In fact, Chaffin *et al*. [8] confirmed that the feet should firmly rest on the floor or foot support to prevent the thighs from supporting the weight of the lower leg.

For the maintenance of a good sitting posture for students, classroom furniture plays a prominent role [37]. Knight and Noyes [22] observed that two major functions of school furniture are to support the student when attending the lecture and when writing or drawing on the working surface, and these activities require adoption of different physical positions by the student.

Molenbroek *et al*. [31] noted that various designs of school furniture have been promoted to improve the posture and mobility of the user. Adjustable prototype tables and chairs were developed and evaluated by [20]. Adjustability of school furniture is essential in ensuring increased comfort and decreased incidence of musculoskeletal disorders [15]. But Oyewole *et al*. [37] noted that fixed-type furniture, to accommodate all users in the design of the seat, arms and backrests of most chairs, was still common, especially in developing countries where budget for education is paltry. The design of ergonomically compliant school furniture has not been given the attention it deserves in Nigeria as the anthropometric data of other countries have been used for such designs and eventual construction. Very few of such studies have been conducted in the higher institutions in Nigeria [2]. The study by Adejuyigbe and Ali [2] identified the ergonomic problems of various furniture items used by staff and students in a Federal University and equally prescribed optimum design for them. However, the proposed specifications were based on foreign anthropometric data. A study by Musa *et al*. [34] confirmed that 93.75 % of students in three selected tertiary institutions complained of neck, shoulder, upper and lower back pains that they attributed to the furniture they used.

Anthropometric data should be established for the user population and the anthropometric data for Nigerians are sparse [18]. There is thus the need for anthropometric data of Nigerian students in the tertiary institution for the design and construction of furniture to suit them. The purpose of this study was to obtain the anthropometric data of students in three selected tertiary institutions in Abeokuta for the design of ergonomic tables and chairs for the use of these students.

2 Experimental investigation

2.1 Sample Selection and Measurements Procedure

Three higher institutions in Abeokuta metropolis namely the University of Agriculture (UNAAB), Moshood Abiola Polytechnic (MAPOLY), and Federal College of Education (FCE, Osiele) were selected to participate in the research. Seven Hundred and Twenty (720) randomly selected amongst the first through final year students participated in the study with 240 students (120 boys and 120 girls) drawn from each participating institution. The ages of the students were between 17 and 27 years (mean of 22.85 years, SD = 2.05 years). The body size of each student was assessed using standard anthropometric measurement techniques based on a study by [40]. The consents of the students were obtained before the commencement of the measurements. All anthropometric measures were taken with the subjects wearing light clothing, in a relaxed and erect posture and without shoes. The measurements were taken on a level floor in one of the classrooms in each of the selected institutions. Measurements were taken every working day for 20 days together with the assistance of a data- recording person in the month of April in year 2010. To ensure accuracy of recorded data, the data-recording person and helper were trained on the use of anthropometers and other measuring devices in the laboratory and trial runs were conducted. The measurements during the trial runs were checked for consistency and accuracy. Also recorded with the measurements was the information on/regarding age and sex. Three replications of the measurements were taken and the averages recorded. The measurements were also checked for consistency.

Fig. 1 shows clearly the exact location of the entire anthropometric dimension. This is important in ensuring that the measurement processes for all participants are done correctly and accurately to minimize the measurement error in data collection. All measurements were measured in centimeter (cm) except for the body mass that was in kilogram (kg).

2.2 Description of Measurements

(i) Sitting Height
The student sits erect with the head in the frank fort plane with arms hanging at the sides and hands resting on the thighs. Vertical distance from the seat surface to vertex of the head with hair pressed down measured with a stadiometer.

(ii) Sitting Elbow height
The vertical distance from the bottom of the tip of elbow (olecranon) to the sitting surface, measured with the elbow in 90^0 of flexion. The subject wears light clothing and sits fully erect with thighs fully supported and the lower legs hanging freely. The upper arms hang freely downwards and forearms are horizontal. The Sitting Elbow height is required to determine the arm rest height.

(iii) Sitting Shoulder height
The student sits erect with his/her upper arms at the sides and hands on the thighs. The vertical distance from the top of the shoulder at the acromion process to the students' sitting surface measured with a stadiometer. This dimension is essential in the determination of Back rest Height (Upper).

(iv)Thigh Clearance
The student sits erect with the legs extended and relaxed. The vertical distance from the sitting surface to the top of the thigh at its intersection with the abdomen measured with a vernier caliper. The thigh clearance, popliteal height and shoe clearance are necessary for the determination of the table height.

(v) Sitting Knee Height
This is the vertical distance from the floor to the uppermost point on the knee. The subject sits erect on a chair and the knee was at the right angle. The measurement was taken with the use of a stadiometer.

(vi) Popliteal height
The vertical distance measured with 90^0 knee flexion from the foot resting surface to the posterior surface of the knee (popliteal space). The subject sits fully erect with thighs fully supported and sitting surface extending as far as possible into the hollow of the knee, the lower legs hanging freely. The distance is measured from the measuring block to the forward edge of the sitting surface. The measurement is necessary in the determination of seat height.

(vii) Stature
This is the vertical distance from the floor to vertex of the head with hair pressed down. Subjects stand fully erect with both feet together and the head is orientated in the Frankfurt Plane. Measurements were read from the stadiometer.

(viii) Buttock-Popliteal length

The horizontal distance is measured with 90^0 knee flexion from the posterior surface of the buttock to the posterior surface of the knee or popliteal space. The subject sits fully erect with thighs fully supported and sitting surface extending as far as possible into the hollow of the knee, the lower legs hanging freely. The distance is measured from the measuring block to the forward edge of the sitting surface. The buttock-popliteal length is needed to determine the seat depth.

(ix) Sitting Hip Breadth

This is the maximum horizontal distance across the hips in the sitting position. The sitting hip breadth is essential to specify the seat width.

(x) Measurement of Body mass

The weight of the student was taken using a calibrated balance upon which the student stands.

(xi) Buttock-knee length

The student sits erect with the feet on the floor at 90^0 knee flexion, arms at the sides and hands resting on thighs. The horizontal distance from the most posterior point on the buttocks to the most anterior point on the knee measured with a stadiometer.

(xii) Forearm-Hand length

The student sits erect with the upper and lower arms at right angles to one another and the hand stretched out. The distance from the posterior end of the elbow to the longest finger of the hand while the upper arm was at an angle of 90^0 with the lower arm measured with a vernier caliper. The forearm-hand length is the relevant measurement that is necessary to specify the table depth.

(xii) Seat depth

The chair seat depth is the horizontal distance of the sitting surface from the back of the seat, at a point where it is assumed that the buttock begins at the front of the seat. This should be deep enough to ensure that the region behind the knees (popliteal) would not hit the front of the seat.

(xiii) Seat slope:

The chair seat slope is the direction and the angle of pitch of the chair seat.

(xiv) Table height: - The table height is the vertical distance from the floor to the top of the front edge of the desk or table.

(xv)Table clearance: - The table clearance is the vertical distance from the floor to the bottom of the front edge of the desk or table.

(xvi) Table slope: - The table slope is the angle of pitch of the top of the desk.

2.3. Measuring Instruments

The measuring instruments used for this study were as follows:
(i) Weighing machine floor type (stadiometer), model-Health Scale ZT-160, Micro field, England, was used to measure the vertical dimensions such as sitting height, sitting elbow height, sitting shoulder height, knee height, popliteal height and eye height
(ii) Vernier Caliper (Range 0-68cm with error 0.1mm) was used to measure the horizontal dimensions such as Buttock-Popliteal Length, Buttock-knee Length and Forearm- Hand Length.
(iii)A metal tape was used to measure the chairs and table dimensions while a Goniometer was used to measure the slope angles of the seat and table.

2.4. Data Analysis

The data was analyzed statistically using SPSS 16.0 statistical package and Microsoft Excel (2007) programs. The anthropometric data was analyzed using average, minimum, maximum, standard deviation, 5^{th} percentile, 50^{th} percentile and 95^{th} percentile.

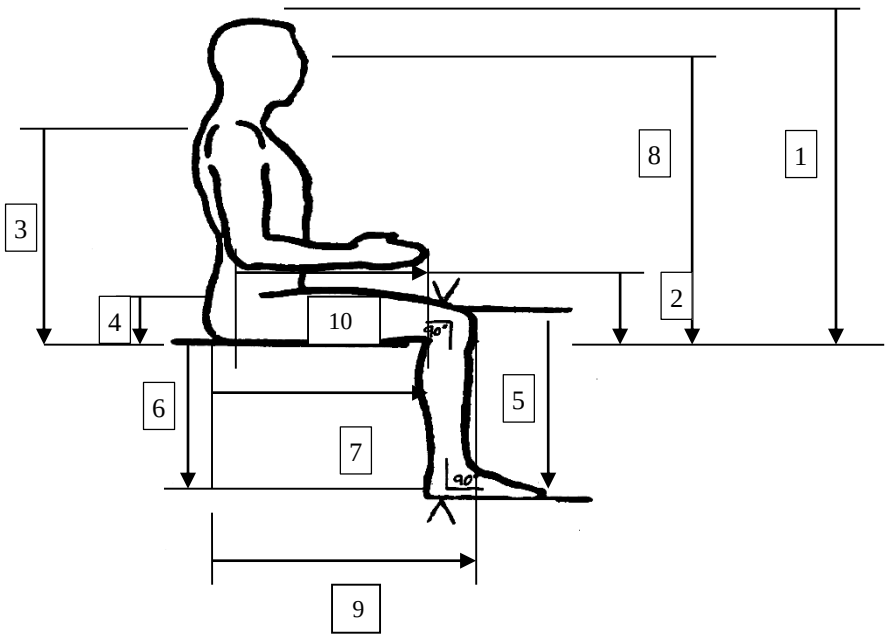

Figure 1. Measured anthropometric data.

Legend

1- Sitting Height
2 - Sitting Elbow height
3 - Sitting Shoulder Height
4- Thigh Clearance
5 - Knee height
6 - Popliteal Height
7- Buttock-Popliteal Length
8- Eye Height
9 - Buttock-knee Length
10- Forearm- Hand Length

Table 1. Dimensions of Existing Chairs and Table in the three selected Institutions

DIMENSIONS / SCHOOLS	***SEAT HEIGHT (cm)***	***SEAT DEPTH (cm)***	***SEAT SLOPE ANGLE (deg)***	***TABLE DEPTH (cm)***	***TABLE HEIGHT (cm)***	***TABLE CLEARANCE (cm)***	***SURFACE SLOPE ANGLE (deg)***
FCE, OSIELE	47,00	38,00	3°	29,50	77,50	67,00	10°
MAPOLY	41,00	29,00	3°	29,00	69,00	55,00	10°
UNAAB	45,00	35,00	3°	26,50	76,50	71,00	10^0

3 Results and discussion

3.1. Characteristics of Tables and Chairs in the Selected Schools

Only one type of chairs and tables was identified in the three institutions, and the dimensions were exactly the same in the respective institutions. Table 1 shows the dimensions of tables and chairs in the three selected institutions. The chair and table at Federal College of Education (FCE, Osiele) were higher than those available at the other two institutions; The University of Agriculture (UNAAB) and Moshood Abiola Polytechnic (MAPOLY). Similarly, the table height and depth at FCE were larger than the ones in the other two institutions. However, the clearance provided for table at UNAAB was more than the ones at FCE and MAPOLY.

Though the seat slope and surface slope angles were the same for the furniture in these institutions, the fact that there existed differences in other/various dimensions suggest that different companies constructed the tables and chairs.

3.2. Anthropometric Dimension of the Students

The anthropometric data of the students are presented in Table 2 as means, standard deviations (SD), and 5^{th}, 50th and 95^{th} percentiles. Furthermore, the minimum, maximum, median of the dimensions and the body mass are included. In anthropometry, percentiles of various body dimensions are used to determine design values for an application. For seat height, the 5^{th} percentile (lower percentile) of the popliteal height of the population is usually recommended so that a larger number of the population is accommodated and thus allow a short person to use the chair. Similarly, 5^{th} percentile of: buttock-popliteal length is considered for seat depth; sitting shoulder height for upper back rest height; arm rest height for lower back rest height. However, the 95^{th} percentile (larger percentile) of the hip breadth is usually recommended in the design of the seat and table/desk widths to accommodate as many people of the population as possible and thus allows a fat person to use the chair.

The seat surface height, seat depth, seat width, backrest height, and backrest width are the important dimensions for the design of chairs while table height, table width and table length are the dimensions that are essential for the design of tables. The design of the chair and table for the use by students in the higher institutions was based on the following criteria:

Seat Height

The popliteal height should be considered in the design of seat height and for non-adjustable seats; the 5^{th} percentile may be used as the maximum allowable seat height [48, 40, 5]. The 5^{th} percentile in the present student is 36,00 cm and if this is added to shoe heel allowance of 0,45 cm [23, 41], the seat height should be 36,45 cm (Table 3).

Seat Depth

The anthropometric dimension to be considered in the design of the seat depth is the buttock-popliteal length. The seat depth should not exceed the buttock-popliteal length of the shortest user [44, 5] and as such the 5^{th} percentile of the buttock-popliteal length should be used to determine the seat depth. In this study, the 5^{th} percentile of the buttock-popliteal and thus the seat depth is 32.05 cm.

Seat Width

The dimension of the seat width should be determined using the hip breadth of those with wide hips. The seat width should be wide enough not only to accommodate the user's hips and clothing but also allow the use of arms comfortably [5]. Thariq *et al*. [44] recommended 95^{th} percentile of hip breadth and allowance 0,40 cm for clothing while [31] recommended a seat width that

Table 2. Summary of Anthropometric Dimension among Student of the selected schools (n= 720)

Anthropometric Dimension	Mean	SD	Min	Max	5th percentile	50th percentile	95th percentile
Age (Yrs.)	22,85	2,05	17,00	27,00	19,00	23,00	26,00
Sitting Height (cm)	78,74	5,30	69,00	92,00	72,00	77,50	89,00
Sitting Elbow Height (cm)	19,18	2,11	15,00	23,50	15,50	19,00	22,50
Sitting Shoulder Height (cm)	49,66	4,89	52,00	60,00	42,00	50,00	55,00
Thigh Clearance (cm)	13,81	1,23	12,00	18,00	12,00	14,00	16,00
Knee Height (cm)	50,50	4,16	42,00	61,00	44,00	50,00	58,95
Popliteal Height (cm)	40,92	4,65	44,00	52,00	36,00	40,00	49,00
Stature (cm)	164,87	7,99	150,00	187,00	153,03	163,75	180,00
Body Weight (kg)	59,66	6,27	41,00	83,00	52,00	59,00	73,90
Buttock Popliteal Length (cm)	40,72	3,54	32,00	47,00	32,05	42,00	46,00
Hip Breadth (cm)	32,88	2,40	27,00	55,00	29,00	33,00	36,00
Eye Height (cm)	69,46	5,22	58,00	87,00	63,00	69,00	79,00
Buttock-Knee Length (cm)	55,74	2,94	50,00	63,00	51,05	56,00	61,00
Forearm- Hand Length (cm)	45,60	3,08	39,00	53,00	41,00	45,00	52,00

is equivalent to 99th percentile hip breadth and 15percent allowance for clothing. In this study, the 95th percentile of hip breadth of 36 cm is used with an allowance of 15 percent of the value (5,4 cm) which translates to a seat width of 41,40 cm.

Seat Angle to Horizontal

It has been confirmed that a forward- inclining seat affects the lumbar spine positively and that a loping desk may do the same and improves the posture of other parts of spine [4]. However, Parcells *et al.* [40] noted that users prefer forward inclinations of 0^0 (horizontal) to 5^0 for comfort. The adopted seat angle to horizontal is 0^0 (horizontal) as the desk angle is expected to provide adequate compensation.

Table 3: Recommended dimensions for chair and table for use in tertiary institution in Nigeria

Feature	Anthropometric measure	Design dimension	Criteria/Determinant
Seat surface height	Popliteal height	36,45cm	5th percentile of Popliteal height + 0,45cm shoe heel allowance
Seat depth	Buttock-Popliteal Length (BPL)	32,05cm	5th percentile of Buttock- Popliteal Length
Seat width	Hip breadth, sitting	41,40cm	95th percentile of Hib breadth, sitting + 15 percent allowance for clothing
Back rest width	Hip breadth, sitting	41,40cm	As with seat width
Back rest Height (Upper) above seat	Sitting Shoulder Height	42,00cm	5th percentile of Sitting Shoulder height
Back rest Height (Lower) above seat	Arm rest height	15,50 cm	5th percentile of Sitting Elbow Height
Backrest angle to horizontal		110^0	
Arm rest Height	Sitting Elbow Height	15,50cm	5th percentile of Sitting Elbow Height
Seat angle to horizontal		0^0	
Table height		56,33cm	Max acceptable height =Seat height + Functional Elbow height + shoe heel allowance
Table depth	Forearm-hand length	45,00cm	50th percentile forearm-hand length
Table width	Hip breadth	46,80cm	95th percentile of hip breadth + 15 % allowance for clothing + 15 % allowance as clearance.
Table angle to horizontal		15^0	

Arm Rest Height

The sitting elbow height is a determinant in the design of armrest height. As long as/Providing that the lowest value is accommodated, the others could also be accommodated, the 5th percentile of the elbow rest height was considered in the design. From Table 3, this value is 15,50 cm.

Seat Back Rest Height (Upper)

For the design of the upper part of the backrest, the shoulder height (sitting) is considered. The 5th percentile of Sitting Shoulder Height used by [44] is adopted in the current study and this dimension is 42,00 cm from the seat surface (Table 3).

Seat Back Rest Height (Lower)
The lower part of the backrest is determined using the armrest height. This is the value of the 5th percentile of sitting elbow height, which is 15, 50 cm.

Back Rest Angle
Cranz [11] recommended that the back rest should have a rearward slope of between 90^0 and 110^0 while [44] recommended 96^0. However, it has been shown that the electric activity of the back muscles is lowest and thus the intradiscal pressures when the back rest has an inclination of 110^0 to 130^0 [16]. A rearward slope of 110^0 is adopted in this study to provide a good backward leaning especially when the student is not writing but listening to the lecture.

Table surface Height
The minimum table height = seat height + minimum (5th percentile of sitting elbow height) + shoe heel allowance

$$= 36,45 \text{ cm} + 15,50 \text{ cm} + 0,45 \text{ cm}$$
$$= 52,40 \text{ cm} \quad (1)$$

The maximum table height was determined as:

The maximum table height = seat height + functional elbow height + shoe heel allowance (2)

The functional elbow height was determined using the equation in [44] given as:

$$h_{Emax} = 0,8517hEv + 0,1483hS \quad (3)$$

where hEv is the 5th percentile of sitting elbow height (15,50 cm) and hS is the 5th percentile of the sitting shoulder height (42,00 cm)

$h_{Emax} = (0,8517 \times 15,50) + (0,1483 \times 42,00) = 13,20 + 6,23 = 19,43$ cm

The maximum table height is thus given by

$= 36,45 + 19,43 + 0,45 \text{ cm} = 56,33 \text{ cm}.$ (4)

Table surface Width
The recommended table width is the dimension of 50th percentile of elbow-to-elbow width of the user [41, 39] with an allowance for clothing and clearance. However, the 95th percentile of the hip breadth with 15 percent as allowance for clothing and another 15 percent for clearance is adopted in this study. The 95th percentile of the hip breadth is 36 cm, which translates to a table surface width of 46,8 cm.

Table surface depth
The distance between the elbow and the hand should be a deciding dimension when determining the desk depth. The average design concept [44, 41, 39] is considered for the dimension of the table depth and from Table 3, the 50th percentile of the forearm-hand length is 45,00 cm.

Table angle to horizontal
Studies have confirmed that sloping tables reduce the trunk and flexion of seated persons engaged in reading and writing [12, 6, 4]. Based on the assertion, Mandal [28] proposed that tables should be at an angle of 15^0 towards the user so that the visual angle may be reduced and allow the user to have an upright posture of the trunk. However, Chaffin *et al*. [8] suggested that the table should have an angle of inclination of between 15^0 and 20^0. The current study agrees that the table should tilt towards the user with an angle of 15^0. The recommended dimensions of the tables and chairs in tertiary institutions are presented in Table 3. The sketch and dimensions for the proposed desk and chair are shown in Figures 2 and 3 respectively. Figure 4 shows the design of the side-mounted desktop chairs that may be constructed for the students in tertiary institutions. As shown in Table 3, the seat height should be 36,45 cm for the students in these institutions. The seat heights of the existing chair are 47,00 cm (FCE); 41,00 cm (MAPOLY), and 45,00 cm (UNAAB) and that make the seats to be high for the students. High a seat makes the underside of the thigh to become compressed causing discomfort and restriction in blood circulation and to compensate for this, a sitting person moves forward his buttocks on the seat making the body stability to be weakened [49]. The proposed dimension of the seat surface height in this study is lower than 44,50 cm proposed by [44] for students in Sri Lanka, 43,5 cm proposed by [9] for Indians, 38, 6 cm proposed by [48] for Turkish students and 37, 7 cm proposed by [32] for students in higher institutions in Iran. This predisposes that chairs designed for the students in these countries, especially Sri Lanka and India may not be comfortable for the Nigerian students.

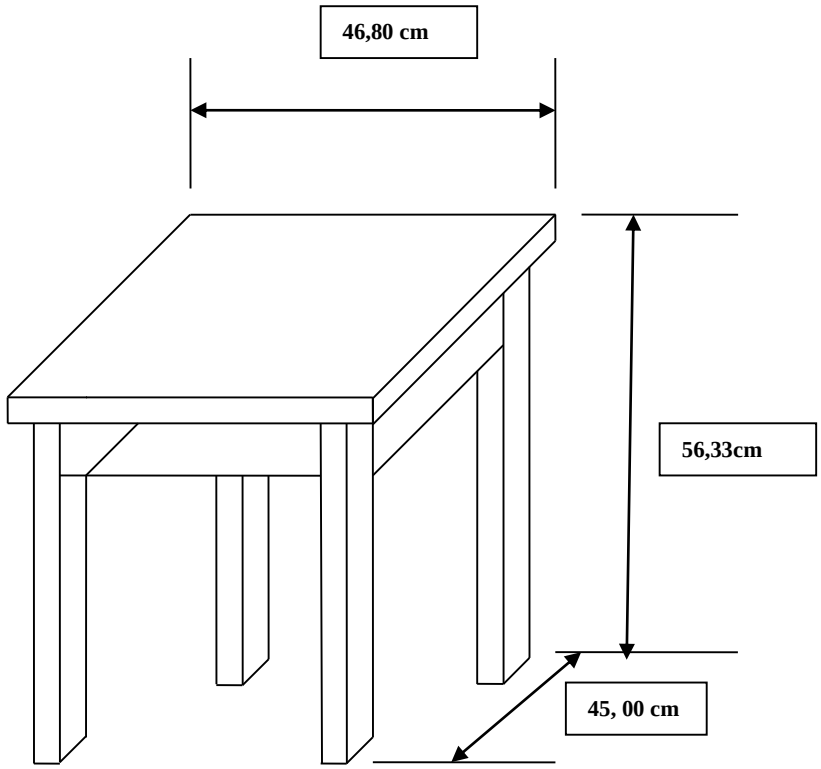

Figure 2. Newly designed Table.

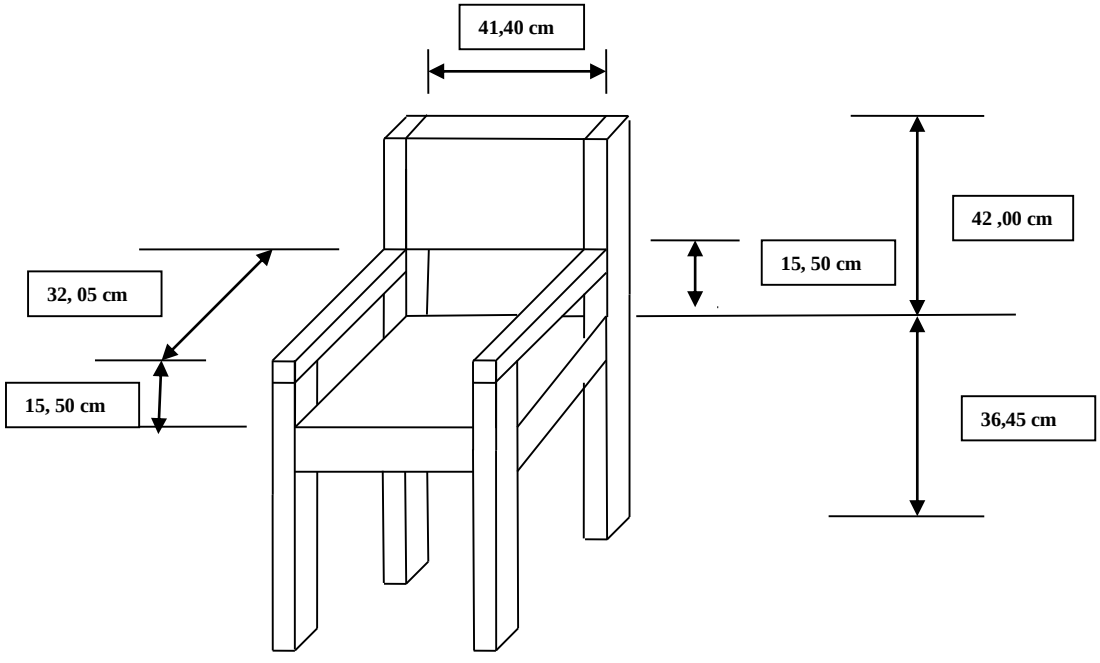

Figure 3. Newly designed Chair.

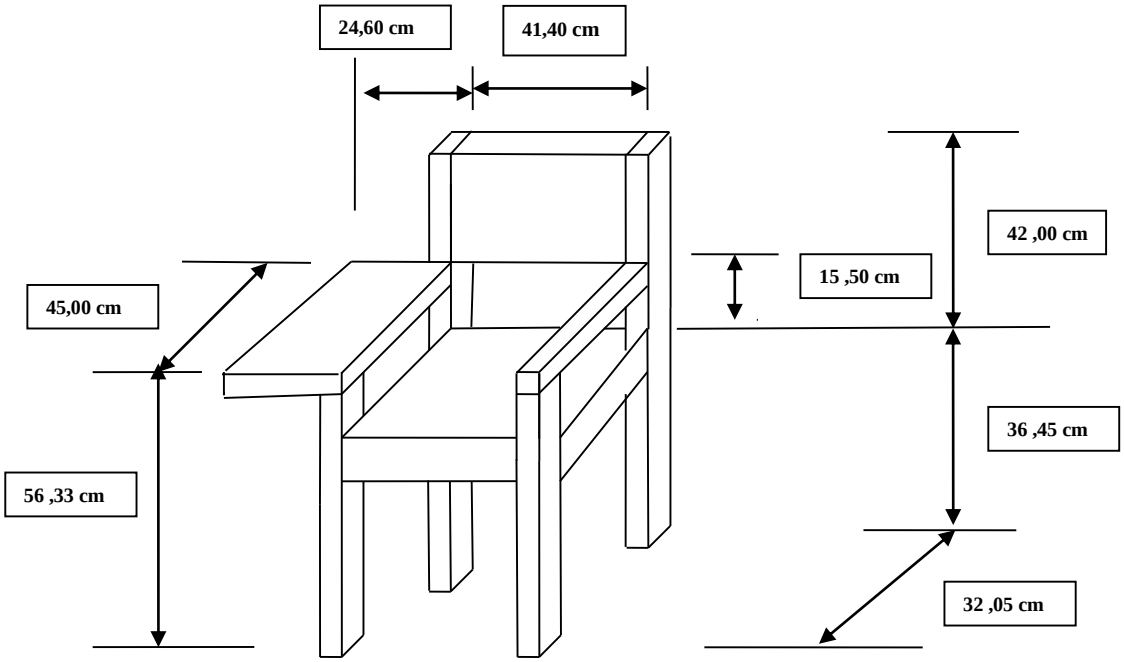

Figure 4. A newly designed desktop chair.

From the present study, the seat depth should be 32,05cm but the seat depths of the existing furniture are 38,0cm (FCE), 29,00cm (MAPOLY) and 35,00cm (UNAAB), which makes the seat deep for the students of FCE and UNAAB but shallow for those of MAPOLY. Large a depth does not allow an appropriate use of back support, which causes curvature of the spine (kyphosis) and may lead to an uncomfortable posture. Shallow a seat may cause the user to have the sensation of falling off and may result in lack of support of the lower thighs [39]. A seat depth of 32, 05cm for Nigerian students is lower than 40,6cm for Turkish students as proposed by [48], 42,1cm for Portuguese students [50, 51], 48.9 cm for Americans [52] and 40,0 cm proposed by [9] for Indian students. For the seat width, the present study proposes 41,40 cm, which is higher than 39, 10cm proposed by [48] for Turkish students, 37. 7 cm proposed for students in higher institutions in Iran, 76.25cm for Americans [51], 51.18 cm for Portuguese [50, 51] and 40. 0 cm proposed by [9] for Indians. As part of the requirements for a good chair, an upper backrest height of 42,0 cm and a lower backrest of 15,50 cm are proposed in this study. The use of the backrest is essential as it promotes a straight back while in the sitting posture and therefore, reduces associated pain at the back. The design for the chair also provides for armrests with a height of 15,50cm. Nag *et al*. [35] noted that the armrest reduces weight on the seat pan and reduces the stress in the spine and other structures. The table heights in the three institutions (MAPOLY-69,00 cm; UNAAB-76,50 cm; FCE-77,50 cm) are higher than the proposed table height of 56,33 cm. The height of the table with respect to the person using it is very important for the bottom, shoulders and torso height depending on the position and supporting arms as a work surface above the elbow causes arm abduction resulting in an increase in the stress of the shoulders, arms and necks [7]. A high table height may make a person to bend forward or be forced to raise shoulders resulting in muscle strain on the back and shoulders [29, 46, 26] as the user would not be able to make use of the backrest.

The anthropometric characteristics of the users are essential for the accomplishment of various tasks safely and economically. If mismatches exist among the human anthropometric data and equipments, tools and furniture, it may result in 'decreased productivity, discomfort, accidents, biomechanical stresses, fatigue, injuries, and cumulative traumas [26]. It was therefore not a surprise that a higher percentage (93,75 %) of the students complained of neck, shoulder, upper and lower back pains that they attributed to the furniture they used [34].

4 Conclusion

The present study may be a pointer to the effect that in the design of tables and chairs for use in higher institutions, the anthropometric data of the Nigerian students were probably not considered. Due to cost considerations and the fact that the amount budgeted for education in Nigeria is paltry, designing tables and chairs with dimensions that would accommodate 90 percent of the target population is an extremely difficult task.

The chairs and tables for use by the students in Nigeria's tertiary institutions were designed using the 'one-size-fits-all' approach, as adjustable furniture would increase the cost of production.

It is hereby recommended that similar study should be carried out in other sections of the country.

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