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Comparative Study of Upper Limb Anthropometry and Occupations in Women of Abakaliki, Nigeria

Njoku CO*[1], Udeh RA[2], Obimma JN[3], Fidelis PC[1], Abraham JC[4]

[1]Department of Anatomy, Ebonyi State University, Abakaliki; [2]Department of Anatomy, David Umahi Federal University of Health Sciences; [3]Department of Physiology, Ebonyi State University, Abakaliki, Nigeria; [4]Department of Radiography, College of Health Sciences, Evangel University, Akaeze, Okpoto Campus

***Corresponding Author:** clinton.njoku@ebsu.edu.ng; clintonnjoku76@gmail.com

ABSTRACT

Abakaliki women generally identify in three major occupations, which are stone crushing, meat selling and market dealings. Every occupation plays a significant role in determining an individual's level of physical activity, and this impacts their overall health. The aim of this study was to compare the upper limb anthropometry of women of various occupational groups: stone crushers, meat sellers and market women. For this research, 259 women, of age between 18 to 60 years, were recruited from the three different occupational groups. Their stature, body mass and upper limb anthropometry, which includes two arm skinfold thickness, arm and forearm girths of both upper limbs, humerus lower end breadth and wrist breadth were measured following the international standard procedures of the International Society for the Advancement of Kinanthropometry, (ISAK). Within the groups, right and left arm girths, right and left forearm girths, right and left biceps skinfold thickness (SKF), right and left triceps SKF, right humerus breadth and left wrist breadth varied significantly ($P<0.05$) as analyzed by one-way Analysis of variance, (ANOVA) but there was no difference in right wrist breadth and left humerus breadth as $P>0.05$. Paired t-test indicated that right parameters were significantly greater than their corresponding left parameters. Every occupation has an inherent level of physical activity, which affects general health outcomes and specifically, shape, volume and fat content of the body. Upper limb anthropometry can be used for routine surveillance of body composition since it has a direct relationship with general body composition.

Keywords: physical activity, anthropometry, occupation

INTRODUCTION

As the epidemic of overweight and obesity continues to exacerbate, which the likely causes include the access to high calorie foods and rising level of inactive lifestyle[1]. The tasks performed by individuals in different occupations vary according to the demands peculiar to each occupation, and the type of activities varies from 'high physical activity' to 'low physical activity' occupations[2]. Occupational demands can drive physical activity, and the person's type of occupation could be a surrogate maker for physical activity levels. The work environment for some workers in certain jobs may experience more inactive times than other occupations. This can be observed in some jobs like construction laboring, which demands workers to be physically active[3], while some other jobs like truck driving impose extended sedentary time [4]. Physically demanding occupations compared with the less physically demanding ones reduce the likelihood of obesity[5,6].

In the bid to reduce errors in body composition measurements, various tools and methods have been established for accurate estimation and mapping of adiposity[7,8]. Body composition is often estimated via anthropometric surrogate measures like body mass index (BMI), which captures excess weight for height rather than precise body fat excess[9,10]. Sufficient evidence has indicated that resistance training improves not just muscles strength but also cardiovascular fitness and body composition. From some observational studies, it has been found that those who are more active tend to lower BMIs compared to less active individuals[11,12]. It was reported that a 12-week resistance training program resulted in increased soft tissue lean mass (LM) with a decrease in fat percentage[13]. Similarly, a result reported by Cullinen and Caldwell [9] for both genders displayed significant gains in soft tissue LM with reduced body fat percentage after 10 weeks without significant weight lost.

Recently, advances in technology, workplace computerization, and the trend towards service-oriented jobs and decline of manufacturing has greatly altered occupational demands and physical exertion to long bout characterized by low-intensity activity and increased sedentary behaviour[14,15,16]. Despite the benefits of exercise, it has been found that occupations involving excessive physical activity level are detrimental to health[17,18].

Some studies, each of approximately 500 young adults, have reported that, for the same BMI, athletes typically have less body fat than non-athletes[19,20]. Consequently, programs that encourage and boost physical activity are vital as they support workers' health and well-being in the workplace[21]. Women of these occupational groups might have varying physical activity levels that may affect their body composition, and such may be detected by measuring upper limb anthropometry, especially as these occupations are female-preferred. Upper limb anthropometry has a direct relationship with general body composition[22,23] and measurement of the upper limb anthropometry is convenient and easy. Consequently, the current study explored the occupation of some women associated with physical activity and its impact on the upper limb anthropometry.

MATERIALS AND METHODS

Recruitment of participants

A population of 259 women, age range of 18 to 60 years, was recruited from the three different occupational groups: stone crushers who manually crush stones at the quarry sites, meat sellers who regularly engage in butchering of meat and market women who sell various items in the market. From this number were extracted different parameters from the upper limb, which include the skinfold thickness of the two arms, arm and forearm girths for the two upper limbs, lower end breadth of humerus and wrist breadth for both upper limbs.

The purpose and procedures of the study were explained to all the participants. Informed consent was acquired from the participants by

their signing the consent form before measurements were taken.

Inclusion Criteria: Only the healthy participants; individuals who had been in such an occupation for a minimum of ten years were selected.

Exclusion Criteria: Participants with skeletal abnormalities and physical disabilities, such as limb amputees or those with visible body asymmetry, were excluded.

Ethical approval: All these research investigations were undertaken according to the provisions of the Declaration of Helsinki in 1995 (as revised in Edinburgh, 2000) and approved by the Faculty of Basic Medical Sciences, Research Ethics Committee of Ebonyi State University, Abakaliki, Nigeria, with the approval number of EBSU/FBMS/2024/57.

Procedures for Anthropometric Measurements

All anthropometric measurements were extracted according to the International Society for the Advancement of Kinanthropometry procedures[24] as indicated in Fig. 1 A, B, C and D.

Stature and sitting height were measured with a stadiometer (Seca 218, Hamburg, Germany). All the participants were measured in a standing position with the head positioned in the Frankfurt plane. Body mass of the participants was acquired using an electronic weighing balance [Camry electronic scale, China]. Girths (arm, forearm and wrist) were measured using Lufkin W606PM flexible and inextensible steel tape (Rosscraft, Vancouver, Canada). Skinfold thickness (Biceps and Triceps) was measured with CESCORF Skinfold Caliper (Porto Alegre, Brazil). A CESCORF small sliding caliper (Porto Alegre, Brazil) was set as a small sliding caliper and was used to measure humeral breadth and wrist breadth.

The value of each parameter was extracted in duplicate from the right and left upper limbs of the body after landmarking[24].

Fig 1: Images of anthropometric measurements (A) Stature (cm), (B) Body Mass (kg), (C) Girth measurements (cm), (D) SKF (mm)

Statistical analysis

The anthropometric characteristics of the participants from different occupational groups were expressed as mean ± standard deviation. Analysis of Variance was used to compare different parameters for different occupational groups. Bonferroni post hoc test was used to determine the real differences that exist between the groups. Paired t-test was conducted to determine the difference between right and left parameters in each of the groups. Data analysis was conducted using SPSS version 21(SPSS Inc., Chicago, IL).

RESULTS

Descriptive statistics

The physical characteristics of different occupational groups: age, weight, height and BMI were presented in Table 1. Descriptive statistics included mean, standard deviation, minimum and maximum values.

Table 1: Physical Characteristics of Different Occupational Groups

Parameters	Occupational groups	Minimum	Maximum	Mean	Std. Deviation
AGE (yr)	Stone Crushers	22	49	30.59	6.87
	Meat sellers	20	55	31.00	8.60
	Market women	23	46	30.32	4.97
WEIGHT (kg)	Stone Crushers	51	84	67.05	8.02
	Meat sellers	51	85	63.68	9.70
	Market women	56	103	71.00	11.59
HEIGHT (cm)	Stone Crushers	158.50	182.40	167.51	7.28
	Meat sellers	155.30	177.20	165.00	7.06
	Market women	153.50	182.40	168.16	7.75
BMI (kg/m^2)	Stone Crushers	20.30	26.95	23.85	1.98
	Meat sellers	20.30	27.07	23.26	1.98
	Market women	20.82	39.25	25.16	4.30

Where Std. =standard deviation, yr=year, kg = kilogram, cm =centimeter and kg/m^2 = kilogram/meter square

In fig. 2, the right parameters of the three occupational groups were compared using a one-way ANOVA analysis, and there were significant differences among the following parameters: right arm girth, forearm girth, right bicep SKF, right triceps SKF and right humerus breadth as $P<0.05$ while there was no significant difference in right wrist breadth within the occupational groups. Bonferroni post hoc test indicated significant difference between stone crushers and market women, meat sellers and market women as $p<0.05$, while there was no significant difference between stone crushers and market women ($p>0.05$).

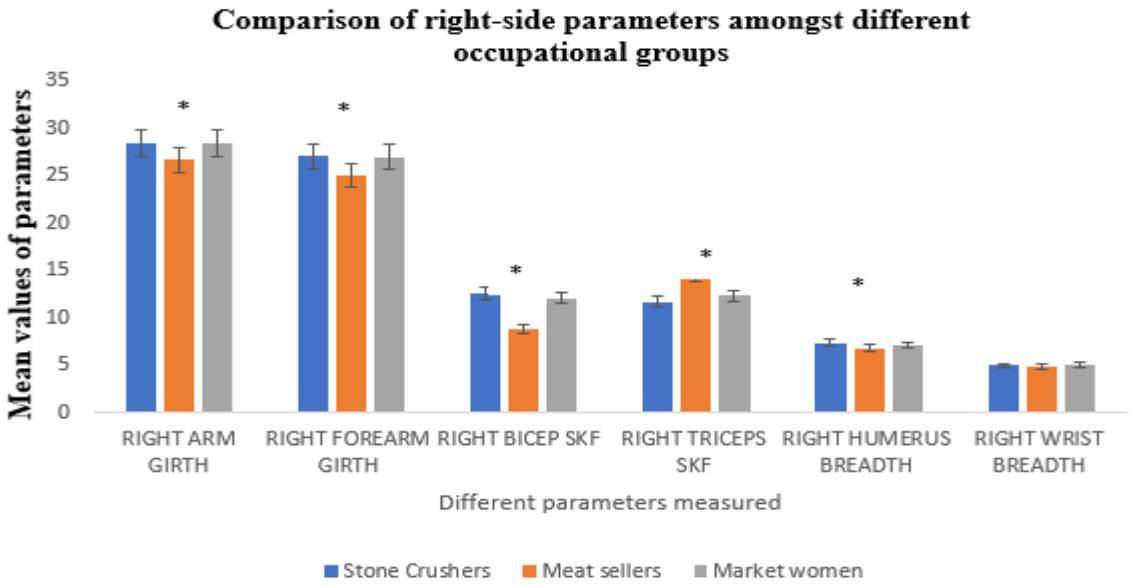

Fig. 2: Comparison of right-side parameters amongst different occupational groups where girths and breadth were measured in cm and SKF was in mm * = P<0.05

Considering the left parameters as presented on fig 3, there were significant difference in all the parameters except Left Humerus Breadth within different occupational groups which include Left Arm Girth with the stone crushers having higher value, left forearm Girth had had higher value, Left Biceps SKF had highest value, Left Triceps SKF had highest value and Left Wrist Breadth also had highest value as P<0.05. However, Left Humerus Breadth indicated no significant difference among the different occupational groups. Bonferroni Post hoc test indicated a significant difference in Arm Girth between stone crushers and meat sellers(P<0.05) and no significant difference between stone crushers and market women, and between Meat sellers and Market women(p>0.05). For Fore Arm Girth, there was a significant difference between stone crushers and meat sellers (p<0.05), but there was no significant difference between Stone crushers and market women, and between market women and Meat sellers (p>0.05). In Left Biceps SKF, there was a significant difference between each of the occupational groups and the other as p<0.05. For Left Triceps, market women significantly had higher SKF than the stone crushers, but there was no significant difference between meat sellers and stone crushers, and between meat sellers and market women. For Wrist Girth, Stone crushers significantly had higher value than meat sellers, but there was no significant difference between Stone crushers and market women, and meat sellers and market women (p>0.05).

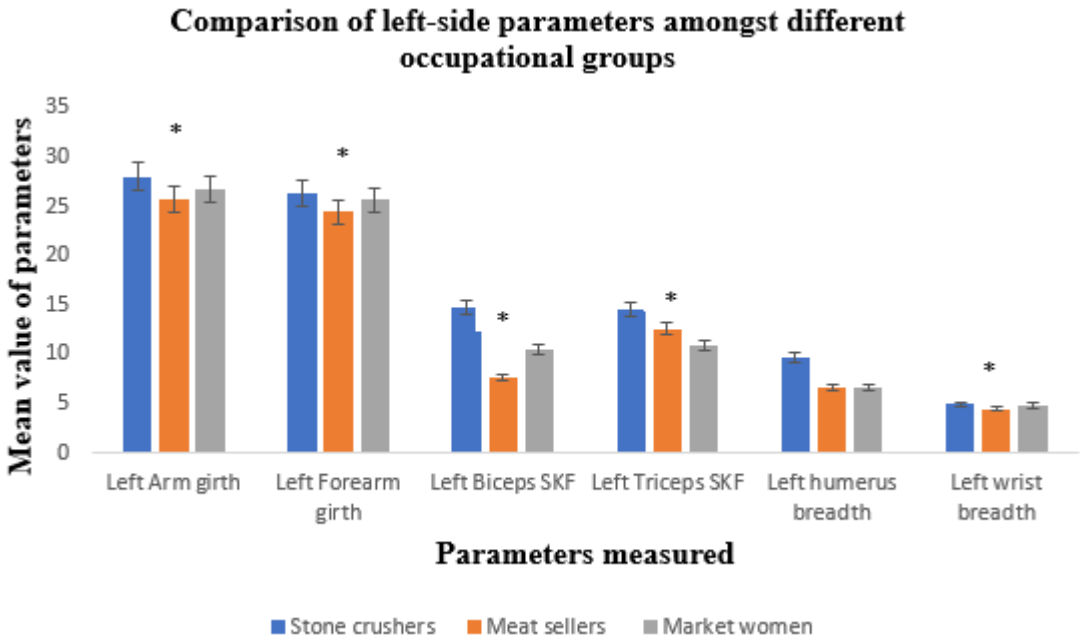

Fig. 3: Comparison of left-side parameters amongst different occupational groups where girths and breadth were measured in cm and SKF was in mm * = P<0.05

Comparison between the right and left parameters

In Table 2, the right and left parameters of different occupational groups were compared. In stone crushers, the fore arm girth, the Biceps SKF and Triceps SKF were significantly higher in the right parameters than the left, however, there was no significant difference in arm girth, Humerus breadth and wrist breadth for both sides as P>0.05. In the Meat sellers' group, all the right parameters were significantly higher than the left parameters, except for the arm girth, which indicated no significant difference. In the market women group, there was a significant difference in all the parameters, with the right side being higher in values than the left.

Table 2: Comparison between the right and left parameters

Occupational Groups	Pairs	Parameters compared	Mean Differences	Std. Deviation	Sig. (2-tailed)
Stone Crusher	Pair 1	Right Arm Girth - Left Arm Girth	.44091	1.41376	.158
	Pair 2	Right Forearm Girth - Left Forearm Girth	.6591	.8862	.002
	Pair 3	Right Biceps SKF - Left Biceps SKF	-2.136	1.125	.000
	Pair 4	Right triceps SKF - left triceps SKF	-2.864	3.285	.001
	Pair 5	Right Humerus Breadth - Left Humerus Breadth	-2.29091	12.11	.385
	Pair 6	Right Wrist Breadth - Left Wrist Breadth	.01818	.39	.831
Meat seller	Pair 1	Right Arm Girth - Left Arm Girth	1.07273	1.52821	.003
	Pair 2	Right Forearm Girth - Left Forearm Girth	.5727	1.8427	.160

	Pair 3	Right Biceps SKF - Left Biceps SKF	1.227	1.478	.001
	Pair 4	Right Triceps SKF - Left Triceps SKF	2.045	.575	.000
	Pair 5	Right Humerus Breadth - Left Humerus Breadth	.27273	.20513	.000
	Pair 6	Right Wrist Breadth - Left Wrist Breadth	.38636	.21667	.000
Market woman	Pair 1	Right Arm Girth - Left Arm Girth	1.69	1.97265	.001
	Pair 2	Right Forearm Girth - Left Forearm Girth	1.39	2.4819	.016
	Pair 3	Right Biceps SKF - Left Biceps SKF	1.66	1.941	.001
	Pair 4	Right Triceps SKF - Triceps Left SKF	1.46	2.405	.010
	Pair 5	Right Humerus Breadth - Left Humerus Breadth	.44	.29058	.000
	Pair 6	Right Wrist Breadth - Left Wrist Breadth	.25	.27208	.000

DISCUSSION

Within the three occupational groups, there was a significant difference among the parameters measured, and these were affected based on the level of physical activities undertaken by the employee. Within each occupational group, the right-side parameters differed significantly, with the more physically active part having higher values in girths and the less active part having higher values in SKF.

It shows that different occupations have varied impacts on the body composition of the upper limb, especially on the skinfold thickness, which is developed to measure muscularity and adiposity, as had similarly been reported in the literature [25,26,27,28]. The major modifiable factor is the fat mass, which can be adjusted based on the intensity of physical activity of an individual; and increased physical activity has a greater impact on it, as observed in stone crushers. This aligns with the conclusion made by You *et al* [29]. which stated that increased physical is associated with lower BMI and body fat and higher muscle mass.

Stone crushers had higher value of right arm girth, right forearm girth and least value in right triceps SKF than those of meat sellers and market women, but on the left upper limb that was snot frequently used in stone crushing the triceps SKF value was the highest, and it is an indication that resistant exercise impacts on muscle and fat volumes [30]. Assessment of arm composition involves calculating upper arm muscle and fat areas, arm fat index, and related estimate from mid arm circumference and skinfold data which have a direct relationship with body composition[31,32,33,26]. Studies have found a correlation between upper limb anthropometry and disease outcomes, biochemical markers and nutritional status [34,35,36]. Assessment of upper limb anthropometry becomes important as it would aid routine surveillance of body composition. This is easy and does not require much expertise to practice.

When the right parameters were compared with the left, the stone crushers, which were the most active group, had significantly higher girths on the right and reduced skinfold on the right than on the left. However, there were significant differences in most of the parameters in the right and the left, but there was no impact on the mass of the upper limb in meat sellers and market women. Many occupations today predispose employees and workers to a sedentary lifestyle, and this has a great negative impact given its

association with poors health outcomes, heart diseases and metabolic syndrome.[37,38,39]

Based on the above, recommendations prioritize moderate-to-vigorous physical activity for all individuals irrespective of their occupations.[40] For optimal health benefits, experts advise engaging in moderate to vigorous physical activity as reported by Tremblay et al.[41,] but large proportion of individuals does not usually achieve the volume of physical activity to acquire these benefits.[42]

CONCLUSION

Various occupations incorporate different levels and intensity of physical activity; which have a profound impact on upper limb composition and anthropometry as observed in women from different occupational groups. Since routine checks are preferred if they are easy to administer, this can easily be evaluated and used to predict general body composition.

Conflicts of Interest: The authors report no conflicts of interest.

Authors' contributions: CON: concept, research design, manuscript draft; RAU, JNO and PCF: data collection; JCA: data analysis and manuscript revision.

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