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Anthropomertric Dimensions of Farmers in Mbaise Nation of Imo State Nigeria

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ABSTRACT: *The anthropometric body dimensions of farmers (male and female) in Mbaise, Imo state of Nigeria was examined. The measurement of the anthropometric data of the male and female farmers was to determine their anthropometric body dimensions to enable the designers of agricultural equipment improve on the agricultural tools that will suit the farmers or agriculturists in order to optimize their usage, enhance posture and comfort of the users and maximize output. Results revealed that male farmers had greater body dimensions than the females. In the waist circumferences and hip breadths, the male measured average of 81.1cm and 34.4cm respectively and the female recorded 88.7cm and 42.1cm at waist and hip respectively. results further revealed that male farmers had average stature and body weight of 168.3cm and 65.9kg respectively with the 5th and 95th percentiles of 162.75cm and 175.77cm respectively in stature; and 60.15kg and 71.73kg in body weight respectively; and the female recorded mean stature and body weight of 163.2cm and 64.8kg respectively with the corresponding 5th and 95th percentiles of 153.96cm and 172.17cm respectively in stature and 60.04kg and 69.35kg respectively in body weight. There were no much variations, in the body dimensions of the farmers in Mbaise region of Imo state which implies that implements/machine designed for agricultural purpose could generally suit the workers or might be adjusted to suit every agricultural worker in the area.*

Keywords: *Anthropometry, farmers, dimensions, machines, Mbaise and Imo state.*

I. NTRODUCTION

Engineering anthropometry deals with the application of scientific physical measurement method to human subjects for the development of engineering design standards. It includes static and functional (dynamic) measurements of dimensions and physical characteristics of the body as they occupy space, move and apply energy to physical objects, as a function of age, sex, occupation, ethnic origin and other demographic variables (Sanders and McCormic , 1992).

According to Agrawal *et al.*, (2010), anthropometric body dimensions play a significant role in human-machine interaction. The authors revealed that the overall working efficiency of human-machine environment and resultant discomfort has severe impact while using farm tools and machinery. They noted that anthropometric dimensions vary considerably across gender, race, age, and that within a particular group, the anthropometry differs due to nutritional status and nature of work, and to achieve better performance and efficiency along with higher comfort and safety to the operators, it is necessary to design tools, equipment and workplaces keeping in view of the anthropometric data of the agricultural workers.

One major reason for low agricultural productivity in some agricultural regions is due to prevalence of traditional method of cultivation and lower mechanization level. Machines or tools manufactured without application of human factors or ergonomic principles are low in working efficiency and most times fail to reduce drudgery and increase discomfort of the operators. Ergonomics is the science which considers human characteristics, expectations and behavior in the design of things mainly used in environment (Sanders and McCormic , 1992). The ergonomic principles or human factors are considered in machine design to enhance effectiveness, efficiency, safety and comfort of the users/operators of the equipment. In most cases, constraints are been experienced in adoption of improved machineries being utilized in other parts of the country; the adopted equipment at times need to be modified before being introduced into other countries or regions to suit agricultural workers of the region for which body dimensions limits of local populations was required. To design any product for human use, engineers have to rely on anthropometric data, otherwise the resulting product may turn out to be ergonomically incompatible (Lewis, 1993; Hastegrave, 1986).

According to Mebarki and Davis (1990), anthropometric dimensions are one of the essential factors in designing machines and device. Gite and Yadav (1989), noted that the design and dimensions of agricultural tools and implements have great bearing on the body dimensions and physical built of the users, requiring compatibility essentially between machine devices and worker body dimensions. Dewangan *et al.,* (2005) suggested that the only way to fulfill this objective is to create database of anthropometric dimensions of the user population.

Gupta et al (1983) observed that most of the anthropometric data in India is limited to male agricultural workers; while it was discovered by Reddy *et al.,* (1994) that about 88% rural women working population is engaged in agricultural sector and stipulated that the value is nearly 50.2% of the total agricultural labour force in India. Dixit *et al.*, (2014) added that due to paucity of female anthropometric data, the anthropometric data of male workers are extrapolated to define women at work whenever necessary. Cox *et al*., (1984) opposed this assumption and said that such an approach is likely to be inaccurate due to obvious anthropometric, physiological and biological differences between male and female subjects. As earlier noted in this review, the body dimensions vary with age, sex, ethnic groups (Sanders and McCormick, 1992). According to Dixit and Namigial (2012),there is considerable difference between the anthropometric data of India and Western population emphasizing the need for generating anthropometric database for agricultural workers as it is not feasible practically to design equipment for an individual sex (male and female).

Based on the foregoing, this study was conducted to generate and analytically compare the anthropometric data of the male and female agricultural workers in the rural areas of south-eastern region of Nigeria. The data so generated will be compared with those of other regions of the western countries for the consideration of ergonomic design of agricultural equipment and machines which will suit the male and female agricultural workers in the study area to enhance effectiveness, efficiency of production, safety and comfort of the users/ operators of the machines.

Agricultural operations involve the use of manually and mechanically operated equipment. Manually operated equipment is extensively used in agriculture for various farm operations like digging, weeding and harvesting. Cox et al., (1994) analyzed the effect of sickle design on manual harvesting and the harvester. The performance of the study was justified by the claim that manual harvesting is a moderately heavy task which requires the worker to adopt many awkward postures. The design of the handles of these tools depends on the mode of operation, amount of effort required, and the anthropometric data of the working population (Yadav *et al.*, 2000). According to Yadav *et al.,* (1995), the internal grip diameter for 5th percentile female Indian is 3.8cm while that of male individuals varies from 4.1 to 4.3cm. For the design of a handle, its diameter should not exceed the internal grip diameter. For animal drawn equipment the handle is one of the most important components with which the operators controls and guides the implement properly during field operations. If the height is too low, the operator has to bend excessively which strains the operator. If the height is too high, the maneuverability of the implement is affected and operation will not be proper. The elbow height (standing) data is helpful for designing proper handle height.

The placement of different controls in a tractor is a complex task for the designer and requires the anthropometric characteristics of the target population (Yadav *et al*., 2000). The efficiency and comfort of the operator can be improved with properly designed tractor workplace. The dimensions of the seat, location of controls and access/exit provisions are the parameters where anthropometric data can provide help in matching the workplace according to the user's capabilities and to the physiological reach of the operator.

For design purpose, Yadav *et al.,* (2000) stipulated that either one of the boundary value (5th or 95th percentile) or the mean values is used depending upon the dimensional element. Anthropometrically, the authors noted that seat height from foot rest to suit female Indian 5th and 95th percentile population would be within the range of 37.0 to 40.0cm. While in the case of male Indians would be within the range of 41.6 to 47.1cm. If the equipment is to be operated by women, the anthropometric data of the female must be considered in the design along with men anthropometric data. Anonymous (1996) revealed that most Indian tractors are manufactured to suit the anthropometric measurements applicable to the countries where the tractors are designed.

Grandjean et al (1981) expressed the opinion that industrial organizations have not paid too attention to the comfort of workers, but believe that providing for the comfort of the workers would be beneficial, even in terms of production performance. They introduced the industrial comfort as a concept with a threshold level below which a worker would not be distracted from the work, and developed a procedure for obtaining the judgments of people regarding their level of comfort, both in an overall sense and regarding sensations of pain associated with specific areas of the body. In one use of this procedure they derived comfort score for spot welders before and after certain changes in their work layout, and found that after the changes were made the discomfort scores were considerably lowered.

The most important possible physical consequence of improper posture is with respect to spinal problem (Sanders and McCormic, 1992). Grandjean *et al*., (19 81) estimate that 50% of adults suffer backaches during at least one period of their lives, and state that the main reason for the frequent backaches is a pathological degeneration of the discs, which lie between the bony vertebrae and act as an elastic cushion between the vertebrae, thus giving the spinal column its flexibility. Improper postures used in such activities as stooping, lifting, and carrying loads tend to wear out the discs. Gupter et al (1983) measured the intradiscal pressure in different postures, and found that in either sitting or standing the pressure increases with increasing degrees of bending the back. They also reported a very sharp increase in such pressure when a person lifted a 20kg weight with a straight knees and a bent back, as opposed the recommended practice of lifting with bent knees and a straight back. Thus, one of the objectives of the use of anthropometric data is to design the things people use so as to enhance the possibility of maintaining proper posture.

As indicated earlier, anthropometric data have very wide applications in the design of physical equipment and facilities. In this regard, although static anthropometric data have certain uses, it is becoming increasingly evident that functional anthropometric data probably have greater potential use. However whatever type of data would be most relevant for a particular design problem, in most circumstances it is important to use data that are based on samples of subjects that are similar to the population who will ultimately use the item in question. However, Lewis (1983) pointed out that comprehensive anthropometric data are still missing for population groups such as female, children, the elderly, and handicapped.

The main goal of this research work is to develop an anthropometric database for male and female agricultural workers in the rural areas of Mbaise nation of Nigeria for a better design of farm machinery to suit them for safety, comfort and efficient operation.

II. MATERIALS AND METHOD

2.1 Description of the Study Area

The study area is Mbaise, Imo state. Mbaise lies approximately latitudes 6° 7′N, and longitudes 7° 23′E, with a land area of approximately 2,783km^2 and population of 1.9 million. The vegetation of the area is a mixture of savanna. The zone has an average annual temperature of above 28^{o}c with mean relative humidity of about 78%. Mbaise is an agricultural area; with fertile and well drained soils; and the people are good farmers and industrialists.

2.2 Samples for the Study

The samples for the study consist of 3000 agricultural workers within the age limit of 18-50 years selected randomly from the area State.

2.3 Apparatus Used

The following anthropometric equipment was used for the study: An anthropometer was used in measuring various body dimensions at standing and sitting postures; Weighing balance of 1kg sensitivity and 150kg capacity was used for measuring the body weight of the subjects; Measuring tape was used for measuring lengths and widths of some body parts; Vernier caliper was used for measuring the internal and external grip diameters; Grip strength dynamometer was used for measuring grip strength; Statoscope was used for measuring rate of heart beat.

2.4 Anthropometric Measurement Procedure/Data Collection

Twenty (20) anthropometric body dimensions considered useful for design of agricultural equipment/machines were measured alongside with the heart rates. The standard anthropometric definitions of measurements and techniques used by Pheasant (1986) as applied by Onuoha *et al.,* (2012) were adopted in the study. Prior to the collection of the data, some persons (male and female) were trained on how to take measurements of body dimensions. The process for data collection was properly explained to the trained personnel so as to maintain accuracy in their measurements and to seek full cooperation from the subjects (Agrawal *et al*., 2010, Dixit *et al.,* 2014, and Oduma and Oluka, 2017). In the process, the subjects were asked to stand on the platform of the anthropometer with their feet well closed, their bodies vertically erect, while heels, buttocks and shoulders touch the vertical plane; the arm of the anthropometer was adjusted according to the subject's height and measurement was recorded from the vertical scale. Measurements were also taking in sitting postures. In this case subjects were asked to sit with their body vertically erect, while their shoulders and head touch the vertical plane and their feet completely touch the base platform. In all the measurements with anthropometer, the subjects were bare footed. The vernier caliper was used to measure the internal and external grip diameter while the grip strength dynamometer was used to measure the grip strength of the subjects. The measuring tape was used to measure waist breadth, waist circumference, foot length, and hand breadth across thump, hand height at metacarpal etc. The weighing balance was used for body weight measurement; the statoscope was used for measuring rate of heart beat. For every subject, measurements of a given body dimension was replicated for three times and average value of the dimension was taken as the real dimension; this is to avoid error in the measurements.

2.5 Data Analysis

The data collected from the measurement was analyzed using range, mean, standard deviation, percentile values (5^{th}, 50^{th} and 95^{th} percentile) and percentages. The percentile was used to adjudge the proportion of a group of individuals who exceed or fall below some possible design limit; therefore, apart from the mean; the 5^{th} and 95^{th} percentile values of body dimensions were calculated to decide various possible design limits of farm machinery and work place layout to be operated by male or female workers (Agrawal 2010).The percentage was used to determine the percentage difference or variation in the set of data obtained for male and female agricultural workers (Oduma and Oluka 2017).

III. PRESENTATION OF RESULT

3.1 Data Presentation

The data collected from the study was analyzed and presented using graphs and statistical descriptive tables. Table 1 shows the results of the research work.

Table showing the Anthropometric data of Mbaise male and female agricultural workers

Body dimensions	Male							Female						
	Range		Mean	S.D	Percentiles			Range		Mean	S.D	Percentile		
	Min	Max			5^{TH}	50^{TH}	95^{TH}	Min	max			5TH	50TH	95^{TH}
Stature	143.9	161.2	170.1	5.4	152.3	161.2	170.1	140.6	170.3	155.45	4.5	148.0	155.5	162.9
Weight, kg	46.8	67.4	57.1	2.3	53.3	57.1	60.9	47.9	70.8	59.4	3.2	53.8	59.4	64.1
Standing eye height	137.5	170.6	154.1	6.5	143.4	154.7	164.7	136.1	173.4	154.8	5.6	145.5	154.8	164.0
Shoulder breadth	43.1	64.8	54.0	4.3	46.9	54.0	61.0	46.0	68.9	57.5	4.3	51.86	57.5	63.0
	129.4	168.0	148.7	7.6	136.2	148.7	161.1	166.2	146.8	135.7	6.7	135.7	146.8	157.8
Shoulder height														
	26.0	53.5	39.8	2.2	36.1	39.8	43.4	24.9	53.3	39.1	2.2	35.5	39.1	42.7
Shoulder elbow length	14.8	24.3	19.6	1.8	16.6	19.6	22.5	14.0	23.9	19.0	1.8	16.0	19.0	21.9
	6.0	10.2	8.0	2.1	4.7	8.1	11.6	5.7	8.8	7.3	1.2	5.3	7.3	9.2
Hand length														
	71.4	93.8	82.6	5.4	73.7	82.6	91.5	68.5	90.7	79.6	4.5	72.2	79.6	87.0
Hand bread	81.2	108.9	95.1	3.2	89.8	95.1	100.3	79.2	106.4	92.8	2.3	89.0	92.8	96.6
Arm reach from wall	12.4	28.7	20.6	4.4	13.3	20.6	27.8	11.8	26.9	19.4	4.4	12.1	19.4	26.6
Elbow height	31.8	63.4	47.6	3.5	41.83	47.6	53.4	28.9	58.0	43.5	5.3	34.7	43.5	52.2
Elbow rest height	15.9	27.3	21.6	0.5	20.8	21.6	22.4	14.8	27.6	21.2	5.0	123.0	21.2	29.4
Grip strength, kg	37.5	59.7	48.7	2.3	44.9	48.7	52.5	34.7	56.8	45.8	3.2	40.5	45.8	51.0
Hand circumference	58.6	88.8	73.7	7.1	62.0	73.7	85.4	56.3	85.9	71.1	1.7	68.8	71.1	73.9
	67.8	101.9	84.9	6.3	74.5	84.85	95.2	69.4	125.5	97.5	3.6	91.5	97.5	103.4
Forearm hand length	59.2	90.4	74.8	4.2	67.9	74.8	81.7	54.1	85.3	69.7	2.4	65.8	69.7	73.7
External grip reach	46.3	75.0	60.7	3.0	55.7	60.7	65.6	44.5	57.0	50.8	0.3	50.3	50.8	51.2
Waist circumference	40.5	58.9	49.7	1.2	47.9	49.7	51.6	36.3	48.2	42.3	2.1	38.8	42.3	45.7
	30.4	42.0	36.2	3.4	30.6	36.2	41.8	36.4	50.1	43.4	4.3	36.3	43.4	50.4
Sitting height	40.7	68.3	54.5	4.5	46.8	54.5	62.2	34.9	59.7	47.3	5.4	38.4	47.3	56.2
Sitting eye height	35.1	64.1	49.6	5.5	40.6	49.6	58.7	50.3	40.4	34.6	3.5	34.6	40.4	46.2

Sitting shoulder height	79.3	109.2	94.3	6.7	83.2	94.3	105.3	72.7	101.3	87.0	7.6	74.4	87.0	99.5
Hip breadth	18.5	40.3	29.4	0.4	28.7	29.4	30.1	12.4	37.2	24.8	4.0	18.2	24.8	31.4
Buttock knee length														
Buttock popliteal length														
Functional leg length														
Foot length														

3.2 Discussion

The body dimensions studied were analyzed using the range, mean, standard deviation, percentile values and percentages; and were presented in descriptive statistical tables and graphs. The mean, standard deviation and percentage values revealed the differences in anthropometric dimensions that exist between the male and female agricultural workers while the percentile values provide a basis for judging the proportion of a group of individuals who exceed or fall below some possible design limits. Therefore, the 5th, 50th (mean) and 95th percentile values of the body dimensions were calculated to decide various possible design limits of farm machinery and workplace layout to be operated by male or female agricultural workers in the study area (Oduma and Oluka, 2017).

Table 1 the anthropometric body dimensions of male and female agricultural workers in Imo state. According to the results of these curves, the male agricultural workers have stature, body weight, standing eye height, shoulder breadth, shoulder height (standing), shoulder elbow length, hand length, hand breadth, arm reach from wall, elbow height, elbow rest height of 161.2cm, 57.1kg, 154.1cm, 54.0cm, 148.7cm, 39.8cm, 8.1cm, 82.6cm, 95.1cm and 20.6cm respectively with 5th and 95th percentile values corresponding to the mean stature of 152.3 and 170.1cm respectively. In that order, the female agricultural workers measured 155.5cm, 59.4cmkg, 154.8cm, 57.5cm, 146.8cm, 39.1cm, 19.0cm, 7.3cm, 79.6cm, 92.8cm, 19.4cm respectively; the 5th and 95th percentile values corresponding to their mean stature are 148.0 and 162.9cm respectively. It was also observed from the results that male agricultural workers in Imo state measured 47.6kg, 5.0cm, 7.9cm, 21.6cm, 48.7cm, 73.8cm, 84.9cm, 74.8cm, 60.7cm and 49.7cm and 51.2cm for grip strength, internal diameter, external grip diameters, hand circumference, forearm length, forward grip reach, waist circumference, sitting height, sitting eye height, sitting shoulder height, hip breadth, knee height respectively; while the female agricultural workers in the same arrangement recorded 43.5kg, 4.7cm, 7.8cm, 21.2cm, 45.8cm, 71.1cm, 97.5cm, 69.7cm, 50.8cm, 42.3cm, 43.4cm,and 45.6cm respectively. Finally, the results showed that male agricultural workers recorded 46.3cm for popliteal height, 58.4cm for knuckle height, 54.5cm for buttock knee length, 49.6cm for buttock popliteal length, 94.3cm for functional leg length, 29.4cm for foot length, 12.3cm for thigh clearance and 59.9cm for metacarpal height; while the female workers measured 44.3cm, 49.3cm, 47.3cm, 40.4cm, 87.0cm, 24.8cm, 11.5cm and 55.0cm for popliteal height, knuckle height, buttock knee length, buttock popliteal length, functional leg length, foot length, thigh clearance, metacarpal height and pulse rate respectively.

IV. CONCLUSION

The body dimensions of male farmers are slightly greater than that of the females except in the waist circumferences and hip breadths. However, the variations were not significant across the entire area. Therefore agricultural implements/machines designed for male agricultural workers within the region may suit or be adjusted to suit the female agricultural workers since the female participation in various agricultural operations in South-Eastern Nigeria is relatively equal to the male; there is greater need to develop improved implement to suit the capabilities of both male and female agricultural workers.

V. RECOMMENDATIONS

The application of ergonomic approach in designing farm implements and machinery is not in practice in developing countries like Nigeria due to lack of anthropometric database. Study of anthropometric body dimensions of this kind should therefore be extended to other geographical regions of Nigeria to guide the engineers or designers of agricultural equipment in designing and manufacturing the equipment to suit the users and make them work in good postures and maximize their output.

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