Hand Anthropometry Of Agricultural Workers In Ebonyi State Central Zone Of Nigeria.

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ABSTRACT

Nigerian government has no specific regulatory standard for design and definition of appropriate implements and machinery to be used by agricultural workers. This is attributed to lack of representative anthropometric database of the population in concern. The purpose of this research is to generate hand anthropometric data of male and female agricultural workers of Ebonyi State (central senatorial zone) for use in machinery design. Ten anthropometric variables most relevant to the design of hand tools were selected and randomly measured from 500 (300 male and 200 female) agricultural workers within the age limit of 22 – 60 years old. The result of analysis show that the percentage difference in dimensions between male and female genders ranged from 0.58% to 9.25%. Arm reach from wall and forward grip reach were significantly ($P < 0.05$) different between the two genders. This study also showed a significant difference between anthropometric dimensions of our population with other ethnic populations of the world. The government of Nigeria at every level and concerned agencies should generate more anthropometric data in the country to serve as database and reference standards for machinery design and other uses.

Keywords: Agricultural equipment, anthropometric data, farm workers, dimensions, measurements, machinery design.

1.0 INTRODUCTION

Reliability of agricultural equipment can be greatly enhanced when designed with due consideration to anthropometric dimensions of target users / operators. In Nigeria, agricultural, workers play a significant and crucial role in various agricultural operations starting from land preparation to post harvest operations where they use different types of farm tools, machinery and equipment. The efficient use of Agricultural farm machines require a good knowledge and proper design of equipment capable of increasing work efficiency, safety and safeguarding of the comfort of these using the machines.

Over the centuries, human have used tools to accomplish a variety of tasks, typically related to agricultural jobs. Today, there is growing demand among professional hand tools users to have ergonomically designed product (Schmudtke, 1984; Snow, 1984). Nag et al. (1988) analyzed the effect of sickle design on manual harvesting and the harvester. The study was justified on the basis that manual harvesting is a moderately heavy task, which requires agricultural workers to adopt many awkward postures. Hence handle height, length of handle, handle inclination, etc of hand held agricultural tools are the key design elements to be considered so that maximum force can be exerted to operate the equipment with less effort comfort and work output from the operator.

In Ebonyi State (Central Senatorial Zone), hand tools are extensively used for various farm operations. Most farm tools used in these areas are locally fabricated and these tools are either operated or and controlled by agricultural farm workers. The resulting effect is that the comforts of the farmers are affected with increase in drudgery and risks during the use of the tools. One of the major reasons of lower agricultural productivity in the zone is due to locally manufactured farm tools coupled with inherited constraints of land tenure systems and soil type. Tools are manufactured by local artisans and small scale manufacturers without due consideration to ergonomic principles thereby resulting in reduced efficiency of agricultural workers. Therefore, there is need for the local hand tools adopted in the area to be modified according to the compatibility of the agricultural workers through the knowledge of hand dimensions limits of the local population. Hand tools need to be held properly with suitable fit to the contours of hand. They need to be held properly with suitable wrist and arm posture. An effective use of tools and implements that require workers to maintain a power grip during task performance, adequate space must be provided on the handle (Okunribido, 2000).

According to Kar et al. (2003), some hand tools require a fairly small force but precise handling while other large require force for higher handling. Hence, the design of agricultural hand tools is a complex ergonomic task and requires hand anthropometry. The interaction of handle size and space with the kinematics and anthropometry of hand have a great effect on hand posture and grip strength (Buchholz et al; 1992). The study was undertaken to generate hand anthropometric dimensions of male and female agricultural workers in the study area. The collected anthropometric data would be compared with the data of other countries of the world with view to improving on ergonomic, efficient design and modification of agricultural equipment and machine for compatibility and sustainability of the target users.

2.0 MATERIALS AND METHOD

2.1 Participants

500 (300 male and 200 female) willing participants were selected randomly among the range 22 – 60 year old agricultural workers from four local government areas in Ebonyi state (central Senatorial zone) of Nigeria for the study. The number of participants selected from each local government area of the study zone is as shown in table 1 below.

Table 1: Participants selected from each local government area of the zone

Name of L.G.A	Name of community	Number of subjects		
		Male	Female	Total
Ezza North	Inyere	70	50	120
Ezza South	Amaezekwe	70	60	130
Ishielu	Eziulo	60	50	110
Ikwo	Ndiagu Amagu	80	60	140

Source: Field Survey (2013)

2.2 Apparatus and Procedure:

Anthropometric dimensions of the hands were taken with the use of vernier caliper except hand circumference that was measured with a steel tape. For the measurement of grip diameter, a wooden cone was used. The measured dimensions were grip diameter for maximum inner curvature of the hand at the touching level between tip of the middle finger and thumb; hand circumference taken as the close measurement that follow a hand contour at the maximum palm level, the measurement is not circular; hand thickness which was the thickness of the hand measured at the level of middle portion of the palm transversely; maximum hand breadth as the breadth of the hand measured at the level of maximum bulge of the palm including thumb; maximum hand circumference for the close measurement that follows a hand contour at the maximum feast level, the measurement is not circular; forearm hand length as distance between acromion and tip of the middle finger. Hand length is the distance from the wrist to the middle finger, while hand breadth measured is the distance from across the hand at metacarpal; arm reach from wall otherwise as horizontal distance from the shoulder to the tip of the longest finger to touching wall and the forward grip reach that is the horizontal distance from the shoulder to the touching level between tip of middle finger and thumb. The methods of hand anthropometric measurements are same as stated by (Davies, 1980, Courtney and Ng,1984). Accuracy and repeatability of measurement was achieved by practice prior to the data collection sessions.

2.3 Data Analysis

Data collected from the measurements were compiled and analyzed in descriptive statistics form (mean, standard error of mean, standard deviation, minimum values, maximum values, 5^{th} , 50^{th} and 95^{th} percentiles). Data was also analyzed using independent samples t – test by SPSS (version. 18.0).

3.0 RESULTS AND DISCUSSION

3.1 Hand anthropometric characteristics of the sampled agriculture workers.

The ten anthropometric measurements for male and female genders are summarized in Table 2 and 3. Ten dimensions were identified and considered most useful for agricultural hand operated machine design. The mean, standard error of mean, standard deviation and percentile values for male and female suggest that there exists a remarkable difference in anthropometric dimensions of male and female agricultural workers of Ebonyi State central Senatorial Zone. With these generated data, it is possible for designers of hand tools and equipment to determine easily the proportion of population who fall within a specific range of value for a given hand dimension. These values may also be used for comparison with those published for other populations.

3.2 The comparison between male and female Ebonyi state agricultural workers

The t – test comparison of anthropometric data of male and female are shown in Table 4. Analysis of data shows that arm reach from wall and forward grip reach of male agricultural workers (75.7cm and 65.0cm) is significantly ($P < 0.05$) higher than their female counterparts (68.7cm and 60.9cm). However their percentage of difference is very small and it ranged from 0.58% to 9.25% between both genders (not shown in the Table).

The arm reach from wall and forward grip reach are important dimensions because they could interactively affect the operation of steering wheel, control handles and other hand operated devices. The difference in these values suggest that the design parameter for both male and female on the affected dimensions must be different in order not to exceed data range obtained for each gender making it cumbersome for use in the zone.

3.3 Variations in anthropometric hand dimensions across ethnic populations of the world.

A comparison of some hand dimensions of male and female farm workers of the present study (Nigerian) was made with that of USA (Hsiao et al. 2005); Korean (Fenmandez et al. 1989) and Indian (Agrawal et al.2010) subjects which are presented in Table 5. It was observed that most of the dimensions are smaller for both male and female farm workers of the present study (Nigerian). However, little variations exist in some dimensions (forearm hand length and hand length) where the present study (Nigerian) is higher than that of Indians for both male and female counterparts. Similar variations in anthropometric dimensions of different countries were also discovered by Yadav et al. 1996, Agrawal et al .2010 and Onuoha et al .2012.

Table 2 : Hand Anthropometry of Ebonyi State male agricultural workers

Body Dimension	Mean	Std. Error of Mean	Std. Deviation	Minimum	Maximum	Percentiles		
						5	50	95
Grip diameter(internal), cm	3.4	0.3	1.0	2.3	5.1	2.3	3.2	5.1
Hand circumference, cm	17.8	0.5	1.6	15.8	20.1	15.8	17.3	20.1
Hand thickness, cm	2.8	0.1	0.2	2.5	3.1	2.5	2.7	3.1
Maximum hand breadth, cm	9.5	0.3	0.7	8.8	10.8	8.8	9.3	10.8
Maximum hand circumference, cm	23.7	0.73	2.1	21.3	27.0	21.3	23.6	27.0
Forearm hand length, cm	41.9	0.8	2.5	38.9	46	38.9	42.1	46.0
Hand length, cm	17.2	0.5	1.5	15.0	19.4	15	17.4	19.4
Hand breadth, cm	7.3	0.2	0.7	6.4	8.4	6.4	7.0	8.4
Arm reach from wall, cm	75.7	1.8	5.4	66.3	83.1	66.3	77.4	83.1
Forward grip reach, cm	65.0	1.1	3.4	58.4	70.4	58.4	65.3	70.4

Source: Field Survey (2013)

Table 3: Hand Anthropometry of Ebonyi State Female Agricultural Workers

Body Dimension	Mean	Std. Error of Mean	Std. Deviation	Minimum	Maximum	Percentiles		
						5	50	95
Grip diameter (internal), cm	3.3	0.2	0.6	2.6	4.2	2.6	3.1	4.2
Hand circumference, cm	17.7	0.4	1.2	16.2	20.1	16.2	17.3	20.1
Hand thickness, cm	2.7	0.07	0.2	2.5	3.0	2.5	2.7	3.0
Maximum hand breadth, cm	9.1	0.17	0.5	8.6	10.0	8.6	8.9	10.0
Maximum hand circumference, cm	23.5	0.4	1.1	21.9	24.7	21.9	23.3	24.7
Forearm hand length, cm	41.0	0.9	2.8	36.5	45.1	36.5	41.4	45.1
Hand length, cm	16.9	0.2	0.7	15.9	17.9	15.9	16.8	17.9
Hand breadth, cm	7.1	0.4	1.1	5.3	8.3	5.3	7.3	8.3
Arm reach from wall, cm	68.7	1.9	5.6	59.3	78.2	59.3	69.4	78.2
Forward grip reach, cm	60.9	1.9	5.7	52.2	68.1	52.2	60.2	68.1

Source: Field Survey (2013)

Table 4: T-test analysis of anthropometric data of male and female Ebonyi State agricultural workers

Body Dimensions	Male Mean	Female Mean	N	tcal	df	Sig.(2 tailed)	Decision P < 0.05
Grip diameter (internal), cm	3.4	3.3	500	0.36	499	0.73	NS
Hand circumference, cm	17.8	17.7	500	0.44	499	0.67	NS
Hand thickness, cm	2.8	2.7	500	0.86	499	0.39	NS
Maximum hand breadth, cm	9.5	9.1	500	2.12	499	0.07	NS
Maximum hand circumference, cm	23.7	23.5	500	-0.56	499	0.93	NS
Forearm hand length, cm	41.9	41	500	-0.72	499	0.49	NS
Hand length, cm	17.2	16.9	500	-0.47	499	0.65	NS
Hand breadth, cm	7.2	7.1	500	-0.42	499	0.69	NS
Arm reach from wall, cm	75.7	68.7	500	3.54	499	0.01	S
Forward grip reach, cm	65	60.9	500	2.51	499	0.04	S

NS and S means not significant and significant respectively

Table5 : Comparison of male and female anthropometric data of present study with other ethnic population of the world

body dimension	Male								Female							
	Present study		[a] USA		[b]Korean		[c] Indian		Present study		[a]USA		[b]Korean		[c]Indian	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Grip diameter (internal), cm	3.4	1.0	NA	NA	NA	NA	4.0	1.1	3.3	0.6	NA	NA	NA	NA	3.6	0.3
Forearm hand length, cm	41.9	2.5	48.2	2.1	NA	NA	40.9	8.1	41	2.8	44.4	1.9	NA	NA	39.5	1.7
Hand length, cm	17.2	1.5	19.7	1.0	NA	NA	16.9	3.8	16.9	0.7	18.2	0.9	17.0	0.1	16.1	0.8
Hand breadth, cm	7.3	0.7	9.1	0.5	NA	NA	9.1	2.2	7.1	1.1	8.0	0.5	7.7	0.4	8.6	0.6
Arm reach from wall, cm	75.7	5.4	NA	NA	NA	NA	NA	NA	68.7	5.6	NA	NA	NA	NA	NA	NA
Hand thickness, cm	2.8	0.2	3.0	0.2	NA	NA	NA	NA	2.7	0.2	2.5	0.2	3.0	0.2	NA	NA
Maximum hand breadth, cm	9.5	0.7	10.8	0.6	NA	NA	NA	NA	9.1	0.5	9.5	0.5	9.0	0.4	NA	NA

Note : [a]Hsiao et al. (2005), [b]Fernmandez et al. (1989), [c]Agrawal et al. (2010), NA means not available

4.0 CONCLUSION

This study provided the first available hand anthropometric information about agricultural workers in Ebonyi State (central senatorial zone), which is valuable for the design of agricultural equipment and machines to be operated with hands. The result of t – test analysis for male and female farm workers indicated that arm reach from wall and forward grip reach of male agricultural workers is significantly ($P < 0.05$) higher than their female counterparts. Variations in anthropometric dimensions among different ethnic populations of the world were also discovered which is in line with the studies of Yadav et al 1996, Agrawal et al 2010 and Onuoha et al. 2012.

These differences in values suggest that the design parameter for any group (subjects) must be in accordance with the data generated, most especially on arm reach from wall and forward grip reach because lower or higher values could interactively affect the operation of steering wheel, control handles and other hand operated devices.

Applying anthropometric dimensions of western world to design machines to be used by Nigerian may be dangerous and establishing national and international standard is critical in developing machines. The Federal government, engineers, designers and related agencies should give end-users of machines the opportunity to be involved in various stages of design and as well take the findings of this study as a reference. By doing this, repetitive hand injuries in many workplaces will be reduced and healthier farm workers and safer work environment assured.

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