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Anthropometrics and Ergonomics of Secondary School Students in Four Yola Metropolis, Adamawa State, Nigeria

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ABSTRACT: Uncomfortable and bad sitting position can impact a student's interest in learning. This study therefore evaluates the anthropometrics and ergonomics of secondary school students in four Yola metropolis, Adamawa State, Nigeria to evaluate their physical measures of a person's size, form, and functional capacities and their working environment using standard methods with 200 students, of which 102 were male and 98 were female. In accordance with the current seat height, a match criterion was established for each class. The extent of mismatch was then assessed by comparing the average popliteal heights of each class using the match criterion. The findings show that in all courses across all schools, more than 80% of the pupils did not have a suitable seat height. Over 80% of the classes in the schools had levels of mismatch (low), which is an obvious sign that the students' seats are on furniture that is too low for their heights. The article suggested a furniture design that was ergonomically orientated. When creating school furniture for pupils, it was suggested that their anthropometrics be employed to account for their diversity between classes and ages.

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Uncomfortable and bad sitting position can impact a student's interest in learning (Savanur *et al.*, 2007). It may also interfere with a student's ability to focus in class (Biswas *et al.*, 2014). A desk and chair in a school are designed to enhance the learning environment for kids. As a result, creating a comfortable learning environment requires the use of appropriate school furniture that meets the needs of the students (Castellucci *et al.*, 2010). Therefore, while designing workstations, machines, or equipment, a collection of body component proportions known as anthropometric data is essential (Ismaila *et al.*, 2013; Samuel *et al.*, 2016). Due to the importance of human body size, shape, and strength in the design of furniture, equipment, and workstations, this field of study has become particularly relevant (Onawumi, 2016). Because it relieves physical discomfort, ergonomically built classroom furniture makes studying more enjoyable (Ajayeoba *et al.*, 2016). When a person is forced to remain in an uncomfortable position for a specific job that is impacted by badly designed furniture for an extended amount of time, health issues and physiological stress are likely to develop (Ajayeoba *et al.*, 2016; Dianat *et al.*,2013). This is due to the possibility of developing back and neck pain, postural dysfunction, and other musculoskeletal illnesses while using unsuitable furniture for prolonged periods of time (Hoque *et al.*, 2016; Ismaila *et al.*, 2013; Macedo *et al.*, 2015; Ismaila, *et al.*, 2015). According to Baharampour *et al.* (2013), one of the main reasons of low back pain and discomfort in school pupils is a mismatch between the anthropometrics of the students and the furniture in the classroom. Because they spend so much time sitting

during lessons, children may be at the receiving end of poorly constructed school furniture. The majority of the time spent in school is spent sitting down (Macedo *et al.,* 2015; Ismaila *et al.,* 2015). In addition to sitting, writing, listening, and using computers, students are required to do these things every day in school. The majority of this work is static and is done while sitting down (Grimes and Legg, 2005). Because muscles contract for an extended amount of time during static work or exercise, muscles quickly become fatigued (Pheasant, 1996). Since there aren't many breaks during school hours, sitting in the same position for a prolonged amount of time is common (Grimes and Legg, 2005). For the purpose of determining the proper school furniture dimensions that will suit children, body part measurements such as popliteal and knee heights are required (Ajayeoba *et al.,* 2016). The management of schools in impoverished countries, however, seldom pay attention to the significance of furniture dimensions for technical and budgetary reasons (Biswas *et al.,* 2014; Hoque *et al.,* 2016). As a result, they offer pupils classroom furniture that is inappropriate for them (Taifa & Desai, 2017), i.e., the seat is either too high or too low for the various classes. When the body size fits the tool or equipment, it is said to be a match. It is typically described by a range, therefore in this instance, a match occurs when the person's popliteal height falls inside the set match criterion limit. A mismatch, on the other hand, is described as an incompatibility between the body's dimensions and those of a tool or piece of equipment (Parcells *et al.,* 1999). A mismatch is established when the popliteal height exceeds the match criterion limit. When the match criterion's maximum limit is lower than the popliteal height, it is said to be a low mismatch; meanwhile, a high mismatch occurs when the match criterion's lowest limit is higher than the popliteal height (Castellucci *et al.,* 2010). It is crucial that school administrators take anthropometrics into account when constructing school furniture, keeping in mind that these vary between ethnic groups, age groups, and gender (Oyewole *et al.,* 2010; Widyanti *et al.,* 2015). In the same class, there could be difference among students of different ages (Macedo *et al.,* 2015; Noshin *et al.,* 2018). In many underdeveloped nations, including Nigeria, the standard for designing school furniture is not taken into account (Ahasan *et al.,* 2018). Because there are so few local anthropometric data reports for furniture design, developed country anthropometric data have been used to create classroom furniture (Ismaila *et al.,* 2013). As a result, every nation, state, and locality need to have access to an accurate anthropometric database (Sadeghi *et al.,* 2015). Local research is made possible by the challenge of creating universally sized furniture that adheres to international standards. Given that there are hundreds of different ethnic groups in Nigeria, schools typically purchase furniture that is "one size fits all" (Altaboli *et al.,* 2015). The diversity of Nigeria's population in terms of ethnic groups, geographic regions, and the scarcity of anthropometric data from the northern section of the country provide this study a solid foundation. Therefore, it is necessary to collect anthropometric information from Northern Nigerian secondary school pupils in order to design and build furniture that is appropriate for them. This study objective is to evaluates the anthropometrics and ergonomics of secondary school students in four Yola metropolis, Adamawa State, Nigeria.

MATERIAL AND METHODS

This study adopted a cross sectional and descriptive research design to determine the potential match or mismatch between Students' anthropometric measurements and their classroom furniture (seat) dimensions in secondary school.

Participants: The study involved 200 students (102 boys and 98 girls) who were chosen from four different secondary schools. A multi-stage sampling strategy was used. Based on Nigeria's public and private education systems, the Yola Secondary schools were split into two categories. Two schools were chosen from each category: Almashkur International Academy and Chiroma Ahmad Academy (private) and Aliyu Mustapha College and Yola Government Day Secondary School (government). Students from both the junior and secondary sections participated equally in the study because both sections were open to students aged 10 to 18 who were enrolled in the chosen schools.

Materials/Measures: Following the guidelines of the standard measuring tape, anthropometric measurements were acquired from the individuals (Ermakovaetal, 1985). The students' anthropometric measurements (Popliteal height), which is measured with 900 degrees of knee flexion, were measured with the same standard measuring tape, as well as the seat height (SH) of the classroom furniture, which is measured as the vertical distance from the floor to the middle point of the front edge of the seat (Dianat *et al.,* 2013). According to Niekerk *et al.,* (2013), all measures were taken while sitting with the knees and hips flexed at 900. They were all taken in centimeters. During the measurements, the students were asked to remove their shoes. All measurements were recorded during a single session.

Criteria for defining a match/mismatch: In order to identify any mismatches, the measurements of each

student and the classroom furniture were compared. The match criterion (equation) displayed in table 1 is used to determine the appropriate relationship between seat and popliteal height, which is described in a number of literary works. Using the match criterion and the current seat height in each class as specified in the literature, the level of match and mismatch was determined. For this study, Equation 1—which incorporates a shoe correction—was used because no measurements were made with the students wearing shoes.

Three alternative equations that can be found in various literature sources are used to compute a seat height discrepancy. Each of them is created using a two-way equation that takes both the maximum and minimum limits into account. The three equations are:

$(PH+3)\cos 30^0 \leq SH \leq (PH+3)\cos 5^0$ (1)
0:88PH _ SH _ 0:95PH (2)
0:80PH _ SH _ 0:99PH (3)

One can see that only equation (1), which accounts for the shoe correction, adds +3 to the popliteal height. Since students wear shoes in class and popliteal height measurements are done without shoes, equation 1 is the most appropriate because it minimizes inconsistencies (Castellucci *et al.,* 2015). Only pupils who meet the match criteria for popliteal height will be ergonomically compatible with or match the seat heights already in use.

Data Analysis: Microsoft Excel was used to enter and filter the data acquired before analysis. Excel was used to compute the descriptive statistics (maximum, minimum values, mean, standard deviation, and percentile values). In order to evaluate whether the furniture in each class matched or mismatched the anthropometric measurements of each class, which were compared to the measurements of the existing furniture. Because every kid has a shoe and measurements were made without one, as was done in other studies (Castellucci *et al.,* 2010; Biswas *et al.,* 2014; Gouvali and Boudolos, 2006; Bendak *et al.,* 2013), a 3 cm shoe adjustment was added to the popliteal height.

RESULTS AND DISCUSSION

The descriptive statistics of the measured parameters for the junior and senior class is shown in table 1. The results show a total of 200 students were measured, 56 of which were male students while 44 are female students in the junior class, and 45 male students and 55 female students were measured in the senior class. The tables also show the subjects mean age. The minimum age and the maximum ages of the subjects involved were 10 and 18 years, respectively. **Table 2:** Shows the existing seat height in each class from all the schools, the minimum and maximum popliteal heights in each class as well as the average popliteal height of the students in each class.

Table 1: The descriptive statistics of the overall Classes from the four schools

Parameters	min	max	Junior (n=100) Mean SD	Senior (n=100) Mean SD
Age	10	18	14.67	.83
Popliteal height (cm)	43	61	49.43	51.90

Source: Field work, 2020

Table 2: Descriptive Statistics of the Measured Parameters (cm)

Schools	Seat Heights (SH)	PH. Min	PH. Max	PH. Mean	Std. dev
Almashkur Jnr	39	43	56	48.48	2.73
Almashkur Snr	38	48	59	52.72	3.12
Chiroma Jnr	48	46	55	51.16	2.01
Chiroma Snr	45	46	61	52.6	3.09
Hammawa Jnr	43	43	61	49.76	4
Hammawa Snr	40	46	57	51.56	3.3
AMC Jnr	45	46	54	48.32	1.99
AMC Snr	45	44	54	50.56	1.88

***Source: Field work, 2020. PH**=Popliteal Height, **SH**=Seat height, **Jnr**=Junior, **Snr**=Senior*

Table 3: Match and Mismatch assessment

School	Class	Existing dimension (SH)	PH+3cm	High mismatch (%)	Match (%)	Low mismatch (%)	Match criterion	Preferred dimension (SH)
Almaskur	Junior	39	51.48	0%	0%	100%	36.37-41.83	44.58-51.27
	Senior	38	55.72	0%	0%	100%	35.51-40.84	48.25-55.50
Chiroma	Junior	48	54.16	0%	60%	40%	44.17-50.80	46.90-53.94
	Senior	45	55.60	0%	4%	96%	41.57-47.81	48.15-55.38
Hammawa	Junior	43	52.76	0%	24%	76%	39.84-45.80	45.69-52.55
	Senior	40	54.56	0%	0%	100%	37.24-42.83	47.25-54.34
Aliyu Musdafa	Junior	45	51.32	0%	44%	56%	41.57-47.81	44.44-51.11
	Senior	45	53.56	0%	8%	92%	41.57-47.81	46.38-53.35

Source: Field work, 2020.

The purpose of this study was to determine the potential match or mismatch between Students' anthropometric measurements and their classroom furniture dimensions in secondary school and to design the required seat height for the different classes based on their average popliteal heights. The result in

general found a high level of mismatch in all the schools. As shown in table 2, it was discovered during the furniture measurement that there is only one model of chair in each class. Similar findings were made in the Bangladeshi study by Hoque *et al.,* (2016), which discovered that all of the schools employed the same style of furniture. The required seat height (preferred dimension) for each class is shown in Table 3, and it is determined by the average popliteal height of the pupils in each class rather than by applying the same equation. According to Table 1, students in the senior class sat on shorter seats than those in the junior class, and the average popliteal height of senior class students is higher than that of junior class students. As a result, it is anticipated that these classes will have a larger percentage of mismatch, which will raise the risk of MSDs or discomfort.

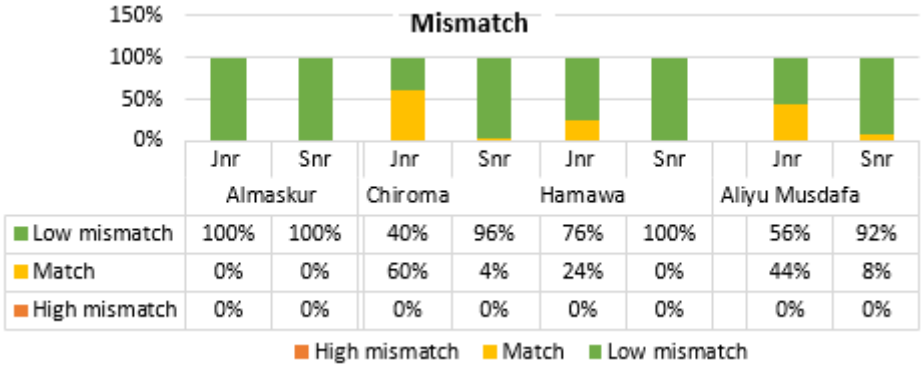

Fig 2: Match and mismatch percentages in the four schools

Outcome of Mismatch assessment in schools: Equation (1) [(PH + sc) COS300 SH (PH + sc) COS50] was used to calculate the degree of furniture mismatch in each class from all four schools. as well as a 3 cm shoe adjustment (sc) for all grades. The seat heights of each class's present seats are used to determine the match criterion. According to figure 2, for the junior classes, Almashkur had a 100% mismatch level (low mismatch), Chiroma had a 40% mismatch level (low mismatch), Hammawa had a 76% mismatch level (low mismatch), and Aliyu Musdafa had a 44% mismatch level (low mismatch). This indicates that the majority of the junior kids in these institutions sit in too-low chairs. These findings are in line with those of a related study by Mohamed (2013), which looked at a school in Egypt and found that there was a low mismatch in the fourth grade (30%), fifth grade (80%), and sixth grade (80%). In all the schools, senior classes had a higher level of mismatching than younger classes. Almashkur had a 100% low mismatch level, while Chiroma had a 96% low mismatch level, Hammawa had a 100% low mismatch level, and Aliyu Musdafa had a 92% low mismatch level. This concurs with studies done in Sao Paulo, Brazil by Batistao *et al.,* (2012) who discovered a substantial amount of mismatch in their research for the 5th grade, 23%, and 8th grade, 50%. Similar findings were obtained in a study conducted in Saudi Arabia by Ramadan (2011), where it was shown that 7.3% of the students were placed in chairs that were not the right height for them. Several studies conducted in Chile, Greece, Malaysia, Saudi Arabia, and Iran all discovered a higher percentage of high mismatch in the schools under study, in contrast to the findings of this research (Castellucci *et al.,* 2010; Afzan *et al.,* 2012; Gouvali and Boudolos, 2006; Dianat *et al.,* 2013); Ramadan, 2011).

Ergonomically fit/Match level found: For every class included in the study, a very low match level was created. The Almashkur result for the junior classes suggests a 0% match level, as seen in figure 2. This indicates that none of the students in that class are ergonomically suited to the classroom furniture. A 60%, 24%, and 56% match, respectively, was seen in Chiroma, Hammawa, and Aliyu Musdafa. A relatively low match % was seen across all schools for the Senior courses, though. Hammawa and Almashkur had a 0% match. No pupil in these classes is ergonomically suited to the classroom furnishings. Aliyu Musdafa and Ciroma both had a meager match percentage of 4% and 8%, respectively. This outcome is comparable to that of a study of a similar nature carried out in Chile in 2010 by Castellucci et al., where it was discovered that only popliteal heights of 14%, 20%, and 14% were suitable for the students included. The study by Biswas *et al.,* (2014) in a primary school in Bangladesh reported a low match % in the classrooms, which is similar to our finding as well.

Preferred dimension of class furniture: The same algorithm was used to determine the optimum furniture dimension once the average popliteal height of students in each class from the schools under study

had been ascertained. According to table 3's findings, the appropriate seat height for Almashkur's junior class is between 44.58 cm and 51.27 cm. The recommended seat height for Chiroma is between 47 and 54 cm. Hammawa prefers seats that are between 45.7 cm and 52.3 cm high. The ideal seat height for Aliyu Musdafa is in the range of 46.4 to 53.4 cm. The ideal/preferred seat heights for the senior classes are 48.25–55.50 cm, 48.15–55.38 cm, 47.25–54.34 cm, and 46.38–53.35 cm, respectively, for Almaskur, Chiroma, Hammawa, and Aliyu Musdafa.

Conclusion: The study concludes that ergonomics are not properly taken into account when providing school furnishings because there was a significant mismatch between the dimensions of the classroom furniture and the anthropometric parameters of the students. In order to give a welcoming and encouraging environment that might improve their learning process, it will be advised that the design and distribution of school furniture should be based on the anthropometric data of the different age groups and classes in all educational settings.

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