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VARIATION OF ANTHROPOMETRIC AND BODY COMPOSITION PARAMETERS WITHIN DIFFERENT AGE GROUPS OF GARI FRYING WORKERS IN SOUTHWEST NIGERIA

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Abstract: Differences in anthropometric data across age groups should be considered in designing workstations to fit gari-frying workers in southwestern Nigeria. This paper investigates the age variation in their anthropometry and body composition. 120 gari-frying workers were randomly selected and divided into five age groups 1-5 i.e. 18-25years; 26-35years; 36-45years; 46-55years and above 55years respectively. Anthropometric parameters of the workers were measured; body mass index (BMI) and body space area (BSA) were calculated while statistical analysis was carried out to investigate the variation between the age groups. Age group 3 accounted for 40% of the population while age group 5 accounted 22%. The discrepancies observed in the values of most of the parameters increased from the lower extremities to the upper extremities across the age groups. Age group 3 and 4 were observed to have the highest variation for most of the parameters (around 71%) compared to other age groups. Sitting height, forearm-to forearm breadth, waist depth, hip breadth (sitting), hand breadth at thumb, hand thickness, grip span and BMI had significant differences between most of the age groups. These results reveal the necessity for age sensitive designs for gari frying workers especially for those above the youthful age.
Keywords: Anthropometry, BMI, BSA, Cassava processing

1. INTRODUCTION

In the design of a system, information on the physical characteristics of humans (users) are usually gathered thereby giving a keen consideration to the characteristics, strengths and weaknesses of the user in relation to the machine, job task and environment. Anthropometric measurement and body composition variables are some of the information required. BMI and BSA are body composition indices which are derived from other anthropometric measurements which help in determining human obesity. According to WHO (2006), BMI can be classified as follows as

i. Severely underweight BMI < 16.5 kg/m^2
ii. Underweight: BMI < 18.4kg/m^2
iii. Normal weight: 18. 5 < BMI < 24.9 kg/m^2
iv. Overweight: 25.0 < BMI < 29.9 kg/m^2
v. Obsessed: BMI > 30.0 kg/m^2. Obesity was further classified into three as follows: Class I: 30.0 < BMI < 34.9 kg/m^2, Class II: 35.0 < BMI < 39.9 kg/m^2 and Class III: BMI > 40.0 kg/m^2.

Anthropometry and body composition are known to vary due to factors such as sex, age, environment, disease, ethnicity, nutrition, job, exercise, genetic make-up etc. These changes in body structure and morphology occur over a lifetime. Hence, ergonomic design goals can only be accomplished by taking the potential human user and the above listed factors into consideration.

At every stage of life, there are physical changes in the human body. Although every person experiences growth and development uniquely, generally, from age 20 to 35 years, most of the physical body dimension is in peak form (Bhubon and Subrata, 2010). Various research works have investigated the anthropometric characteristics and body composition of the different age groups for different ethnic and have found the result useful in various fields of science as ergonomics, medicine, and forensics (Kumar and Gopichand, 2013). Age variations in anthropometric and body composition parameters have been studied in several populations such as:

1. Calabar, South-East Nigeria (Enang*et al.,* 2014)
2. Ife, South-West Nigeria (Adebayo *et al.,* 2014)

3. Female and male of Bathudis, Orissa, India (Bose *et al.,* 2007 and Bose *et al*., 2006)
4. KoraMudi, West Bengal, India (Bisai*et al.,* 2008)
5. BishnupriyaManipuris, Assam, India (Bhubon and Subrata, 2010)
6. Haryanvi, India (Kumar and Gopichand, 2013)
7. Females of Savart, Orissa, India (Bisai*et al.,* 2009)

The effect of age on other anthropometric related parameters such as nerve conduction measures (Stetson *et al.,* 1992) and measures of motor performance (Imanipour *et al.,* 2012) have also been investigated. Owing to the variation in anthropometry and body composition across different ages, some applications have been developed such as" Relative Age Effect" which has been applied in sports (Salinero *et al.,* 2013; Sandercock *et al*., 2013; Sandercock *et al*., 2014) and "Age Cut-off Points" which is used in screening and health (Subramoney *et al*., 2014).

It is quite unfortunate that the effect of age changes on agricultural workers in rural areas have not been considered. Gari frying (and most other cassava processing operations) has been identified as a stressful operation especially the traditional methods. Hence, there is need to investigate the effect of age on different anthropometric and body composition parameters. Based on this, the aim of this paper is to investigate the variation of anthropometric and body composition parameters within different age groups of gari frying workers in southwest Nigeria.

2. METHODOLOGY

2.1. Sampling, Anthropometric Measurement and Instrumentation

Anthropometric measurements of 120 gari frying workers, selected by random sampling, were taken from the six states in the southwestern part of Nigeria. The age of the population under study ranged from 17 to 65. The workers were divided into five age groups as follows; Age group 1: 18.00-25.00, age group 2: 26.00-35years; age group 3: 36.00-45.00years; age group 4: 46.00-55.00 years and age group 5: above 55.00 years.

Table 1: Anthropometric definition of parameters measured

Anthropometric dimension	Definition
Shoulder Height (sitting)	The vertical distance from the sitting surfaces to the uppermost point on the lateral edge of the shoulder with the subject sitting erect
Sitting Height	The vertical distance from the sitting surface to the top of the head. To measure, the subject sits erect, looking straight ahead, with the knees at right angles.
Stature	The vertical distance from the floor to the top of the head (vertex). To measure, the subject stands erect and looks straight ahead
Thigh Clearance (sitting)	The vertical distance from the sitting surface to the top of the thigh at its intersection with the abdomen
Waist Depth	The horizontal distance between the back and abdomen at the level of the greatest lateral indentation of the waist; (if this is not apparent, at the level at which the belt is worn).
Popliteal height (sitting)	The vertical distance from the floor to the underside of the thigh immediately behind the knee
Knuckle Height	The vertical distance from the floor to the largest knuckle of the middle finger, where the finger meets the palm (metacarpal-phalangeal joint of digit 3)
Knee Height (sitting)	The vertical distance from the floor to the uppermost point on the knee. To measure, the subject sits erect with his knees at right angles
Hip Breadth (sitting)	The maximum horizontal distance across the hips when seated. To measure, the subject sits erect, knees and ankles supported at right angles; knees and heels together.
Hand breadth at metacarpal	The maximum breadth across the hand where the fingers join the palm. To measure, the right hand is extended straight and stiff with the fingers held together.
Hand length	The distance from the wrist crease (palmar side) to the middle fingertip of the right hand extended straight on the arm.
Hand length at index	The maximum distance between the back and palm surfaces of the hand at the knuckle (metacarpal-phalangeal joint) of the middle finger where it joins the palm of the right hand when the fingers are extended.
Forearm-forearm breadth	The horizontal distance from the tip of the right elbow to the tip of theleft elbow
Eye height (sitting)	The vertical distance from the sitting surface to the lateral (outer) corner of the eye (ectocanthus).
Eye height (standing)	The vertical distance from the floor to the lateral (outer) corner of the eye (ectocanthus).
Hand thickness	The depthof the hand measured transversely from the level of middle portion of the palm to the opposite surface.
Elbow rest height (sitting)	The vertical distance from the sitting surface to the bottom of the right elbow
Elbow height	Vertical distance between the floor to the radiale
Forward grip height (sitting)	Vertical distance from the centre or a cylinderial rod fully grasped in the palm of the hand which is horizontally raised forward at shoulder level to the shoulder blade while sitting.
Forward grip height (standing)	Vertical distance from the centre or a cylinderial rod fully grasped in the palm of the hand which is horizontally raised forward at shoulder level to the shoulder blade while standing.
Lumbar height	Vertical distance of the lower back to the ground surface
Grip span	Distance between thumb and index finger

The samples were basically women (without any disability) actively involved in gari frying whose consent had earlier being sought before taking the measurements. Age, weight and 25 body dimensions {i.e. stature, shoulder height, sitting height, eye height (sitting and standing), forward grip reach (sitting and standing), buttock-popliteal height (sitting), buttock-knee length, knee height, thigh clearance, forearm-forearm breadth, waist depth, elbow rest height, knuckle height, elbow grip length, hip breadth (sitting), hand length (at index), hand breadth (at thumb and knuckles), hand thickness, grip span and lumbar height} were taken. Table 1 shows how the description of the anthropometric dimensions taken. The instruments used included Vernier Caliper, Stadiometer and measuring tape. Each body dimension was measured three times and the average taken to ensure reliability.

2.2. Body Composition

Body mass index (BMI) and body space area (BSA) were calculated from the Du Bois Du Bois formula (equation 1) and Quetelet formula (equation 2) which were reported by Jeje *et al.,* (2014) and Nupo *et al.,* (2013);

$$\mathrm{BMI} = \frac{\text{weight (kg)}}{\text{height}^2\ (\mathrm{m}^2)} \tag{1}$$

$$\mathrm{BSA} = \frac{71.84 \times \text{weight}^{0.425} \times \text{height}^{0.725}}{10000} \tag{2}$$

where weight is measured in kg and height in cm

2.3. Statistical Analysis

The data collected were analysed using descriptive and inferential statistical analysis with the aid of SPSS 20 software and Microsoft Excel. Histogram was plotted for the age distribution while box plots were drawn for each parameter. The box plot was used in showing the 5th, 25th, 50th, 75th and 95th percentiles and other out laying values. The percentage difference of the mean of the parameters between some of the age groups was calculated. This further assisted in investigating the discrepancy between the data collected from across the various age groups.

For the inferential statistical analysis, comparison of means was carried out using t-test so as to know whether there was any significant difference between the means of each of the parameters across different age groups. In carrying out the analysis, each of the age groups was compared to the other four. This was done at 5% level of significance.

The correlations between the parameters and the age groups were calculated so as to determine whether the parameters can be estimated from an age group.

3. RESULTS AND DISCUSSION

3.1. Age Distribution of Gari Frying Workers

Figure 1 shows the age distribution of gari frying workers in south west Nigeria. A right skewed age distribution curve was observed with a mean age of the workers is 42.4 years and a standard deviation of 12. Most of the workers surveyed (40%) were of age group 3 (i.e. 36-45 years) while 22% of them fell into age group 5 (i.e. above 55 years). Age group 1 (i.e. 18-25 years) has the lowest number of workers which was 3% of those surveyed. This result shows that most of these workers (around 60%) were above youthful age which is consistent with the conclusions made by Adetifa and Samuel, (2012); Bello *et al.*, (2013); Adisa *et al.,* (2013); Fapojuwo (2010); Ikwuakam (2013); etc.

Figure 1: Age Distribution of gari frying workers

3.2. Variation of Anthropometric and Body Composition Parameters with Age

Figure 2 shows the box plots of the anthropometric and body composition parameters across different age groups. The plots show variation in the distribution within the age groups. It was observed that the level of discrepancy observed increased from the lower extremities (little or no variation was observed for the 5th percentiles) to the upper extremities value (highest variation was observed for 95th and 99th percentiles) of most of the parameters across the age groups. For instance, the 5th and 95th percentiles for the weight was 45.00 and 51.00kg; 41.00 and 83.50kg; 44.00 and 97.00kg; 44.50 and 98.00kg; 43.00 and 90.00kg respectively for age groups 18.00 - 25.00yrs, 26.00 - 35.00yrs, 36.00 - 45.00yrs, 46.00 - 55.00yrs and above 55.00 years respectively while the extreme values for fore arm to fore arm breadth are 35.39 and 40.15cm; 33.78 and 47.24cm; 34.45 and 56.04cm; 35.91 and 51.74; 36.58 and 51.75 respectively. For body composition parameters, 19.11 and 20.43 kg/m^2 ;17.78 and 31.62kg/m^2 ; 18.47 and 39.79kg/m^2 ; 18.26 and 42.98kg/m^2; 19.30and 34.22kg/m^2 were observed as the 5th and 95th percentile BMI values for age groups 18.00 - 25.00yrs, 26.00 - 35.00yrs, 36.00 - 45.00yrs, 46.00 - 55.00yrs and above 55.00 years respectively. Similarly, the respective 5th and 95th BSA values are 1.37 and 1.50m^2; 1.34 and 1.85m^2; 1.37 and 2.01m^2; 1.35 and 1.92m^2; 1.30 and 1.97m^2. Generally, age group 3 and 4 were observed to have the highest variation for most of the parameters (around 71%) compared to other age groups.

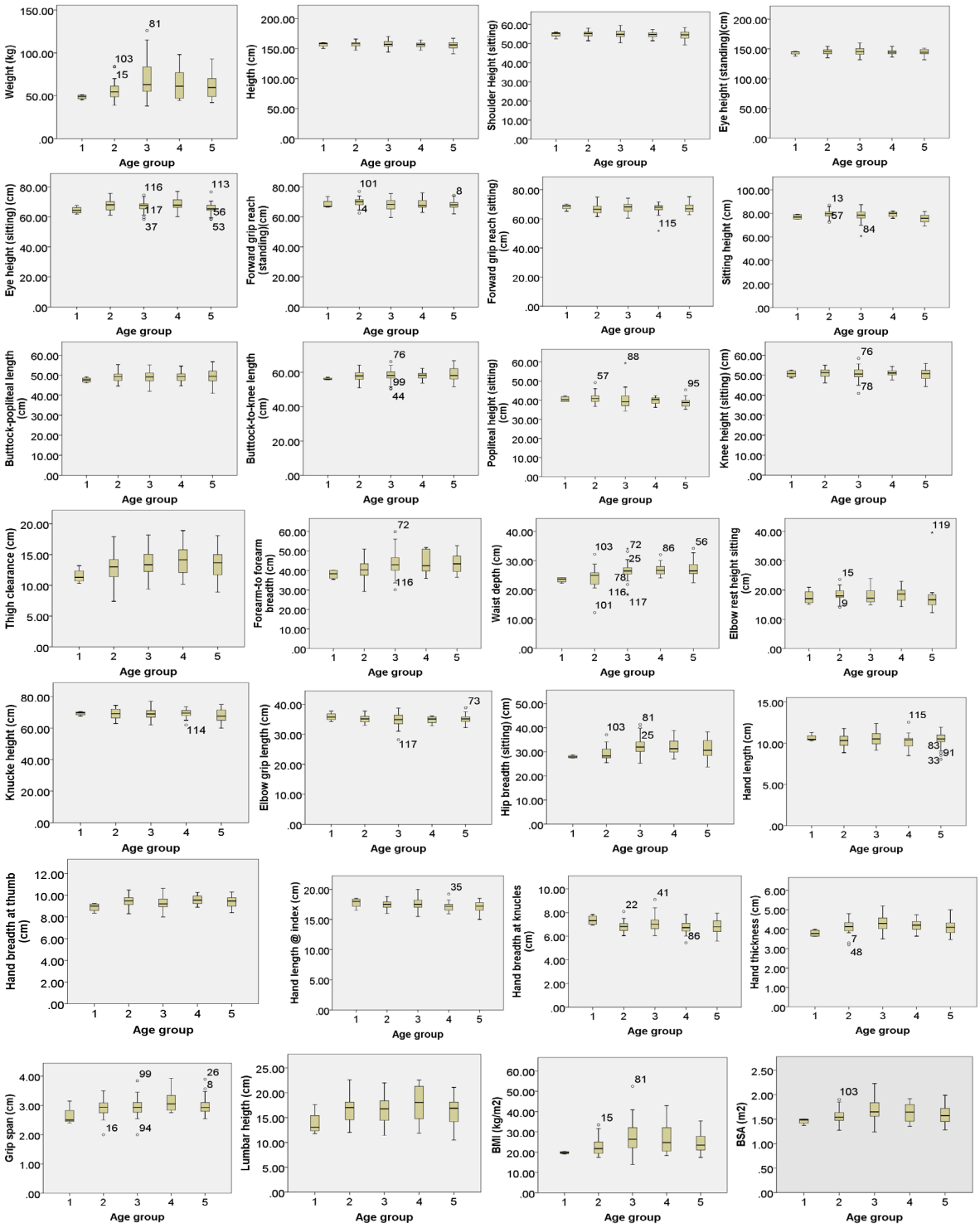

Figure 2: Variation of anthropometric and body composition parameters across different age groups

Figure 3 a and b shows the percentage difference of the parameters across various age groups compared to age group 3 and 4. A low percentage difference (around 0.1-6.0%) was observed for height, shoulder height, eye height, forward grip reach, sitting height, buttock-popliteal length, buttock-to-knee length, popliteal height and knee height. On the other hand, higher percentage difference was observed for weight, thigh clearance, forearm-to forearm breadth, waist depth, hip breadth, grip span, hand length at index, lumbar height, BMI and BSA.

The assertion of variation in some of the parameter across different age groups (especially for age group 3 and 4) was further accredited by the result of the comparison of means in table 2. It was observed that age group 3 and 4 had significant difference for most parameters when compared to that of the lower age groups (i.e. age group 1 and 2). From table 2, it could be seen that the following parameters had significant differences between most of the age groups; sitting height, forearm-to forearm breadth, waist depth, hip breadth (sitting), hand breadth at thumb, hand thickness, grip span and BMI.

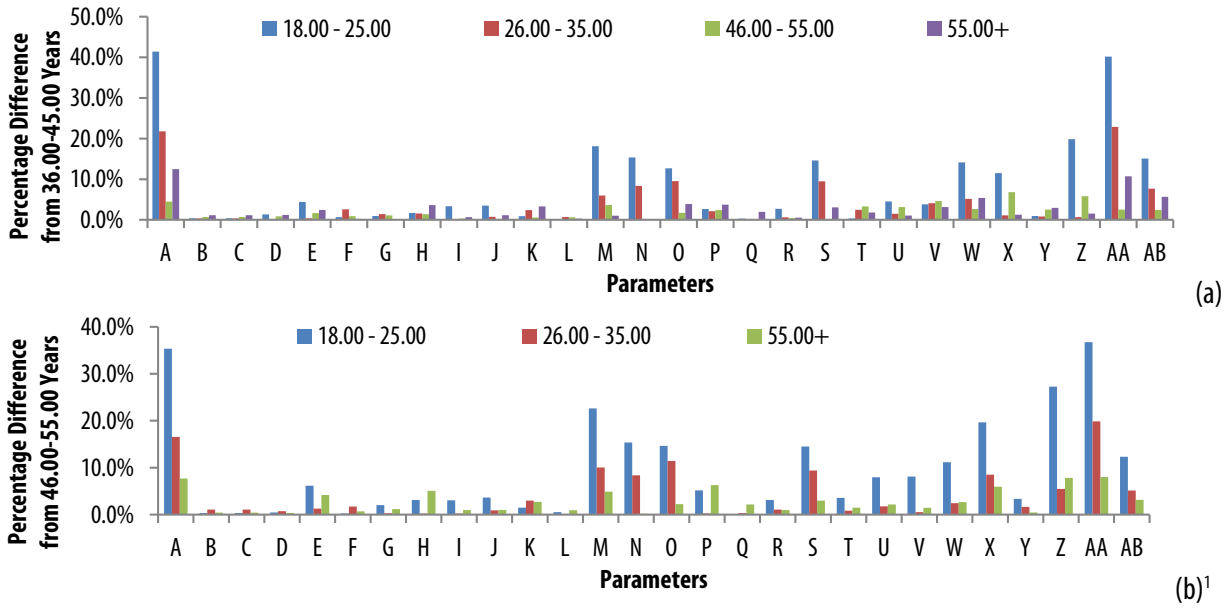

Figure 3. a and b: Variation of the mean of the parameters across different age groups

Table 2: Comparison of means at 5% significance

Age	Parameters																											
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB
1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	-	-	-	-	-	3	-	5	-	-	5	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
3	1,2	-	-	-	-	-	-	5	-	-	-	-	-	1,2	1,2	-	-	-	1,2	-	-	-	1,2,5	-	1	-	1,2	1,2
4	-	-	-	-	5	-	-	5	-	-	-	-	1	1,2	1,2	-	-	-	1,2	-	1,3	-	1	1,2,3	-	1	1,2	-
5	-	-	-	-	-	-	-	-	-	-	-	-	-	1,2	1,2	-	-	-	-	-	-	-	-	1	-	-	-	-

Key: A-Weight; B-Height; C-Shoulder Height (sitting); D-Eye height (standing); E-Eye height (sitting); F-Forward grip reach (standing); G-Forward grip reach (sitting); H-Sitting height; I-Buttock-popliteal length; J-Buttock-to-knee length; K-Popliteal height (sitting); L-Knee height (sitting); M-Thigh clearance; N-Forearm-to forearm breadth; O-Waist depth; P-Elbow rest height sitting; Q-Knuckle height; R-Elbow grip length; S-Hip breadth (sitting); T-Hand length; U-Hand breadth at thumb; V-Hand breadth at knuckles; W-Hand thickness; X-Grip span; Y-Hand length at index; Z-Lumbar height; AA-BMI and AB-BSA.

Table 3: Correlation of age with other parameters

S/N	Parameters	Pearson Correlation	Correlation at 0.05 significance level
1	Weight	0.099	No Correlation
2	Height	-0.151	No Correlation
3	Shoulder Height sitting)	-0.151	No Correlation
4	Eye height (standing)	-0.114	No Correlation
5	Eye height (sitting)	-0.092	No Correlation
6	Forward grip reach (standing)	-0.092	No Correlation
7	Forward grip reach (sitting)	0.052	No Correlation
8	Sitting height	-0.261	Negative Correlation exists
9	Buttock-popliteal length	0.070	No Correlation
10	Buttock-to-knee length	0.134	No Correlation
11	Popliteal height (sitting)	-0.212	Negative Correlation exists
12	Knee height (sitting)	-0.032	No Correlation
13	Thigh clearance	0.142	No Correlation
14	Forearm-to forearm breadth	0.229	Positive Correlation exists
15	Waist depth	0.372	Positive Correlation exists
16	Elbow rest height sitting	-0.066	No Correlation
17	Knuckle height	-0.142	No Correlation
18	Elbow grip length	-0.032	No Correlation
19	Hip breadth (sitting)	0.207	Positive Correlation exists
20	Hand length	-0.030	No Correlation
21	Hand breadth at thumb	0.117	No Correlation
22	Hand breadth at knuckles	-0.072	No Correlation
23	Hand thickness	0.015	No Correlation
24	Grip span	0.193	Correlation exists
25	Hand length at index	-0.213	Negative Correlation exists
26	Lumbar height	0.063	No Correlation
27	BMI	0.138	No Correlation
28	BSA	0.060	No Correlation

Table 3 shows the correlation between the ages of the workers and their anthropometry. The result reveals that despite the fact there was variation between some parameters across certain age groups, it will be wrong to attempt to predict or estimate body anthropometry or composition for the population from their age. This is because most of the parameters showed no correlation with age at 5% level of significance. The variation observed had no particular trend hence, a regression analysis cannot be conducted.

4. CONCLUSION

The variation of anthropometric and body composition parameters within different age groups of gari frying workers in southwest Nigeria has been investigated and the results presented. Most of the workers which were above 35 years were found to have most of their parameters significantly different from those of

[1] 36.00-45.00 years was exempted from the analysis because its percentage difference with 46.00-55.00 years was done in figure 3a.

the younger ages. Hence, it is important for designers to make use of the appropriate anthropometric data for the target population and age group as a wrong anthropometric data can result to an unsafe workplace which will not only affect the gari-frying worker but also the efficiency of the system.

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