Journal of Ergonomics & Advanced Research
Volume 3 | Issue 1

Research Article Open Access

Anthropometric Data of Nigerian Agro Equipment Operators

Onyeagba Obinna[1], Ike Oluka[2]

[1]Machine Building Department, Scientific Equipment Development Institute, Enugu (A unit of NASENI), Nigeria
[2]Department of Agricultural and Bioresource Engineering, Enugu State University of Science and Technology Enugu State, Nigeria

[*]**Corresponding Author:** ONYEAGBA OBINNA, Machine Building Department, Scientific Equipment Development Institute, Enugu (A unit of NASENI) Nigeria, Tel.: 2348032865684, E-mail: obinnaonyeagba@yahoo.com

Citation: Onyeagba Obinna, Ike Oluka (2023) Anthropometric Data of Nigerian Agro Equipment Operators J Ergon Adv Res 3(1): 102

Received Date: October 04, 2023 **Accepted Date:** November 04, 2023 **Published Date:** November 07, 2023

Abstract

Anthropometric data of Nigerian male and female agro equipment operators was determined as the operators were in a standing position. Field workers that facilitated the anthropometric measurements were trained and grouped into three groups – namely, coordinating supervisors, data collating officers and data collecting officers. The anthropometric data were collated from various individuals within the ages of (18 to 60) years from three states in each of the six geopolitical zones in Nigeria. A total of 3,895 Nigerians comprising of 2,007 males and 1,888 females were measured. Measuring instruments such as weighing balance, stadiometer, digital caliper and flexible tape were all used during the measurement which contains 20 different human body dimensions on standing anthropometric positions. The obtained data were collated and analyzed statistically using SPSS software into range, standard deviation, mean, 5th and 95th percentiles. The results obtained indicated that males have greater anthropometric dimension values than the females, aside the hip breadth where the females recorded a higher value. More so, there is a significant change in the anthropometric data of Nigeria agro – equipment operators when compared to that of other countries. The outcome of this research will be useful in the design and manufacturing of agricultural equipment and machineries made for Nigerian agricultural tractor operators.

Keywords: Anthropometric; Data; Agro; Equipment, Operators; Nigeria; Male; Female

Introduction

From the earliest advancement, the measurement of the human body has been done and used for ample basis. These human body measurements were used basically in designing human figurative arts, paintings and sculptures representing the truthful mortal pictures, paints and models [21]. The importance of safety and ergonomics have developed notably, making it one of the essential factors to be considered in a design process [5]. Ergonomics is the meditation of the connection linking persons and machines and the factors that influence the connection.

During the 20th century, there has been an elevated interest for ergonomic researches in the technology for work, furniture and agricultural machinery designs based on biomechanics of the human body. The branch of ergonomics that deals with human volatility in size, shape and strength is called anthropometry. Anthropometry is the research that deals with individual measurement i.e. body size, shape, strength and working capacity [6] for design aspiration [17] and body arrangement [11]. It has been considered as a highly vital core of ergonomics in a bid to resolve the perplexity of fitting people to machine [5].

As recorded by few studies, human lateral, population, countries, gender, age and race/ethnicity were cited as contributing factors to anthropometric irregularity [15, 7]. The technological advancement and economic growth have prompted higher demand and development of machines and devices used in industrial and agricultural settings. Anthropometric data are one of the essential factors in designing farm machines, equipment and devices as shown in [3] study. Incorporating such information would yield additional impressive designs, ones that are safer, easily operated and will permit upward performance and productivity.

Presently in Nigeria, emphasis has been on mechanized agriculture as a major way to provide enough food needed for the growing population. Appropriate design and development of machines, equipment etc for farm mechanization in Nigeria needs availability of adequate anthropometric and biomechanical database of the operators of such machine for efficient man – machine – environment interactions required for high productivity. [1] Established that anthropometric data plays a vital role in human machine relation. (2) In their work noted that anthropometric data has been used as design product guideline for heights, clearance, grips, and reaches of workplace and equipment.

These accrued benefits of anthropometric data have motivated a lot of researchers to develop various anthropometric databases. For instance, (14) worked on the comparative study of the anthropometric dimension of females and males in southeastern Nigeria. Their study outcome found out variations in the anthropometric data of males and females of the region. Also, [12] developed an anthropometric database for Saudi students. They compared Saudi dimensions relative to Turkish and Iranian people which revealed significant changes. In the same vain, (16) developed an anthropometry database for the Malaysian population. They noted that having an anthropometric database defines a countries population. Also, the Engineers produce a better design using anthropometric data. [9] Developed anthropometric database for university students in Northern Mexico. Their research findings indicate that body weight and stature of students in Northern Mexico are considerably bigger to that of people from other Mexican regions. Furthermore, [4] in their study, determined the anthropometric dimensions for a large sample of Portuguese adults. They noted that the results of their study will be of great value for the design of workstations, tools and protective equipment. The aim of this work is to determine anthropometric characteristics of agro equipment operators in Nigeria. The specific objective are to take the anthropometric measurements of agro equipment operator as they perform threshing, fertilizer application, irrigation system control and every other tasks performed while standing. Also, to collate and analyse the data obtained.

Methodology

The study areas for this research are eighteen states namely, Zamfara, Kano, Gombe, Taraba, Kwara, Benue, Edo, Oyo, Ogun, Enugu, Anambra, Cross River, Bauchi, Katsina, Kogi, Osun, Ebonyi and Delta. The anthropometric equipment used are digital caliper, weighing balance, soft metric tape, stadiometer, sitting box, computer, trammel, and personnel. According to [13], a set of

people, services, elements, events, group of household that are being investigated can be defined as population. Nonetheless, studying the entire Nigerian population is strenuous, [18] formula as shown below in equation 1 allows researcher to sample the population with a desired degree of accuracy [19]. A 95% confidence level was used for this study as suggested by [10], because there are 95 chances in 100 that the sample results represent true conditions.

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

$$Wheren = SampleSize$$

$$N = TotalPopulation$$

$$e = ErrorTolerancelevel$$

In the course of this research, the ages of samples between 18 – 60years were used. Recruited personnel were trained for the anthropometric measurements. For effective training, the trainees were grouped into three: namely the coordinators, the data officers and data collating officers. The data collating officers at the various local government areas measure the samples from 10am to 1pm on daily basis, the data officer collate the sample measurements and the coordinators coordinate in the six geopolitical zones for the research head. Note, these data collating officers are the field offices to take measurements of the samples as the agro operators are in a standing position. For effective coverage, measurements were taken randomly from at least three states in each geopolitical zone. 1,888 females and 2,007 males were collated making up a sum total of 3,895 Nigerians. The sample size was used in line with [22] recommendation of a minimum sample size of 200 samples for anthropometric data to be used as a reference standard. The mean age for male operators is 35year while that of female operators is 27. Data collated was analysed using SPSS software to develop a standing anthropometric data of Nigerian agro – equipment operators having there range, mean, standard deviation, 5th and 95th percentile. Also MATLAB software was used for the ANOVA table and bar charts.

Table 3.1.1 represents the anthropometric data of Nigerian female agro equipment operators in a standing position. These data were collated from eighteen states and were statistically analysed.

Table 3.1.1: The Range, Mean and Standard Deviation of the Anthropometric Characteristics of Female Agro Equipment Operators in Nigeria: Standing

S/N	Anthropometric Dimension	Range	Mean	SD	5%	95%
1	Stature (cm)	142.96 187.22	165.09	13.14	147.00	177.86
2	Weight (kg)	41.11 - 79.73	60.42	13.17	46.10	75.74
3	Eye height standing (cm)	121.60 185.72	153.66	18.06	134.00	176.43
4	Shoulder height standing (cm)	100.18 184.58	142.38	26.88	121.00	175.35
5	Crotch height (cm)	68.45 - 88.31	78.38	3.41	75.00	83.89
6	Waist height (cm)	85.00 - 103.12	94.06	4.02	87.80	97.96
7	Chest height standing (cm)	103.62 -129.38	116.50	5.36	108.20	122.91
8	Axilla height (cm)	110.50 -142.98	126.74	6.06	119.20	135.83
9	Radiale stylion length (cm)	24.00 - 30.81	27.62	1.30	25.80	29.27
10	Sleeve outseam (cm)	48.53 - 62.07	55.30	3.28	51.80	58.97
11	Bimalleolar breadth (cm)	12.43 - 18.69	15.56	1.44	14.00	17.76
12	Chest breadth (cm)	26.08 - 40.52	33.30	4.74	28.00	38.49
13	Buttock height (cm)	74.44 - 96.58	85.51	3.71	81.00	91.75

14	Sleeve inseam (cm)	35.55 - 56.01	45.78	8.15	39.00	53.21
15	Elbow rest heightstanding(cm)	91.06 - 108.42	99.74	3.40	95.40	103.00
16	Hip breadth (cm)	29.97 - 51.93	40.95	5.61	37.00	49.33
17	Knuckle height (cm)	62.05 - 75.75	68.90	2.25	66.00	71.96
18	Shoulder waist length (cm)	31.75 - 56.01	43.88	5.62	39.00	53.21
19	Forearm hand length (cm)	37.97 - 52.55	45.26	3.15	42.00	49.92
20	Shoulder elbow length (cm)	30.98 - 41.02	36.00	2.47	33.00	38.97

Table 3.1.2 below shows the result for the statistical analysis of the anthropometric data of Nigerian male agro equipment operators in a standing position. A total of twenty anthropometric dimensions were considered.

Table 3.1.2: The Range, Mean and Standard Deviation of the Anthropometric data of Male Agro Equipment Operators in Nigeria: Standing Position

S/N	Anthropometric Dimension	Range	Mean	SD	5%	95%
1	Stature (cm)	146.87-199.03	172.95	9.02	153.50	189.08
2	Weight (kg)	49.97 -101.07	70.52	13.08	57.20	96.02
3	Eye height standing (cm)	131.21-192.77	161.99	10.61	140.00	183.13
4	Shoulder height standing (cm)	122.62-188.78	150.20	13.28	131.50	179.34
5	Crotch height (cm)	70.36 - 90.44	81.40	4.26	72.60	85.92
6	Waist height (cm)	87.73 - 114.43	101.08	5.68	89.40	108.71
7	Chest height standing (cm)	110.53-156.95	132.74	8.51	118.80	149.10
8	Axilla height (cm)	121.79-157.67	139.73	6.41	129.50	149.79
9	Radiale stylion length (cm)	24.54 - 35.74	30.14	2.82	25.00	33.95
10	Sleeve outseam (cm)	50.00 - 71.59	62.05	5.14	52.51	68.01
11	Bimalleolar breadth (cm)	9.54 - 38.44	21.49	8.21	11.90	36.52
12	Chest breadth (cm)	27.17 - 48.87	36.02	4.76	30.60	46.43
13	Buttock height (cm)	78.34 - 105.64	91.99	4.85	84.50	100.36
14	Sleeve inseam (cm)	33.60 - 60.84	48.72	5.54	36.00	57.80
15	Elbow rest height standing(cm)	96.34 -119.68	108.01	4.62	99.50	113.70
16	Hip breadth (cm)	25.00 - 39.74	32.87	3.96	27.56	37.75
17	Knuckle height (cm)	59.84 - 84.54	72.69	5.49	61.00	80.31
18	Shoulder waist length (cm)	39.34 - 57.96	48.65	4.15	41.00	55.06
19	Forearm hand length (cm)	40.87 - 59.47	50.17	3.60	46.00	56.50
20	Shoulder elbow length (cm)	27.87 - 45.71	37.79	3.81	29.87	43.42

3.2.1: Comparison of the Anthropometric Data of Male and Female Agro Equipment Operators in Nigeria

Comparative analyses were performed on the male and female anthropometric data for agro equipment operators to determine their variation in their level of comfort when in operation through bar charts representation.

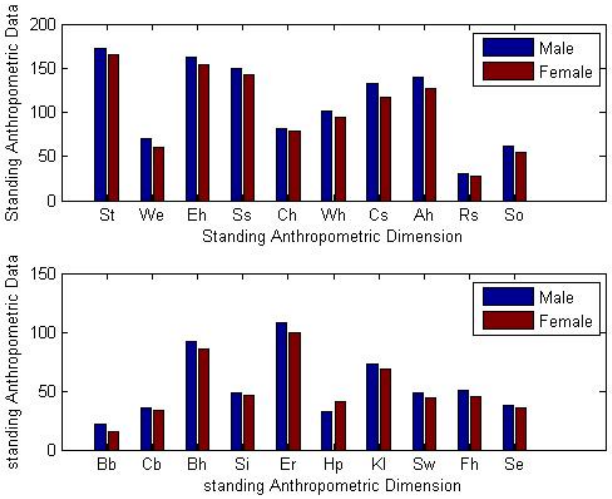

Figure 3.2.1: Bar Chart of Male and Female Standing Anthropometric Data

Figure 3.2.1 above is a bar chart describing the comparative analysis of male and female standing anthropometric data of agro equipment operators in Nigeria. It has two different colours blue representing male and red representing the female. In all the Anthropometric dimensions male has higher anthropometric data than female save for Hip Breadth. St (Stature), We (weight), Eh (Eye height standing), Ss (shoulder height standing), Ch (crotch height), Wh (waist height), Cs (chest height standing), Ah (Axilla height), Rs (radiale stylion length), So (Sleeve outseam), Bb (Bimalleolar breadth), Cb (Chest breadth), Bh (Buttock height), Si (Sleeve inseam), Er (Elbow rest height standing), Hp (Hip Breadth), Kh (Knuckle height), Sw (Shoulder waist length), Fh (Forearm hand length), Se (Shoulder elbow length).

3.3.1: Validation Analysis on Three Anthropometric Dimensions

The Mean values of male Anthropometric dimensions of agricultural workers of various countries compared with that of the present study is presented in Table 3.3.1. All measurements are in millimeter (mm). Source (5, 20, 4, 1, 9, 23 and 8). It could be seen that there is consequential difference in each of the countries anthropometric data. Turkey has the highest value for stature while Mexico has the highest value for weight and India has the least hip breadth value.

S/n	Anthropometric dimensions	Present study	Turkey	Portugal	Iran	Malaysian	China	India	Mexico
1	Stature	1729.5	1749	1690	1725	1686.18	1678	1614	1726
2	Weight	70.52	69.50	74	65.66	66.64	59	53.7	80
3	Hip breadth	328.7	351	380	342	375.39	306	300	384

Table 3.3.1: Mean Male Anthropometric Data of Nigerian Compared To Other Countries

The average value of female Anthropometric data of agricultural workers of different countries related to that of present study is set out in table 3.3.2 Source [1, 4, 5, 8, 9, 20, 23]

Table 3.3.2: Mean Female Anthropometric Data of Nigerian Compared To Other Countries

s/n	Anthropometric dimensions	Present study	Turkey	Portugal	Iran	Malaysian	china	India	Mexico
1	Stature	1650.9	1618	1565	1597	1565	1570	1546	1599
2	Weight	60.42	56.02	64	56.52	60.40	52	49.5	59
3	Hip breadth	409.5	350	400	363	378.34	317	364	382

3.4.0 ANOVA Analysis on Anthropometric Measurements from Different Countries.

The result shown in Table 3.4.1 below indicates that there is a significant difference in the male anthropometric data of the eight countries within a 5% level of significance. The P – value shows that there is a significant difference because it is less than 0.05. The column represents the different countries while the row represents the three anthropometric variables.

Source	SS	df	MS	F	Prob >F
Columns	12319.8	7	1759.97	2.93	0.0415
Rows	12199774	2	6099887.01	10141.04	0
Error	8421.1	14	601.51		
Total	12220514.9	23			

Table 3.4.1: ANOVA Table of Male Anthropometric Data for Different Countries

Anova of female anthropometric data for respective countries as illustrated in Table 3.4.2 reveals high level of statistical differences as both parameters (rows and columns) has F values less than 0.05 (5%).

Source	SS	df	MS	F	Prob >F
Columns	7021.91	7	1003.13	1.92	0.01409
Rows	10475920.99	2	5237960.49	10044.34	0
Error	7300.77	14	521.48		
Total	10490243.67	23			

Table 3.4.2: ANOVA Table of Female Anthropometric Data for Different Countries

Conclusion

From the results given the following conclusions could the drawn

- That the Nigerian male and female agro equipment operators have 95th percentile value of 189.08cm and 177.86cm respectively for stature.
- Comparison of the male and female standing anthropometric data of agro equipment operators indicates that the males possess higher anthropometric data values than the females save for the hip breath where the females have higher values
- That the ANOVA shows a high significant variation in both columns (countries) and rows (anthropometric dimensions) implying that for design of unique agricultural equipment the anthropometric data of the country should be considered for optimum comfort of the operators in the country.

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