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# Mismatch Between Anthropometric Measurements of Occupational Drivers in Southwest Nigeria and Vehicle Seat Design Parameters

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**Abstract:**
Most commercial vehicles used for transportation are not manufactured in Nigeria. As a result, the design of these vehicles, which relies on anthropometric measurements from the manufacturing countries, does not adequately accommodate the variations in anthropometric measurements of Nigerian drivers. This mismatch can lead to ergonomic risk and musculoskeletal disorders. Therefore, this study investigated the level of mismatch between drivers' anthropometric characteristics and seat design variables of selected commercial vehicles. A total of 161 male drivers were randomly selected, and data was collected using standard Nordic questionnaires. The anthropometric characteristics of the drivers were measured using a stadiometer and measuring tape. Seat design variables were also measured using a tape rule and steel rule. The collected data were subjected to statistical analysis, including the calculation of means, standard deviations, and 5$^{th}$, 50$^{th}$, and 95$^{th}$ percentiles of the anthropometric measurements. The results revealed the average anthropometric measurements for sitting height (erect), sitting height (normal), shoulder height, buttock-knee length, and buttock-popliteal length to be 83.01, 77.86, 52.71, 57.07, and 50.20 cm, respectively. Comparing the results of the seat variables with the relevant anthropometric characteristics, a mismatch in the measurements was observed. This led to the conclusion that the existing commercial vehicle seats in the Southwest region are not compatible with the anthropometric dimensions of the drivers.

**Keywords:** Ergonomic risks, Anthropometric, Musculoskeletal disorders, Occupational drivers, Vehicle Design.

## Introduction

In our day-to-day activities, the movement of people, goods, commodities, and equipment is an integral part that relies on various means of transportation. The significance of transportation extends to being a fundamental component of socioeconomic interactions (Muqimova, 2022). According to Lucas & Onawumi (2013) revealed that Nigeria has four notable modes of transportation: road, rail, water, and air. Among these, road transportation stands out as the most commonly used and affordable mode, with fleets of automobiles and motorcycles fulfilling transportation needs. Automobiles, in particular, hold a distinct advantage due to their ability to cover long distances compared to other forms of road transportation.

It's worth noting that different types of commercial vehicles are used in various geopolitical locations or states in Nigeria, driven by specific reasons or requirements; nevertheless, regardless of the specific commercial vehicle being used, ergonomics is a crucial factor to consider (Onawumi & Lucas, 2012). Fajobi *et al.* (2019) stated that an ergonomics investigation in commercial vehicles involves examining and improving the design and layout of the vehicle's interior to enhance driver comfort, safety, and productivity. Ergonomics focuses on optimizing the interaction between humans and their environment, and in the case of commercial vehicles, it aims to minimize the physical and cognitive strain on drivers, which can lead to fatigue, discomfort, and even accidents (Onawumi and Lucas, 2012).

Zhang (2016) explained that the goal of human factors/ergonomics is to reduce human error, increase productivity, and enhance safety and comfort with a specific focus on the interaction between the human and the thing of interest. Examples of ergonomic risks are but are not limited to, awkward posture position, overstretching of bodily parts, over-straining the eyes, excessive motions, vibration, repetitive movements, etc. These ergonomic risks would lead to occupational injuries such as musculoskeletal disorders. Musculoskeletal conditions are the leading contributor to disability, with low back pain being the single leading cause of disability globally (Abdul-Raheem *et al.,* 2022). It significantly limits mobility and dexterity, leading to early retirement from work, reduced accumulated wealth, and reduced ability to participate in social roles (Abledu *et al.,* 2014). Therefore, the incorporation of ergonomic principles into vehicle design is essential to mitigate the persistent musculoskeletal and biomechanical trauma caused by imported technological (vehicle) systems. As drivers are forced to adapt to these vehicles, they face an increased risk of various occupational hazards, including Lower Back Pain (LBP), whole-body vibration, fatigue, and musculoskeletal disorders. The constrained work postures and vibration-induced fatigue on muscles and tendons are known to contribute to problems such as back pain while driving (Sharotry *et al.,* 2022)

Anthropometry is the art and science of measuring the physical geometry, mass properties, and strength capabilities of the human body (Hassanain *et al.*, 2023). It is concerned with the scientific study of human subjects for the development of standards and evolving of specific demands associated particularly with manufactured goods and services to enhance product usability and ergonomics suitability for the user population (Halek, 2023). Anthropometric dimensions and other various factors such as gender, age, race, nutritional status, physiological build, and nature of work were found to vary widely across every region, state, and country; however, contributing to the unsuitability of vehicular workspace design (Agrawal *et al*, 2010; Zhang *et al.,* 2016; Jinhuan *et al.,* 2016). It is important to take into account measurements of the human body when designing a vehicle. Driver's posture encompassing the static and dynamic anthropometric demands of the operator is also considered in the vehicle design process (Benos *et al.*, 2020; Yitayal *et al.,* 2022). Other variables that could be used to determine the ergonomic suitability of the drivers in the workstation are; seating comfort, postural composition, and body flexibility (Ismaila *et al.,* 2015). These can also be used to estimate the driver's resilience and endurance level at work (Alam, 2014). To have a better understanding of the causal factors of musculoskeletal disorder and discomfort to the driver while at the workstation, the relationship between the operator's seat, steering column, and wheel and pedals in the workstation must also be clearly understood.

Ajayeoba and Adekoya, (2012) studied the anthropometric data points of 939 passengers (612 male and 327 female) to evaluate the anthropometric suitability of seats of 92 locally made commuter buses in Nigeria and proposed new seat dimensions. Ismaila *et al.* (2010) examined the potential mismatch between the anthropometric dimensions of 200 passengers and seat measurements of 30 Toyota Hiace buses in Nigeria. Onawumi and Lucas (2012) investigated the ergonomic suitability of the seat dimensions of taxicabs in Nigeria based on the drivers' anthropometric data. Zhou *et al.* (2014) analyzed anthropometric measurements of 1243 vehicle drivers aged between 17 and 34 years to develop correlation and fitting formulas for body height, sitting height, and other parameters. Therefore, it is significant to investigate the possible mismatch that may exist within the man-machine system, namely the relationship between the vehicle and its operator. By conducting such an investigation, solutions can be proposed, and parameters can be identified for improvement.

**Materials and methods**

In this study, male drivers were chosen through a random selection process. Information was collected from them using Standard Nordic questionnaires. Anthropometric Measurements were taken using a stadiometer and measuring tape. Additionally, seat design parameters were assessed using a combination of a tape rule and a steel rule. Subsequently, the gathered data was subjected to statistical analysis, which encompassed the determination of means, standard deviations, and the 5th, 50th, and 95th percentiles for the anthropometric measurements.

**Study area**

The study areas are six states in Southwest Nigeria; Ogun State (Mowe) Latitude: 41° 25' 25.7" N Longitude: -79° 0' 59.5" W; Oyo State (Ogbomoso) Latitude: 8° 14' 11.3" N Longitude: 3° 27' 20.2" E; Lagos State (Iyanapaja) Latitude: 6° 37' 31.0" N Longitude: 3° 18' 17.0" E; Osun State (Osogbo) Latitude: 7° 45' 03.0" N Longitude: 4° 34' 12.0" E; Ondo States (Akure) Latitude: 7° 29' 55.2" N Longitude: 5° 19' 24.8" E and Ekiti States (Ado-Ekiti) Latitude: 7° 30' 15.0" N Longitude: 5° 19' 12.0" E.

**Sample size and sample techniques**

The sample size was determined by Equation 1 adopted from Elenwo (2018). The sampling technique employed was random sampling in which all vehicle drivers were chosen from different state garages while instructions were given and the purpose of the study was explained to them prior. The sample size surveyed shown in Table 1 was used for vehicle drivers with a confidence value of 95%.

$$n = \frac{N}{1+Ne^2} \quad (1)$$

Where n = sample size, N = population of vehicle drivers, e = level of precision = 1 – confidence level.

| **Garage** | **Sample size (n)** |
|---|---|
| Mowe, Ogun State | 30 |
| Iyanapaga, Lagos State | 36 |
| Ora and Owode, Ogbomoso | 18 |
| Osogbo | 27 |
| Akure | 26 |
| Ado Ekiti | 24 |
| **Total** | **161** |

**Vehicle seat and anthropometric measurements**

The physical measurements of seat variables that were assessed on the sampled commercial vehicles include the following: seat width, seat cushion depth, seat cushion length, seat lumber support, seat shoulder support, seat total height (backrest height + the headrest height), seat to pedal distance as shown in Figure 1. The characterization of interfacing elements of in-vehicle and driver's anthropometric variables of a randomly selected operator with a sample size of 161 subjects of commercial vehicles in the study area was considered as represented in Table 2 and the average values of the measurements was determined. Body variables considered were Sitting Height Normal (SHN), Sitting Height Erect (SHE), Shoulder Height Sitting (SHS), Shoulder Elbow Length (SEL), Thigh Clearance Height (TCH), Thumb Tip Reach (TTR), Buttock Knee Length (BKL) and Buttock Popliteal Length (BPL) as presented in Table 2 and Table 3 showed a 2D model based on vertical and horizontal anthropometric dimensions.


**Figure 1: Measured Seat Variables.**

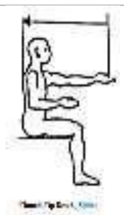
1 - Seat width; 2 - Seat cushion depth; 3 - Seat cushion length; 4 - Seat backrest height; 5 - Seat lumbar support; 6 - Seat shoulder support; 7 - Seat total height (backrest height + headrest height)

**Table 2: Vertical Sagittal Plane Anthropometric Description (Fajobi *et al.*, 2019).**

| Model | Description | In-vehicle applications |
|---|---|---|
|  | **SHN:** The vertical distance from the sitting surface to the uppermost point of the head (subject sits relaxed). | Vehicle roof distance,<br>Seat vertical adjustment range. |
|  | **SHE:** The vertical distance from the sitting surface to the uppermost point of the head (subject sits erect) | Backrest height,<br>Headrest height,<br>Vehicle roof distance. |
|  | **SHS:** The vertical distance from the sitting surface to the uppermost point on the lateral edge of the shoulder (acromial). | Backrest height,<br>Seat belt design, Headrest adjustment range. |

| | | |
|---|---|---|
|  | **SEL:** The vertical distance from the uppermost point on the lateral edge of the shoulder (acromiale) to the bottom of the elbow (alecranon). | Armrest height, Side gear control knob, and Side door armrest buttons. |
|  | **TCH:** The vertical distance from the sitting surface to the top of the thigh at its intersection with the abdomen. | Seat depth adjustment range,<br>Seat plane-steering wheel distance. |

**Table 3: Front View Sagittal Plane Anthropometric Description (Fajobi *et al.,* 2019)**.

| **Model** | **Description** | **In-vehicle applications** |
|---|---|---|
|  | **TRS:** The horizontal distance from the back of the shoulder (greatest bulge of trapezium) to the tip of the extended thumb. | Dashboard buttons-driver distance, Seat backrest-windscreen distance. |
|  | **BNL:** The horizontal distance from the most posterior point on the buttocks to the most anterior point on the knee. | Seat plane depth, Knee-dashboard clearance. |
|  | **BPL:** The horizontal distance from the most posterior point on the buttocks to the most interior point on the knee (i.e., back of the kneel) | Seat depth<br>Seat plane contour |

**Data analysis**

Descriptive statistics, including measures such as mean, standard deviation, and percentiles (5th, 50th, and 95th), were calculated using the Statistical Package for the Social Sciences (SPSS) version 26 and Microsoft Excel. These measures provide insights into the central tendency, variability, and distribution of the anthropometric variables. The percentile analysis is often carried out to determine the percentage showing the lower and upper end of the distribution.

For the analysis of the correlation between the anthropometric variables of the drivers, Python libraries such as Pandas, Scipy, and Seaborn were utilized. These libraries offer functionalities for data manipulation, statistical analysis, and data visualization. The correlation matrix, which shows the relationships between pairs of variables, was generated using these libraries. The correlation matrix helps to determine the strength and direction of the relationships among the variables under investigation.

**Results and Discussion**

This section displays the data that was acquired in relation to the particular issues that this research was trying address.

**Demographic characteristics**

The results of the demographic characteristics of the drivers collected through a questionnaire, it was found that all the respondents were male drivers, indicating that there are no female drivers in the commercial vehicle sector in the study area. The age of the operators is observed to be normally distributed around 41-45 years, with an average age of 42. However, it is important to note that the operation of a Taxicab and public transportation in particular is largely a job for adults as shown in Figure 1.

Figure 2 shows that 32% of drivers in Southwest Nigeria are Secondary School Certificate holders, which is the highest educational background and a lower percentage of 1.4% has a Bachelor's degree. This indicates a relatively high level of literacy among commercial drivers in the Southwest region, making it possible to administer online Google form-based questionnaires. It was observed that 81% of the interviewed drivers work above 10 hours per day as shown in Figure 3. This however can cause musculoskeletal disorder due to long confined sitting posture and repetitive hours of driving with limited breaks to stretch or rest.

Figure 4 also shows the years of experience of the drivers. It is revealed that about 31% of the drivers have driving experience ranging from 16 to 20 years while about 17% of the drivers have driving experience of more than 20 years. This implies that higher driving experience causes an increase in musculoskeletal troubles that impede the safe and comfortable operation of the vehicles.

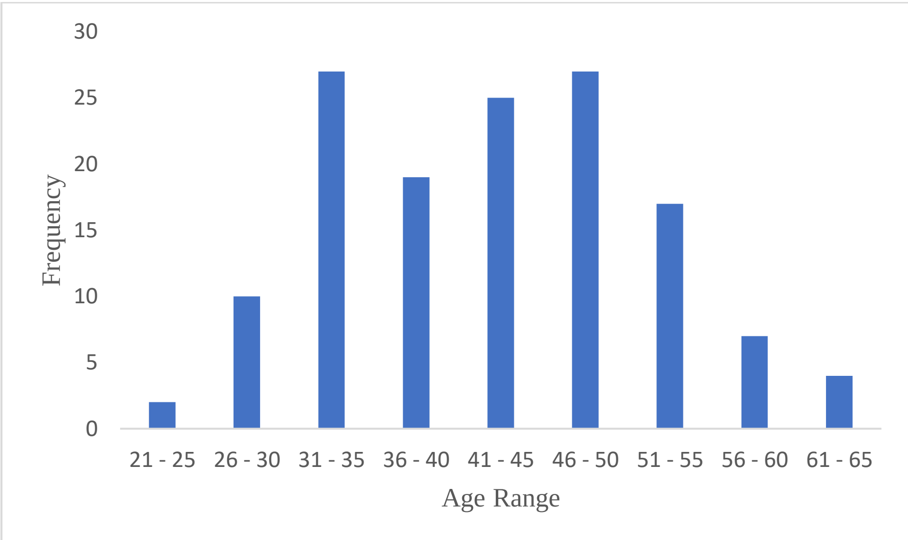



**Figure 1: Age range of the Southwest Commercial Vehicle's Driver**.

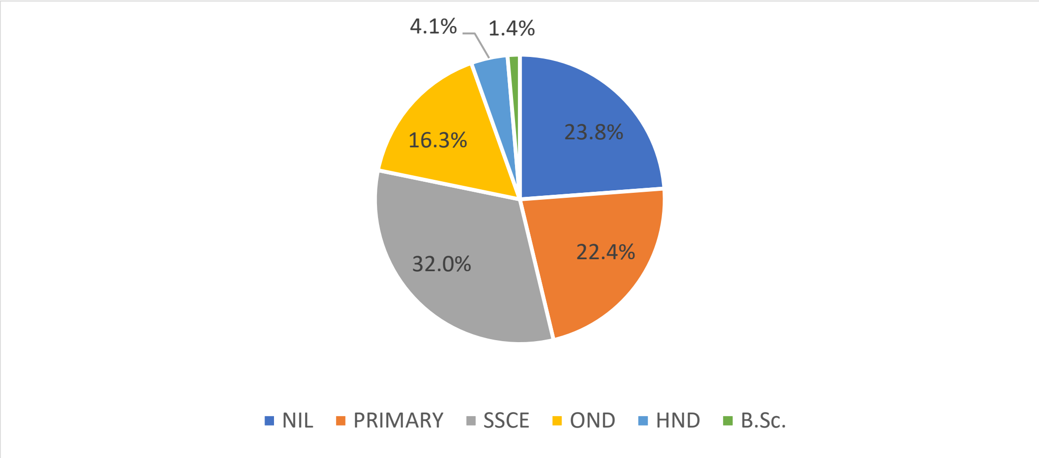



**Figure 2: Educational Background of the Interviewed Drivers.**

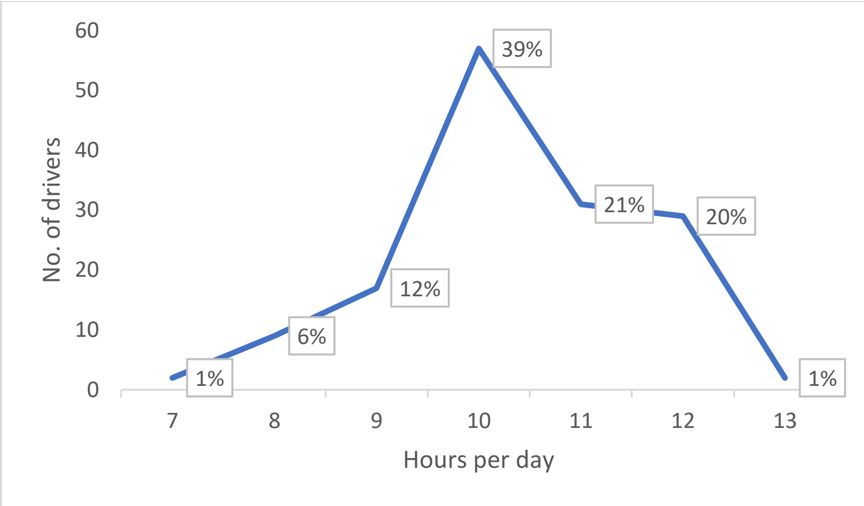



**Figure 3: Drivers Working Hours per Day.**

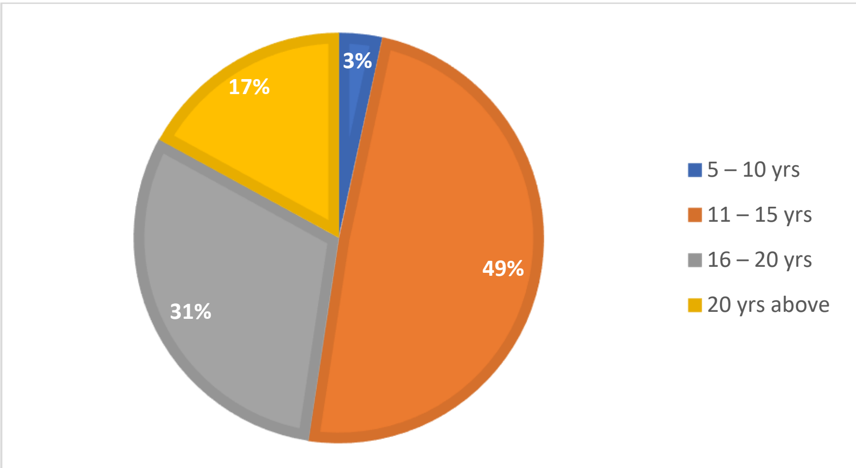



**Figure 4: Year of Experience of the Drivers.**

**Dimension of seat design**

The key factors in seat design encompass seat width, seat backrest height, seat backrest width, seat cushion length, seat cushion depth, seat angle, and total seat height (which combines seat and headrest height). Given that prolonged seating can lead to discomfort, it is necessary to incorporate adjustable features in seats to enable changes in body posture and reduce discomfort (Drachsler *et al.,* 2009). However, the adjustable design involves utilizing the 5th and 95th percentiles of the required dimensions as the minimum and maximum values respectively.

**Seat backrest width**

As shown in Table 8, the measured mean dimension of the seat backrest width (lumbar) at 50.05 cm aligns well with the 95th percentile of the shoulder breadth anthropometric variable studied by Fajobi *et al.,* (2017). However, to ensure that the shoulder backrest width (42.23 cm) adequately covers the shoulder breadth of 45.42 cm and accommodates 95% of the drivers, it is recommended to increase the average backrest width (shoulder) by approximately 18.52% of the current dimensions, making it 50.05 cm. This adjustment will provide a better fit and comfort for a majority of the drivers.

**Seat cushion depth**

The design of an adjustable seat necessitates that the seat dimensions accommodate the 5th (44.51 cm) and 95th (55.88 cm) percentiles of the buttock-popliteal length as the minimum and maximum dimensions, respectively, as outlined in Table 6. A deep seat can restrict the driver's ability to utilize the backrest, leading to spinal curvature and uncomfortable posture (Ismaila *et al.,* 2013). However, the mean cushion depth of the seat in Table 4, measured at 47.30 cm, does not align with the relevant anthropometric measurement. Furthermore, more than 50% of the drivers studied might find the average seat length in the current design, measured at 53.76 cm, uncomfortable.

**Seat cushion width**

From Table 6, the seat width appears to be suitable for 95% of the drivers when compared to the hip breadth, as observed in the anthropometric study conducted by Fajobi *et al.,* (2017). Since it accommodates the maximum or wider range of vehicle operators, it is recommended to maintain the average seat width at the existing measurement of 48.03 cm. The seat width should be designed to accommodate the user's hip width and allow for comfortable arm movement. Diant *et al.* (2013) utilized the 95th percentile of the driver's hip breadth, with an allowance of 15% of the hip breadth. Considering that the 95th percentile of hip breadth for drivers is 42.70 cm, with an allowance of 15% (6.41 cm), the recommended seat width would be 49.11 cm, which closely aligns with the seat width (49.23 cm) observed in this study.

**Seat backrest height**

The average seat backrest height of the vehicles included in Table 4 is measured at 57.42cm. For optimal driver comfort, the backrest height should ideally reach shoulder level for 95% of drivers. However, upon comparing the recorded average with the shoulder height values provided in Table 5, it does not align with either the 50th or 95th percentile measurements, representing the average and maximum percentage of the drivers respectively. In a study by Harry *et al.* (2020), it was suggested to utilize the $5^{th}$ percentile of shoulder height (while sitting) as a reference. However, this percentile value is significantly lower than the average seat backrest height reported in this study. Consequently, using such a low reference value may potentially lead to back pain or discomfort.

**Table 4:** Mean Dimension of Seat Variables

| **Seat Design** | **Mean** |
|---|---|
| Backrest width (shoulder) | 42.23 |
| Backrest width (lumber) | 50.05 |
| Cushion seat length | 53.76 |
| Cushion seat depth | 47.30 |
| Seat width | 48.03 |
| Seat backrest height | 57.42 |
| Seat total height | 76.27 |
| Seat-pedal distance | 45.20 |

All parameters were measured in centimeters (cm)

**Table 5:** Comparison of the Result with the Previous Related Study

| Seat Variable | Current Study | Fajobi (2019) | Ismaila (2021) |
|---|---|---|---|
| Backrest width (shoulder) | 42.23 | 47.70 | 44.50 |
| Backrest width (lumber) | 50.05 | __ | 49.00 |
| Cushion seat length | 53.76 | 55.60 | 49.67 |
| Cushion seat depth | 47.30 | __ | 47.50 |
| Seat width | 48.03 | 49.80 | 50.33 |
| Seat backrest height | 57.42 | 53.30 | 53.67 |
| Seat total height | 76.27 | 77.10 | 76.67 |
| Seat-pedal distance | 45.20 | 34.40 | 42.83 |
| All parameters were measured in centimeters (cm) | | | |

| **Table 6:** Anthropometric Data of Southwest Bus Driver (n=161) | | | | | | |
|---|---|---|---|---|---|---|
| **Anthropometric Variables** | **Mean** | **Std. Dev** | **Range** | **Percentile** | | |
| | | | | **5th** | **50th** | **95th** |
| Sitting height erect | 83.01 | 7.26 | 35.56 | 64.64 | 85.09 | 90.17 |
| Sitting height normal | 77.86 | 6.83 | 33.02 | 59.69 | 80.01 | 86.36 |
| Shoulder height | 52.71 | 5.05 | 25.40 | 44.45 | 54.61 | 59.69 |
| Shoulder elbow length | 36.06 | 3.31 | 24.13 | 33.02 | 35.56 | 40.64 |
| Thigh clearance | 17.90 | 4.97 | 17.78 | 12.70 | 15.24 | 25.40 |
| Thumb-tip reach | 77.07 | 3.94 | 22.86 | 71.12 | 76.20 | 83.82 |
| Buttock-knee length | 57.07 | 3.55 | 20.32 | 50.93 | 55.88 | 63.50 |
| Buttock-popliteal length | 50.20 | 3.77 | 17.78 | 44.51 | 50.80 | 55.88 |
| All dimensions were measured in centimeters (cm) | | | | | | |

| **Table 7: Comparison of drivers' anthropometric dimensions of the current study with previous related study** | | | | |
|---|---|---|---|---|
| | **Mean Dimensions** | | | |
| **Anthropometric Variables** | **Current Study** | **Ismaila (2021)** | **Fajobi (2013)** | **Onuoha (2012)** |
| Sitting height erect | 83.01 | 83.18 | 83.36 | 83.70 |
| Sitting height normal | 77.86 | __ | 79.32 | __ |
| Shoulder height | 52.71 | 55.4 | 57.54 | 54.20 |
| Shoulder elbow length | 36.06 | 34.61 | 37.26 | 31.00 |
| Thigh clearance | 17.90 | __ | 14.06 | __ |
| Thumb-tip reach | 77.07 | __ | 81.44 | __ |
| Buttock-knee length | 57.07 | 55.6 | 58.89 | 58.00 |
| Buttock-popliteal length | 50.20 | 48.75 | 48.97 | 48.20 |
| All dimensions were measured in centimeters (cm) | | | | |

**Seat backrest depth**

A proper backrest depth helps ensure adequate support to the user's lumbar region and promotes a comfortable sitting posture. The thickness of the backrest can impact the transmission of vibrations through the foam cushion at the seat pan (Zhang *et al.,* 2015).

**Seat backrest angle**

It was noted that only a few buses had adjustable backrests, and most of the seats had damaged backrest adjusters. In the Akure park, Toyota vehicles stood out as having good adjusters, as they appeared well-maintained and relatively new, often being chartered vehicles for transportation. To accommodate users who may lean against the backrest, Harry *et al.* (2020) suggested that the driver's seat backrest should be adjustable (tilt) to 35 degrees from the vertical. Studies have recommended that the seat backrest should be inclined at an angle between $90^0$ and $110^0$ towards the rear (Ghaderi *et al.*, 2014). Ismaila *et al.* (2013) proposed an inclination of $96^0$. Kramer *et al.* (1999) found that the electric activity of the back muscles and intradiscal pressures are lowest when the backrest is inclined between $110^0$ and $130^0$.

**Table 8:** Driver's workstation design variables fitted with related anthropometric variables

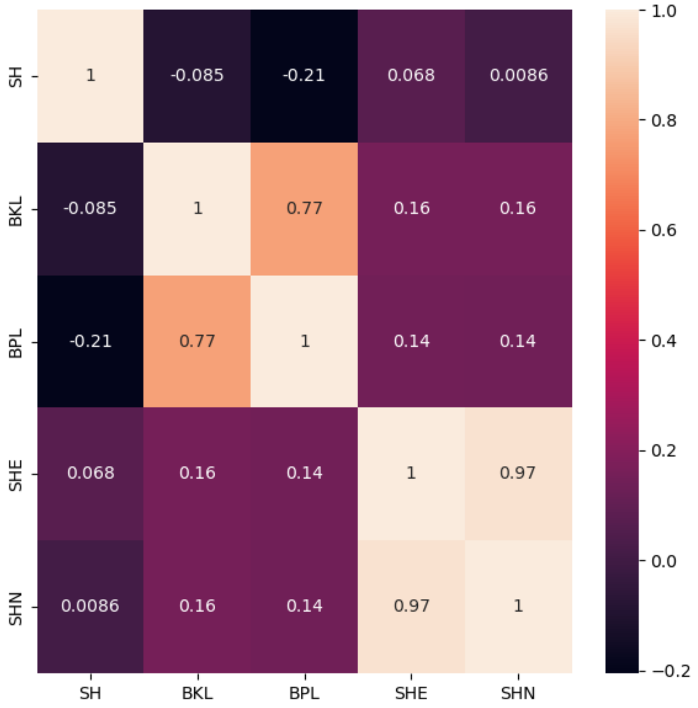
| Design Variables | Mean Dimension | Anthropometric Variable | Mean | Percentile | | |
|---|---|---|---|---|---|---|
| | | | | 5th | 50th | 95th |
| Backrest width | 50.05 | Shoulder breadth* | 45.42 | 40.04 | 45.1 | 50.10 |
| Cushion seat length | 53.76 | Buttock-knee length | 57.07 | 50.93 | 55.88 | 63.50 |
| Cushion seat depth | 47.30 | Buttock-popliteal length | 50.20 | 44.51 | 50.80 | 55.88 |
| Seat width | 48.03 | Hip breadth sitting* | 37.95 | 32.8 | 37.90 | 42.70 |
| Seat backrest height | 57.42 | Shoulder height | 52.71 | 44.45 | 54.61 | 59.69 |
| Seat total height | 76.27 | Sitting height normal | 77.86 | 64.64 | 85.09 | 90.17 |

All parameters were measured in centimeters (cm) * Not Present

**Correlation of anthropometric measurements**

This analysis helps to calculate the degree and magnitude of the relationship between variables. Figure 5 presents the correlation matrix of the measured anthropometric data of commercial vehicle drivers in the Southwest region of Nigeria. In general, correlation coefficients range in magnitude from -1.00 to +1.00, indicating the strength and direction of the relationship. The correlation between sitting height normal and sitting height erect (r = +0.97) indicates a strong positive correlation. This implies that as the sitting height normally increases, the sitting height erect also increases, at a certain threshold determined by the p-value.

Similarly, the correlation between BPL and BKL (r = 0.77) shows a strong positive correlation, indicating that these variables vary in direct proportion. On the other hand, there is a weak negative correlation between BKL and SH (r = -0.085), as well as between BPL and SH (r = -0.21). This suggests that an increase in shoulder height due to stretching caused by sitting height erect will lead to a decrease in the measurements of buttock-popliteal length and buttock-knee length. However, these negative correlations are weak, indicating that the relationship is not strong.




SH – Shoulder height; BKL – Buttock-knee length; BPL – Buttock-popliteal length; SHE – Sitting height erect; SHN – Sitting height normal.

**Figure 5:** Correlation matrix of the driver's anthropometric measurements.

**Table 9:** P-value corresponding to the correlation matrix ($p < 0.05$)

| | SH | BKL | BPL | SHE | SHN |
|---|---|---|---|---|---|
| **SH** | 0.00 | 0.18 | 0.11 | 0.63 | 0.58 |
| **BKL** | 0.18 | 0.00 | 0.02 | 0.48 | 0.53 |
| **BPL** | 0.11 | 0.02 | 0.00 | 0.56 | 0.61 |
| **SHE** | 0.63 | 0.48 | 0.56 | 0.00 | 0.00 |
| **SHN** | 0.58 | 0.53 | 0.61 | 0.00 | 0.00 |

## Comparison of the existing and proposed seat design

To ascertain the necessity of incorporating anthropometric data of Nigerian bus drivers into seat design, an independent t-test was conducted to compare the existing seat height and seat depth with the recommended values as presented in Table 10. The analysis revealed a significant difference between the recommended and existing values for both seat height and seat depth. For seat height, the independent t-test yielded a p-value < 0.05 and a t-statistic of 9.287, indicating a highly significant difference between the recommended and existing values. This suggests that the current seat height does not align with the optimal anthropometric measurements of Nigerian bus drivers.

Similarly, the independent t-test for seat depth resulted in a p-value < 0.05 and a t-statistic of 6.90, indicating a significant difference between the recommended and existing values. This implies that the current seat depth does not correspond to the ideal anthropometric measurements of Nigerian bus drivers. These findings, as presented in Figure 11, emphasize the need to consider the specific anthropometric data of Nigerian bus drivers when designing seats for their vehicles. Adhering to the recommended seat height and seat depth based on the drivers' anthropometric measurements can help improve their comfort, reduce the risk of musculoskeletal disorders, and promote overall ergonomics within the transportation industry.

**Table 10:** Recommended Seat Design Specifications based on Nigerian Drivers' Anthropometric Measurements

| Design Variable | Mean Recommended Dimension | Range (Min & Max) |
|---|---|---|
| Seat width | 37.95 | 32.80 - 42.70 |
| Seat cushion length | 57.07 | 50.93 - 63.50 |
| Seat cushion depth | 50.20 | 44.51 - 55.88 |
| Backrest width | 45.42 | 40.04 - 50.01 |
| Seat backrest height | 52.71 | 44.45 - 59.69 |
| Headrest height | 25.15 | 13.12 - 25.15 |

All parameters were measured in centimeters (cm)

**Table 11: Independent T-test of the Existing and Recommended Seat Variables**

| Seat Height | Dimension | | Seat Depth | Dimension | |
|---|---|---|---|---|---|
| | Existing | Recommended | | Existing | Recommended |
| Mean | 57.45 | 52.71 | Mean | 47.27 | 50.20 |
| Std. dev | 4.03 | 5.05 | Std. dev | 3.80 | 3.76 |
| Variance | 16.28 | 25.46 | Variance | 14.41 | 14.15 |
| T stat | 9.287060549 | | T stat | 6.899459249 | |
| P value | 2.56807E-18 | | P value | 2.831E-11 | |

**Conclusion**

Measurements of seat variables considering the support features, and adjustability options were carried out to compare and assess their compatibility with the drivers' anthropometric characteristics. Upon comparing the results of the seat variables with the relevant anthropometric characteristics, a mismatch between the measurements was observed. This led to the conclusion that the existing commercial vehicle seats in the Southwest region are not compatible with the necessary anthropometric dimensions of the drivers. As drivers are forced to adapt to these vehicles, they face an increased risk of various occupational hazards, including LBP, whole-body vibration, fatigue, and musculoskeletal disorders. These findings highlight the need for seat designs that are better aligned with the anthropometric measurements of the drivers. By addressing these disparities, it becomes possible to enhance driver safety and comfort, ultimately improving their overall experience while operating commercial vehicles in the Southwest region. Hence, it is recommended that these certain dimensions range; seat width (32.80 - 42.70 cm), seat cushion length (50.93 - 63.50 cm), seat cushion depth (44.51 - 55.88 cm), backrest width (40.04 - 50.01 cm), backrest height (44.45 - 59.69 cm), headrest height (13.12 - 25.15 cm), and seat backrest angle (90° to 130°) should be used to ensure a better fit between the seat and the anthropometric characteristics of Southwest Nigerian drivers.

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