

Relationship between Some Anthropometric Indices and Occupation in a South-South Nigerian Population - Implications in Factory Ware Design

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Abstract

It is imperative to take into cognizance the anthropometry of workers in order to increase productivity and efficiency as well as the comfort and safety of the users in ware designs. We hope therefore in this study to investigate the variations in some anthropometric parameters of common occupations. 412 participants (283 males and 129 females), at age range of 18-75 years and who had a working experience of more than five years participated in this study: 60 male and 42 female farmers, 60 male and 43 female fishers, 60 male and 43 female civil servants as well as 103 male auto-mechanics. Areas measured include the thumb length and width, big toe length and width as well as the foot length and width. Measurements were taken to the nearest 0.01cm using a high precision digital caliper. Male and female civil servants had a foot length of 262.62±1.58 and 247.08±2.01 respectively while the foot width was 101.74±0.8 for males and 101.74±0.83 for females. Foot length and width for male auto-mechanics were 284.13±2.79 and 113.13±9.99 respectively. The study showed that among males, big toe length showed statistically significant variation ($p=0.00$). Females showed statistically significant variation ($p\leq 0.05$) in the thumb length, big toe length, and foot length and foot width. Variations in thumb width and big toe width were not common. The male anthropometric parameters were more homogenous among auto-mechanics, farmers and fishers as against the civil servants. These findings have shown that factory design should consider anthropometric parameters when making wares for workers.

Keywords: Anthropometry, Factory ware, Foot length, Occupation, Thumb length.

INTRODUCTION

Anthropometric measurement have played critical role not just for anatomic and anthropological requirements, but also for use in factory ware design. This is supposedly needed to reduce or eliminate hazards associated with work places, and more so to improve efficiency and provide such work places with skilled and efficient manpower. According to Agarwal et al., 2010, human body measurement are crucial for work that needs human-machine interaction, industrial design, apparel design, and architecture. These ultimately require the application of statistical data on the distribution of body sizes in the population to promote and improve the various

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disciplines (Sandeep et al., 2018, 1450-62). Therefore as it pertains to the development of tools and equipment, and as well the design and setting up of workplaces, it is most imperative to take into cognizance the anthropometry of the users in order to increase productivity and efficiency as well as the comfort and safety of the users. In fact according to Sombatsawat et al., 2019, anthropometric parameters vary with age and sex hence mismatches between human anthropometric dimensions and equipment dimensions have been implicated in decreased work efficiency. Also Agarwal et al., 2010 posits that based on the nature of job and nutritional requirement, the measurement patterns could differ and especially with race, gender and ethnicity. Also the influences of altitude, ethnicity, religion, geographical distance, and occupation has been demonstrated by some authors to impact markedly on adult anthropometric parameters and body dimensions and about 50% of the total variance in shape and size of the body could be traced to these influences (Majumder et al., 1986,380, Baten et al., 2004,200, Sandeep et al., 2018, 1460). We intend therefore in this study to investigate the relationship between some anthropometric indices and occupation in a south-south Nigerian population. Udoh, 2000 in his study documented that the majority of households in Nigeria depend primarily on farming as their source of livelihood. Aside farming however, most of these households especially in the south-south of Nigeria have their occupation primarily domiciled in fishing, civil service and manual day -to-day jobs like the auto-mechanic and tailoring.

Khanal et al., 2015 conducted a study on Nepalese individuals and found out that mean standing height of farmers was less than that of industrial workers for males and more than industrial workers for females. Also in same study the wrist breadth was also more in farmers than that of industrial workers in both sexes. In another study involving female farmers in western Nigeria, Okunribido, 2000 stated that female hands were wider and thicker, but shorter when compared to their foreign counterparts. Meanwhile Wibowo et al., 2014 compared farmers across different geographical regions and showed that anthropometric indicators in Java farmers were often higher than those of Maduro farmers in Indonesia. Also Jinhua et al., 2012 documented that truck drivers were heavier than the U.S. general population, with a difference in mean body weight of 13.5 kg for males and 15.4 kg for females. In same study they noted that these truck drivers were also different in body physique from the general population. Samuel et al., 2016 in their work observed that most anthropometric parameters measured were higher in the cassava processing workers compared to the general population. Ekezie, 2013 examined the relationship between height and foot dimensions in the Igbos, Nigeria, for forensic and prosthetic application and documented that sex differences were found to be highly significant for all the measurements with males having higher values than the females. Some authors have documented very relevant results as it pertains factory ware design and related hazards for several other workers including bus drivers, auto-mechanics and farmers and discovered that their anthropometric parameters varies from the general population (Ahmed, 2015, 4525, Samuel et al., 2016, Ikubanni et al., 2017,50, Oduma et al., 2017,262, Oluranti et al., 2018,110, Oladipo et al., 2009,5, Onawumi et al., 2016,5, Owhor et al., 2021, 140).

MATERIALS AND METHODS

This is a descriptive cross-sectional study involving participants drawn from various local government areas of Rivers State, Nigeria after informed consent. These participants were drawn from the fishermen and women, crop farmers, including auto-mechanics and civil servants. 412 participants involving 283 males and 129 female subjects, who are within the age range of 18 and 75 years and who had a working experience of more than five years participated in this study. The years of experience was premeditated on the fact that actual physical and structural changes on the body could be noticeable following a somewhat protracted time. These group of workers in developing countries like Nigeria have been found to go to work frequently within a given period hence the bench mark of five years and more is sufficient to impact on anatomic structures. The population of study included 60 male and 42 female farmers, 60 male and 43 female fishers, 60 male and 43 female civil servants as well as 103 male auto-mechanics. The civil servants were drawn from those engaged in a white-collar job like clerks, doctors, teachers and bankers. Areas measured include the thumb length and width, big toe length and width as well as the foot length and width. Measurements were taken to the nearest 0.01cm using a high precision stainless steel digital vernier caliper 8”200mm with 0.02 precision (Kales Industry and Trade Co., Ltd, Jinhua, Zhejiang, China).

Measurement procedure

The subjects were instructed to open their palm extending their thumb, while the sliding caliper was placed on the thumb with one jaw at the tip of the thumb and the other jaw at the boarder crease with the palm for the length of thumb. The both jaws of the caliper were placed around the thumb at the widest diameter precisely the interphalangeal joint to measure the width of the thumb. In order to measure the big toe, the subject was made to sit comfortably with the foot placed on a flat surface. One of the sliding caliper jaws placed at the metatarso-phalangeal joint of the big toe and the other jaw at the tip of the big toe to measure the length. The sliding caliper jaws were placed around the widest diameter of the big toe to measure the width. The foot length is measured from the most posterior projection of the heel to the most anterior part of the big toe. The foot width was measured as the distance between the medial margin of the head of the first metatarsal and the lateral margin of the fifth metatarsal being the widest diameter of the foot.

RESULTS

Table 1a: Descriptive Statistics of Anthropometric Parameters in Study Population

PARAMETERS (mm)	FISHERS		FARMERS	
	MALE N = 60	FEMALE N = 43	MALE N = 60	FEMALE N = 42
THUMB LENGTH	66.01 ± 0.40	64.88 ± 0.52	66.27 ± 0.42	61.97 ± 0.58
THUMB WIDTH	23.27 ± 0.15	22.30 ± 0.15	23.12 ± 0.15	22.28 ± 0.17
BIG TOE LENGTH	73.58 ± 0.38	69.51 ± 0.67	72.72 ± 0.53	66.99 ± 0.57
BIG TOE WIDTH	33.57 ± 0.12	32.04 ± 0.29	33.69 ± 0.16	31.87 ± 0.21
FOOT LENGTH	260.27 ± 1.11	242.53 ± 1.80	268.03 ± 0.32	247.95 ± 1.28
FOOT WIDTH	101.63 ± 0.74	90.80 ± 0.68	102.89 ± 0.80	94.92 ± 0.63

Values were expressed as mean ± SEM.

Table 1a shows the mean values for the thumb length and width, big toe length and width and foot length and width for male and female fishers and farmers. The male values are seen to be higher in all the parameters studied.

Table 1b: Descriptive Statistics of Anthropometric Parameters in Study Population

PARAMETERS (mm)	CIVIL SERVANTS		AUTO-MECHANICS
	MALE N = 60	FEMALE N = 39	MALE N = 103
THUMB LENGTH	66.01 ± 0.43	65.01 ± 0.52	66.39 ± 0.36
THUMB WIDTH	23.05 ± 0.14	22.25 ± 0.15	23.37 ± 0.10
BIG TOE LENGTH	68.92 ± 0.53	66.79 ± 0.67	72.24 ± 0.86
BIG TOE WIDTH	33.44 ± 0.19	32.16 ± 0.29	35.22 ± 1.01
FOOT LENGTH	262.62 ± 1.58	247.08 ± 2.01	284.13 ± 2.79
FOOT WIDTH	101.74 ± 0.83	90.80 ± 1.15	113.13 ± 9.99

Values were expressed as mean ± SEM. Note: There were no female auto-mechanics.

Table 1b shows the mean values for the thumb length and width, big toe length and width and foot length and width for male and female civil servants and auto-mechanics. The male values are seen to be higher in all the parameters studied.

Table 2: Test of variation among various occupations using ANOVA

PARAMETERS	MALE		FEMALE	
	F value	p value	F value	p value
Thumb length	0.24	0.87	8.54	0.00*
Thumb width	1.32	0.27	0.03	0.97
Big Toe length	6.89	0.00*	5.92	0.00*
Big Toe width	1.53	0.21	0.18	0.83
Foot length	0.50	0.68	3.16	0.05*
Foot width	0.72	0.54	6.52	0.00*

*Significant. p value ≤ 0.05

Table 2 shows test of variation of the anthropometric parameters among the various occupations under study. Both male and female populations were tested to see if these parameters reflect any statistically significant difference between one occupation and the other.

Table 3: Test of variation in Anthropometric parameters of Auto-Mechanics and Civil servants

Parameters	Male		
	t stat	t crit	p value
Thumb length	0.66	1.65	0.25
Thumb width	1.86	1.65	0.03*
Big Toe length	2.78	1.65	0.00*
Big Toe width	1.33	1.65	0.09
Foot length	0.72	1.65	0.23
Foot width	0.87	1.65	0.19

*Significant (p<0.05)

Table 3 shows the test of variation between auto-mechanics and civil servants. Among the parameters studied only the thumb width and big toe length showed statistically significant variation.

Table 4: Test of variation in Anthropometric parameters of Auto-Mechanics and Fishers

Parameters	Male		
	t stat	t crit	p value
Thumb length	0.67	1.65	0.25
Thumb width	0.55	1.65	0.29
Big Toe length	-1.15	1.65	0.13
Big Toe width	1.24	1.65	0.11
Foot length	0.80	1.65	0.21
Foot width	0.88	1.65	0.19

*Significant ($p \leq 0.05$)

Table 4 shows the test of variation between auto-mechanics and fishers. None of the parameters studied showed statistically significant variation.

Table 5: Test of variation in Anthropometric parameters of Auto-Mechanics and Farmers

Parameters	Male		
	t stat	t crit	p value
Thumb length	0.21	1.65	0.42
Thumb width	1.21	1.65	0.11
Big Toe length	-0.40	1.65	0.34
Big Toe width	1.15	1.65	0.13
Foot length	0.54	1.65	0.29
Foot width	0.78	1.65	0.22

*Significant ($p \leq 0.05$)

Table 5 shows the test of variation between auto-mechanics and farmers. None of the parameters studied showed statistically significant variation.

Table 6: Test of variation in Anthropometric parameters of Fishers and Farmers

Parameters	Male			Female		
	t stat	t crit	p value	t stat	t crit	p value
Thumb length	-0.45	1.65	0.33	3.67	1.66	0.00*
Thumb width	0.55	1.65	0.29	-0.00	1.66	0.49
Big Toe length	1.32	1.65	0.09	3.04	1.66	0.00*
Big Toe width	-0.58	1.65	0.28	0.27	1.66	0.39
Foot length	-4.54	1.65	0.00*	-2.55	1.66	0.01*
Foot width	-1.16	1.65	0.12	-4.50	1.66	0.00*

*Significant ($p \leq 0.05$)

Table 6 shows the test of variation between fishers and farmers for both male and female subjects. There was a statistically significant variation in the foot length for males while thumb length, big toe length, foot length and foot width all had statistically significant variation for females.

Table 7: Test of variation in Anthropometric parameters of Fishers and Civil servants

Parameters	Male			Female		
	t stat	t crit	p value	t stat	t crit	p value
Thumb length	-0.00	1.65	0.50	-0.09	1.66	0.46
Thumb width	1.09	1.65	0.14	0.21	1.66	0.42
Big Toe length	7.20	1.65	0.00*	2.83	1.66	0.00*
Big Toe width	0.60	1.65	0.27	-0.31	1.66	0.38
Foot length	-1.22	1.65	0.11	-1.69	1.66	0.05*
Foot width	0.01	1.66	0.50	-1.88	1.66	0.03*

*Significant ($p \leq 0.05$)

Table 7 shows the test of variation between fishers and civil servants for both male and female subjects. There was a statistically significant variation in the big toe length for males while big toe length, foot length and foot width all had statistically significant variation for females.

Table 8: Test of variation in Anthropometric parameters of Farmers and Civil servants

Parameters	Male			Female		
	t stat	t crit	p value	t stat	t crit	p value
Thumb length	0.44	1.65	0.33	-3.42	1.66	0.00*
Thumb width	0.51	1.66	0.30	0.20	1.66	0.42
Big Toe length	5.12	1.66	0.00*	0.06	1.66	0.48
Big Toe width	1.01	1.66	0.16	-0.68	1.66	0.25
Foot length	2.63	1.66	0.00*	0.47	1.66	0.32
Foot width	1.12	1.66	0.13	1.32	1.66	0.10

*Significant ($p \leq 0.05$)

Table 8 shows the test of variation between farmers and civil servants for both male and female subjects. There was a statistically significant variation in the big toe length and foot length for males while only thumb length had statistically significant variation for the females.

DISCUSSION

Anthropometric indices have been acknowledged by some researchers to influence measurement of foot, hand and body wares for work efficiency, and this has been demonstrated by the present research which has investigated farmers, fishers, auto-mechanics and civil servants. This study has investigated the peculiarity with various occupations and whether the nature or type of work has impact on body dimensions necessitating the factory ware designer to consider when making wares. Male and female fishers and farmers appear to have closely related measurements for their thumb length, big toe length and width except for their foot length and with slight difference for their foot width (Table 1a). Foot length for male and female fishers was 260.27 ± 1.11 and 242.53 ± 1.8 respectively while that of farmers was 268.03 ± 0.32 and 247.95 ± 1.28 respectively (Table 1a). Also foot width for male and female fishers was 101.63 ± 0.74 and 90.80 ± 0.68 respectively while that of farmers was 102.89 ± 0.8 and 94.92 ± 0.63 respectively (Table 1a). Foot length and width for male auto-mechanics were 284.13 ± 2.79 and 113.13 ± 9.99 respectively (Table 1b). The male and female civil servants had a foot length of 262.62 ± 1.58 and 247.08 ± 2.01 respectively while the foot width was 101.74 ± 0.83 for males and 101.74 ± 0.83 for females (Table 1b). Our findings show markedly elevated foot length and width among auto-mechanics compared to their male counterparts in other occupations. Ibeabuchi et al., 2018 in their study on some

Nigerian subjects documented very similar values to those obtained in the present study.

Further analysis was done to investigate variation among the various occupations using ANOVA. The study showed that among male subjects, big toe length showed statistically significant variation ($p=0.00$) among the various occupations studied (Table 2). The female subjects showed statistically significant variation ($p\leq 0.05$) in the thumb length, big toe length, and foot length and foot width among various occupations (Table 2). The variation in thumb and big toe width were not statistically significant for the various occupations for both male and female subjects ($p>0.05$) (Table 2). This could infer that when designing factory wares, length of the foot, thumb and big toe as well as the foot width are more important indices needed to make appropriate fitting wares for these group of workers. Asadujjaman et al., 2019 in their study on some industrial workers obtained very closely related values as those obtained for our thumb length and width of our study population. They also observed just like the present study that males have greater anthropometric values compared to the females. In a test of variation between auto-mechanics and civil servants, our study obtained statistically significant variation ($p\leq 0.05$) in the thumb width and big toe length of male auto-mechanics and male civil servants (Table 3). There were no female auto-mechanics among participants hence only males were considered. This variation especially for the thumb width could be due to anatomical differences following muscle and bone enlargement from incessant use of the hands by auto-mechanics as compared to their other counterparts. The thumb length, big toe width, foot length and width showed no statistically significant variation ($p>0.05$). In a similar vein we looked at the variation between auto-mechanics as against fishers and farmers (Table 4 & 5), and we observed that there were no statistically significant variation ($p\geq 0.05$) in all the parameters studied. This could be due to the fact that these three categories of workers all employ the use of their hands and feet nearly equally for their respective jobs, and hence growth and development of these parts of the body followed same pattern as compared to their counterparts who are civil servants. Hence making of factory ware should consider that these group of workers share similar anthropometric features.

On a further analysis we considered differences between fishers and farmers for both sexes. Among the male subjects, only the foot length showed statistically significant variation ($p=0$) (Table 6). The female subjects showed statistically significant variation ($p=0$) in the thumb length, big toe length, foot length and foot width. The reasons for these variations as seen between female farmers and fishers cannot be explained by this study. However we do know that females in the study environment are more inclined to farming than fishing, as those who fish only do so for leisure. Hence finding marked variations in their anthropometric parameters may not be unconnected to the time duration invested in their jobs. In fact we saw that female farmers have greater foot length and foot width than female fishers (Table 1a), which confirms the reason we obtained significant variation here (Table 6) as the use of the feet appears commoner among farmers than fishers. This was also the case for males as farmers possessed greater foot length than their fisher's counterparts. Also big toe length and thumb length appears larger in female fishers than farmers (Table 1a) because fishers commonly would engage their big toe for tying nets while preparing the nets for a catch and as well their hands while working. Hence obtaining marked variation among these female workers is justified owing to their job definition and the body parts commonly in use.

Also in table 7 and 8 we considered the differences that could exist among civil servants as against fishers and farmers in both sexes. In male fishers and civil servants, the variation in the big toe length was statistically significant ($p=0$) while in the females both the big toe length, foot length and width were seen to be statistically significant as well (Table 7). There were more marked differences noticed in the feet use than the hand use in these category workers. Big toe length and foot length were also seen to be significantly different between male farmers and male civil servants (Table 8). But among the female subjects, there was a marked variation ($p\leq 0.05$) in the thumb length of farmers and civil servants (Table 8). The present study however obtained greater thumb lengths in female civil servants than farmers at $65.01\pm 0.52\text{mm}$ and $61.97\pm 0.58\text{mm}$ respectively.

CONCLUSION

Our study has investigated the anthropometric variations that exist among various occupations. We obtained from this study that though variations do exist some parameters showed no statistically significant variation. However variations were more commonly noticed in the thumb length, big toe length, foot length and foot width whereas variations in the thumb width and big toe width were not a common finding. The male anthropometric parameters were more homogenous among auto-mechanics, farmers and fishers as against the civil servants. Also in most of these parameters the males showed greater measurements compared to the female subjects.

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