

Anthropometry Dimensions of Ghanaian Public Workers: Comparison of Age, Gender and Body Mass Index (BMI)

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ABSTRACT: Studies have indicated that variations in anthropometry vary not only from region to region but within the region as well which must be considered while designing of furniture. To determine whether there are differences in the anthropometric data of the public workers in Ghana, anthropometric data collected from a survey from three public institutions was used. The results showed that some anthropometric dimensions were influenced by age and gender. About 60% of the male workers were in the overweight and obesity group compared with the female workers of 80%. Women have bigger hip width than males. Increase in age results in decrease in seat height and desk clearance. The analysis has provided important information in designing products for institution working populations. There should be a change of lifestyles and diet in women as these are the two most common causes of overweight and obesity among populations.

KEYWORDS: Public workers, Age, BMI's, Anthropometry dimensions and Gender

I. INTRODUCTION

Overweight and obesity are classifications of a person's excess body fat and are commonly assessed using the Body Mass Index(BMI). The BMI is derived from a person's weight (in kilograms) divided by their height (in metres) squared (kg/m^2) [1]. An adult is considered overweight if their BMI is greater than $25 \text{ kg}/\text{m}^2$ and obese if their BMI is greater than $30 \text{ kg}/\text{m}^2$ (Table 1). Females had a higher mean BMI than males [2]. This clearly indicates that those belonging to these categories are at risks, with females workers having higher risks. The BMI represents the easiest and most frequently used index to identify subjects at risk for under-or over-nutrition. With this information it is possible to gain insight into the characteristics of people and product that can affect the institutions in which these workers work.

Table 1: Classification of Adult Weight according to Body Mass Index

Classification	BMI	Risk of Co-Morbidities
Severe malnutrition	< 16.0	Very high
Moderate malnutrition	16.0 – 16.9	High
Mild malnutrition	17.0 – 18.4	Moderate
Underweight	< 18.5	Risk of clinical complications increased
Normal range	18.5 – 24.9	
Overweight	25.0 – 29.9	Mildly increased risk of co-morbidities
Obese	≥ 30	Risk of co-morbidities associated with weight

Source: [3]

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Public workers constitute a large group of people who spend a lot of time on the institution chairs and desks in a static or awkward posture [4]. Age is a factor in the consideration of anthropometric measurements [5-6]. Age correlates with weight and stature [5], while age correlates with weight [6]. In addition relationship between age and workers anthropometric dimensions is important in this study.

Anthropometry is the science that measures the range of body sizes in a population [7]. In a research work, it is seen that the anthropometric dimensions vary not only from region to region but within the region as well which must be considered while designing of furniture [8]. Anthropometric dimensions of workers determine the standards and functional dimensions of office furniture [9-10]. There are some differences in anthropometric dimensions among different ages, genders, races, and ethnicities [11]. Anthropometric data are used for proper design of workstation, equipment, furniture and so on in order to decrease awkward postures and stresses on human body due to improper design [12-14]. Anthropometric data are used in ergonomics to specify the physical dimensions of work spaces, equipment, furniture, and clothing [11, 15, 16]. Appropriate use of anthropometry in design may improve the well-being, health, comfort, and safety of a product's users [17-18]. Anthropometric data is one of essential factors in designing machines and devices [19]. Incorporating such information would yield more effective designs, ones that are more user friendly, safer, and enable higher performance and productivity.

The study looks at relationship between Body Mass Index (BMI) and gender; anthropometric measurements and gender, age and anthropometric measurements and age category and institutions. As part of this work, personal data comprised of age, height, weight and gender. Body Mass Index (BMI, $\text{weight}/\text{height}^2$) was calculated and categorized from same data into four groups (underweight, normal, overweight and obesity) using the World Health Organisation (WHO) standard method.

The purpose of the study was to give some indications of the relative sizes between age and gender in Ghanaian working populations. A survey to be conducted should establish whether office workers who work in public institutions are of varying age differences and levels of body mass index (BMI) of the working population gender.

II. MATERIALS AND METHODS

All public workers in the studied institution were approached and consents were sought from both institutional heads and workers before the data collection. Materials used included adjustable office chair (used in anthropometric data collection), bathroom scale and measuring tape.

The subjects were office workers between 24 and 59 years of age, with a mean of 39.88 and standard deviation of 8.80. A sample size of 261 workers (163 males and 98 females) participated in the study. Thus, distribution of gender was 62% male and 38% female. The range of heights is from 1474 to 1846 millimetres, with a mean of 1690.45 and standard deviation of 79.33. In addition, the range of weights is from 47 to 133 kilograms, with a mean of 73.84 and standard deviation of 10.72. Subjects were contacted during working hours, because all subjects were required to be at work, and this setting offered easy access to data collection. Approval to conduct the study in these institutions enabled the researcher to visit the offices.

The criteria for selection were that the subject had to be office worker, patronised locally made office furniture (chair and desk) and had to spend a minimum of six to eight hours in an office environment. Before the filling of the set of questions; the researcher explained to subjects individually to understand the essence of the study. Recording started immediately after the explanation. The privacy of the office workers was maintained by writing codes (office code and institution code) on the data sheet instead of putting their names directly. All of the subjects participated voluntarily in the research as no compensations were given to the subjects.

All measurements were taken in relaxed standing and sitting positions. The unit for all the measurements was millimetres and kilogram. There were two main groups of measurements: anthropometry (stature) and anthropometry (sitting). Anthropometry (stature) is body height, which is the measurement is taken while the worker was standing erect (i.e. barefoot) against the wall, while anthropometry (sitting) is the collection of workers anthropometric measurements with workers sitting bare footed on an adjustable office chair for the taken of the measurements. During the survey, subjects considered for the measurements were in their personal office clothing. The researcher located

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body landmarks and used proper measuring tapes and measurement techniques to take the measurements. Each subject was required to sit on an adjustable chair and the seat was adjusted till the seat gave the worker maximum comfort. The seat gives maximum comfort when the subject sits comfortably erect on the adjustable chair with the trunk straight, the back of the head and buttock pressing firmly against the walls of the chair. The chair's height was adjusted so that the upper part of the leg is horizontal to the floor. The lower part of the thigh at the back of the knee not pressing on the edge of the chair but leaves a small space between the leg and the chair, with knee bent 90⁰, and the feet (without shoes) flat on the floor. With the exception of weight that has kilogram as unit, all measurements were made by measurer (researcher) and recorded in millimetres by a recording assistant in three different sessions. Accuracy and repeatability of the measurements were achieved by undergoing thorough training and practice on the performance measurements in a pilot study carried out prior to the collection sessions.

In this study, researcher measured anthropometric measurements directly, as this is an economical and practical method. The simplicity greatly reduces the costs of the survey, and the mobility of the equipment makes it easy to record measurements. Based on the results of the literature review, the researcher selected the most common anthropometric parameters, measured these parameters for each subject involved in the study. Common anthropometric dimensions measured were popliteal to floor height, buttock to popliteal length, elbow to seat height, sitting shoulder height, knee height and width of bitrochanter [20].

In comparing Body Mass Index (BMI) between Males (m) and Females (f), Chi-square test of association was used to measure the level of relationship between genders in BMI categories. Use of chi-square deals with the situation in which one has two variables (gender and BMI categories) and to determine whether these variables are independent of one another (H_0 : BMI is independent of gender).

Also, in comparing anthropometric data of Males and Females, the t-test analysis was used to compare the differences between mean values of the male and female body dimensions. Male and female were treated as two independent groups and the null hypothesis (H_0) is to check whether mean of each anthropometric dimension between female office workers and male office workers is the same ($H_0 : \mu_{1(m)} = \mu_{2(f)}$).

Correlation between age and anthropometric dimension is to compare whether there is a significant correlation between age and the anthropometric dimensions of the institution workers. The null-hypothesis tests that there is no relationship between the two variables ($H_0 : \rho = 0$).

Determination of the difference in age category in the three groups of institutions, Chi-square test of association was used to measure the level of relationship between the three institutions in age categories. Level of significance used for the data was set at $p < 0.05$ (two-tailed). The use of chi-square deals with the situation in which one has two variables (institution and age categories). The null hypothesis (H_0) is to check whether these variables are independent of one another. (H_0 : Age category is independent of institutions).

III. RESULTS AND DISCUSSION

The findings of the study are presented in tables and charts below.

Table 1: Body Mass Index (BMI) of Male and Female Samples (n = 261)

Gender	BMI Category				Total
	Underweight (< 18.5)	Normal ($18.5-24.9$)	Overweight ($25.0-29.9$)	Obesity ($30.0\&over$)	
Male	0 0.0%	66 40.55%	90 55.2%	7 4.3%	163 100.0%
Female	1 1.0%	19 19.45%	65 66.3%	13 13.3%	98 100.0%
Total	1 0.4%	85 32.6%	155 59.4%	20 7.7%	261 100.0%

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Table 1 shows the chi-square test of association, the study rejects the null hypothesis since the probability value (0.000) was lower than the chosen α -level of significance (0.05). The study therefore concludes that, statistically there is enough evidence to suggest that BMI and gender are dependent. BMI differences were found between genders in the four groups. About 60% of the male workers were in the overweight and obesity group compared with the female workers of 80%. The problem of obesity was more frequent in females (13.3%) [2]. About 60% males in the overweight and obesity group compared with females 80%. The study reinforces the findings of some other studies that showed females are more at health risks due to overweight and obesity compared to males. In research, females had a higher mean BMI than males [21]. This clearly indicates that those belonging to these categories are at risks, with females workers having higher risks.

Table 2: Mean, Standard Deviation and t-test for Anthropometric Dimensions of Institution Male and Female Office Workers Aged 24 to 59 years (n = 261)

Dimensions	Male, N = 163		Female, N=98		Independent t-test	
	Mean	Std.Dev	Mean	Std.Dev	t	p
Weight (kg)	75.7	10.5	70.8	10.5	3.621	0.000
Height	1728.6	65.3	1627.1	56.9	12.736	0.000
Popliteal-floor height	468.1	29.7	450.0	30.4	4.730	0.000
Butt-popliteal length	495.7	37.8	497.5	32.0	-0.388	0.698
Elbow-seat height	195.6	16.8	192.3	19.7	1.444	0.150
Sitting shoulder height	516.9	43.8	508.4	37.4	1.592	0.113
Knee height	612.2	33.6	600.8	32.8	2.679	0.008
Width of bitrochanter	354.8	31.7	366.6	39.3	-2.644	0.009

Table 2 shows the results of anthropometric dimensions (mean value, standard deviation and t-test) for males and females. Analysis showed that there were significant differences ($p < 0.001$) in some anthropometric measurements (height, weight, popliteal to floor height, knee height and width of bitrochanter) between male and female workers except for buttock to popliteal length, elbow to seat height and sitting shoulder height. For all measurements, the male dimensions exceeded the females except for width of bitrochanter (hip breadth). From the t – test analysis, both hypotheses were satisfied to show that some of the anthropometric variables were different and others were the same. The anthropometric measurements that showed significance were popliteal to floor height, knee height and width of bitrochanter together with height and weight. On the other hand, there were no differences in the means of buttock to popliteal length, elbow to seat height and sitting shoulder height in both males and females.

Table 3: Correlations – test for Anthropometric Measurements and Age (n = 261)

Anthropometric Dimensions	r	Significance of P
Height, Standing	.004	.945
Weight, Standing	.088	.156
Popliteal-floor height, Sitting	-.146	.018
Buttock-popliteal length, Sitting	-.021	.738
Elbow-seat height, Sitting	-.093	.134
Sitting shoulder height, Sitting	.053	.397
Knee height, Sitting	-.296	.000
Width of bitrochanter, Sitting	.081	.194

In Table 3, there were significant relationships between age and popliteal-floor height ($r = -.146$, $p = 0.018$) and knee height, sitting ($r = -.296$, $p < .001$). Note that the column labeled “Significance of P” presents the p value associated with the probability of the sample results assuming the null hypothesis is exactly true in the population given the sample size. Accordingly, one can reject the null hypothesis that there was no relationship between age and the two anthropometric measurements and concludes that there was a relationship. In the correlation between age and anthropometric dimensions, an assumption can be made from this result, and is that the changes of body dimension are also related with age. The negative correlation values showed that as age increases, these measurements decrease. In this present study, anthropometry changes among institution workers revealed that popliteal-floor height and knee

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height declined with age. Thus, age correlated with popliteal to floor height and knee height. These findings were different from results stated by [5] and [6] who correlated age with weight and stature, and age with weight respectively.

Table 4: Relationship between Age category and Institutions

Institution	Age category (years)				Total	
	< 25	25 – 35	36 – 45	46 and above		
I	0 0.0%	36 40.0%	40 44.4%	14 15.6%	90 100.0%	
II	0 0.0%	24 27.0%	22 24.7%	43 48.3%	89 100.0%	
III	1 1.2%	31 37.8%	32 39.0%	18 22.0%	82 100.0%	
Total	1 0.4%	91 34.9%	94 36.0%	75 28.7%	261 100.0%	

Table 4 shows the chi-square test of association. It rejected the null hypothesis since the probability value (0.000) was lower than the chosen α -level of significance (0.05). It therefore concludes that, statistically there is enough evidence to suggest that age category and institutions are dependent. Age differences were found between the three groups of institutions. About 60% each of the workers in I and III were adults compared with those in II of 73%.

The purpose of this study was to increase the understanding of age levels in public institutions. From the Chi-square analysis, the alternative hypothesis was selected. Age differences were found in the three groups of institutions. In a situation where old age was more frequent in the ministry, does not augur well for government effort to ensure sustainability of expertise in the ministries as the older workers go on retirement.

IV. CONCLUSION

On the basis of the type of workers in the public institutions, obtained results and their analysis, the following conclusions can be drawn:

- More females were in the overweight and obesity group than males. More female workers are at higher risks than male. Probably as female aged, they become more sedentary.
- For most of the measurements (such as height, weight, popliteal to floor height and knee height, the male dimensions exceeded that of females except for width of bitrochanter. Women have bigger hip breadth than men.
- Age is a factor in the consideration of popliteal to floor height (seat height) and knee height (desk clearance) since increase in age results in decrease in seat height and desk clearance.
- There are more adults in the ministry than in the Polytechnics and the Universities.

V. RECOMMENDATIONS

- Health status of workers should be the concern of managers of institutions since health status of workers has direct influence on absenteeism, workers compensation and productivity levels.
- There should be a change of lifestyles and diet in women as these are the two most common causes of overweight and obesity among populations.
- In the construction of seat height and desk clearance, age should be considered since elderly people should not use too high a seat.
- For efficient work performance in the Ministry, the government of Ghana should employ young people into the ministries so that older workers can impart their expertise to the young workers when they go on retirement.

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