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Association between Anthropometry and Blood Pressure among Female Teachers of Child-Bearing Age in Ghana.

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Abstract
The prevalence of hypertension is high among women due to the high prevalence of obesity observed among them. This study determines the relationship between anthropometry and blood pressure among women of child-bearing age. A cross-sectional survey was conducted on a total of 400 female teachers between the ages of 18-49 years from the Accra District of Ghana. A structured questionnaire was used to gather information on the socioeconomic status, anthropometric and blood pressure measurements, physical activity, alcohol and nutrient intakes. Appropriate statistical methods were used to determine the association between variables. In this study, anthropometric measurements such as body mass index, waist-to-hip ratio and waist circumference indicated a strong positive relation with blood pressure. The prevalence of hypertension among the female teachers was found to be 11.5%. About 35% of the women were overweight while 27% were found to be obese. Parity, income level and beer intake showed significant association with high blood pressure. Consumption of fruits and vegetables was observed to be low. Waist-to-hip ratio and age of the female teachers appeared to be the greatest predictors of high blood pressure. Women with central obesity were 2 times at risk of developing hypertension than those who were not [2.12 (0.99-4.51)]. Female teachers who knew their hypertension status were 6 times more likely to be detected as hypertensive by this study [6.11 (2.37-15.78)] and participants who were above 35 years were 5.7 times at risk of developing hypertension [5.68 (2.10-15.38)] than those below 35 years. Measures such as healthy eating guidelines supported with vigorous physical activities must be put in place in the various schools to help teachers maintain healthy body weights.
Keywords: Anthropometry, Blood pressure, Female Teachers, Childbearing age

1. INTRODUCTION

Hypertension, though manageable can lead to complications such as stroke and other cardiovascular diseases. In women of child-bearing age hypertension may lead to pre-eclampsia or eclampsia during pregnancy and this may cause maternal mortality, prenatal deaths and even low-birth weight infants. Pre- eclampsia is one of the leading causes of maternal deaths and accounts for a substantial portion of prenatal deaths and low-birth-weight infants (Halpern 1979). Eclampsia in women with deprived socio-economic status has a link with nutritional deficiencies than any other environmental factor (Halpern 1979). Therefore, hypertensive status of a woman within the child-bearing age is important to control the risk involved. Early detection and adequate managements may prevent this life -threatening condition among women in the reproductive age bracket.

Studies on body dimension and hypertension have been conducted among various categories of people and professions (Motta *et al*. 2001; Huang *et al*. 1998). Incidentally, not much of these studies have been carried out in Ghana. Information generated in this study will bridge this knowledge gap. This study focuses on female teachers of child-bearing age because they constitute a homogeneous group of people as defined by their work schedule and the kinds of pressures they undergo. Teachers have a sedentary lifestyle. This is due to the nature of their work which allows for more sitting during the day rather than walking or any physical activity. Again females are vulnerable due to the complex nature of their physiology. A woman, by her physiology has less lean mass and more fat mass and after child birth, tends to accumulate more fat. (O'Sullivan 2011). This accumulated fat is important to provide energy for the mother to breastfeed (O'Sullivan 2011). When this accumulated fat is not shed off after child birth and breastfeeding, fat mass increases over a period of time. This puts the woman at risk of obesity and its related problems such as hypertension.
The objective of this study was therefore to establish the association between anthropometry and blood pressure

among female teachers of child-bearing age in Ghana.

2. METHODOLOGY

2.1 Study Design and Study Population

A cross sectional design was used to conduct a survey on female teachers in their reproductive age bracket of <50 years. The teachers were selected from two circuits in Accra, Ghana. A total of 58 basic public schools under these circuits were used for the study. Permission to carry out the study was sought and granted by the Ghana Education Service, the District Education Officer and the circuit heads. In each school, the Head teachers also granted permission for the survey to be conducted. Teachers in the selected schools who consented to be part of the study were recruited. A woman in this study refers to female teacher unless otherwise stated.

2.2 Inclusion/ Exclusion Criteria

Non-pregnant female teachers between the ages of 15-49 years who taught in basic public school and consented to be part of the study were included. Teachers who were ill at the time of recruitment were excluded. This is because illnesses such as malaria may affect dietary intake and may cause an individual to lose weight within a short time which may not give a true reflection of the nutritional status of that individual.

2.3 Sample Size

With a 95% confidence interval and a 5% margin of error, the formula $n= (Z /2m)^2$ was used in determining the sample size (McCabe and Moore 1993). A sample size of 384 was obtained, based on which a total of four hundred female teachers were recruited for this study.

2.4 Data Collection

A structured questionnaire was used to collect information on the background, socioeconomic status, anthropometry, blood pressure levels, physical activity, dietary intake and alcohol intake.

2.4.1 Anthropometric Measurement

Nutritional status of the teachers was determined using anthropometric measurements. Weight, height, waist and hip circumference measurements were taken using standard procedures. Body mass index (BMI) and Waist-to-hip ratio were computed for each subject and then classified according to WHO cut-off ranges (WHO 1987)

2.4.2 Dietary Assessment

A 24hr dietary recall assessment method was used to collect data on the food taken over the past 24hr period using household measures (spoons, ladles, sardine tin etc.). Subjects were made to recall all foods consumed in the past 24hours. The estimated food quantities were converted into grams and the nutrients calculated using the ESHA Food Processor (Davison *et al.*1994).

2.4.3 Food Frequency

The frequency of consumption of food and four alcoholic beverages were determined using a food frequency questionnaire. Subjects were made to report the average frequency of consumption of specific list of foods and alcoholic beverages in the week preceding the survey. These were classified as high(4-7x/week),moderate(2-3x/week) or low (0-1x/week) intakes.

2.4.4 Blood Pressure Measurements

A simple sphygmomanometer (Unisonic Health Watch blood pressure monitor) was used to take the blood pressure measurements. All measurements were taken on the left hand. The systolic and diastolic blood pressures were recorded in duplicate within five minutes interval and the mean value calculated.

2.5 Data Analysis

Data entry was done using Epi-info version 6.02 (CDC/WHO 2001) after which statistical Package for Social Sciences for Windows software package (SPSS) version 10 was used to analyze the data. The ESHA food processor version 6.02 (Davison *et al.* 1994) was used to convert dietary intake into nutrients. Body mass index

(BMI) was calculated as body weight (in kg) divided by the height in meters squared (Wardlaw 2003). The following cut off points were used for waist to hip ratio (WHR). WHR ≤0.85 indicates lower risk, while WHR >0.85 indicates high risk group (WHO 1996) and 80cm for waist circumference (Public Health Nutrition 2004). Also, BMI <18.5kgm^{-2} indicates underweight, while BMI between 18.5-25kgm^{-2} indicates normal weight. Overweight individuals would have their BMI >25-30kgm^{-2} and BMI >30kgm^{-2} will indicated obesity (WHO 1996). Descriptive tools such as means, standard deviations and ranges were used to describe continuous variables while proportions were used for categorical variables.

Data was presented on frequency tables. Blood pressure and nutrient intake were adjusted for age, body mass index and waist-to-hip ratio. The association among body anthropometry, nutrient intake and blood pressure were determined using correlation and chi-square test. Analysis of variance was used to test for differences between groups. Significant differences between three or more groups were identified using Duncan's multiple range Test and the independent sample t-test was used for comparisons between 2 groups. Multiple step wise linear regression analysis was used to determine factors associated with systolic and diastolic blood pressure while Binary logistic regression was used to show predictors of high blood pressure.

3. RESULTS/DISCUSSIONS

3.1 General Findings

A total of 400 female teachers from basic public schools in Accra district completed the study. Their mean age was 42.3±6.0 years. The majority of the teachers were above 35years of age (50.5%). Only 12% of them were below 25 years of age (young adults). The majority of them were trained teachers (66.3%) while the untrained teachers formed about 14.3. The percentage of married women in this study was high (64%) while divorced rate was low (Table 1). Parity was relatively low with 40% having a child or 2 compared with 31.5% who had no child; only 2.1% had more than 4 children. Only 6.3% of the teachers were medically diagnosed hypertensives with the majority (54.8%) having no family records of hypertension while 45.3% had family recordof hypertension. Fruits and vegetables consumption was low among the teachers. Alcoholic beverage was not commonly consumed by the teachers. The prevalence of hypertension, obesity and overweight was found to be 11.5%, 27% and 35% respectively.

3.2 Prevalence of Hypertension among the teachers

The prevalence of hypertension among female teachers of child-bearing age in Accra District was found to be 11.5% (Table 1). Some studies reported hypertension prevalence between 19%-48% across studies (Bonso 2010). This lower prevalence observed could be due to the fact that as teachers, they may be aware and/or knowledgeable about the risk of hypertension and therefore could be taking precautions in terms of their dietary choices and other lifestyle to prevent this situation. This was shown in the low intake of foods such as eggs, high intake of fish and moderate consumption of wine found in this study (Table 2), although other factors such as low income (unaffordability) may also contribute.

The prevalence of hypertension was high among obese individuals (41.3%) however, no hypertensive was underweight. Body fat mass described by BMI increased with the prevalence of hypertension. This means that a high body fat mass (BMI) is a risk factor to hypertension while a low fat mass is protective of hypertension. However, the trend was different for varying waist-to-hip ratio; a high prevalence of hypertension was observed for WHR ≤0.85 than WHR >0.85 (Table 3). This is in contrast to findings of other studies which indicated an increase in the prevalence of central obesity with the prevalence of hypertension (Olinto *et al*. 2004; Larsson *et al*. 1984; Jansen *et al*. 2002; Welborn 2003). When the prevalence of hypertension was adjusted for age, the prevalence was low for the ages below 25years (2.2%) but increased slightly between the ages 26-35 years (8.9%). Above 35 years however, the prevalence increased by about ten times that of the middle-aged adults (88.9%), Table 3. The results indicate that at any age group, hypertension existed. The high prevalence found for the ages above 35years are consistent with results from other studies (Pobee *et al.* 1977; Caroline *et al.* 2000; Glover *et al*. 2005).

3.3 Association between socioeconomic status and blood pressure

There is an association between socioeconomic status and hypertension (Monteiro 1995; Davey-Smith *et al*. 1996).

This study also found an association between hypertension, income level and parity. However, these socioeconomic variables did not contribute to the regression model. This means that income level and parity may have some effect on blood pressure but may not be strong predictors of hypertension.

Again, parity and marital status showed some association with body mass index, waist circumference and waist-to-hip ratio (Table 4). This confirms studies that have shown a positive correlation between parity and anthropometry among Brazilian women and Moroccan women (Belahsen *et al.* 2003; Coitinho *et al.* 2001). A possible reason for this finding may be that married individuals are more likely to have high parity and hence high BMI. During pregnancy and lactation, women may accumulate stored energy in their body (Mwambingu *et al*. 1998; Benjelloun 2002; Huang *et al*. 1998). If they do not engage in any active work after pregnancy, they may not lose the extra weight. Some studies have shown that women gain more weight after their first child than other women of the same age group who have no child (Benjelloun 2002, Huang *et al*. 1998). Also, married females are more likely to increase their body mass index due to the social support which may increase their income. As indicated in Table 3, there was a significant association between BMI and income level. If these situations are coupled with the nature of the teaching job, which is considered sedentary, this may eventually lead to obesity and hence hypertension.

3.4 Association between physical activity, dietary intake and Blood pressure

There was no association between blood pressure and physical activity in this study. Physical activity did not make any contribution to the regression model either, even though the majority of the teachers claimed to walk a lot during the day. A possible explanation could be that the nature of their job involves more sitting and standing (sedentary activities) and therefore they may not be engaged in vigorous activity during the day.

A negative correlation was found between intake of some nutrients and blood pressure (Table 5). Systolic blood pressure correlated negatively with cholesterol and zinc while diastolic blood pressure correlated negatively with cholesterol and folate. Studies by Ascherio *et al.* (1996) showed a similar finding between zinc and blood pressure. High intake of zinc lowers blood pressure and prevents the onset of hypertension. This study also indicated a negative effect of folate intake with blood pressure and agrees with studies from the American Heart Association which found a reduced risk of hypertension with folate intake among young women (Rimm *et al.* 2004). Folate reduces homocysteine, a blood component that can damage blood vessels and may also help blood vessels relax, thereby improving blood flow (Forman 2005; Tucker *et al*. 1996).

Cholesterol intake was also found to correlate negatively with both systolic and diastolic blood pressures. This means that as cholesterol intake increases, blood pressure decreases. These result were unexpected and contradicts with studies that have shown a positive correlation between cholesterol intake and blood pressure (Rivera *et al*. 2002). Reasons for this may be that at the time of the study, the majority of the teachers indicated that having realised their high BMI status they resorted to reduced food intake. It was also realised that majority of the teachers were managing their weight by themselves as such avoided food totally. The 24-hour recall could not therefore capture the true nutritional intake of the teachers. This could result in the negative correlation observed in this study. In addition to this, the Food Frequency Tables indicated low consumption of fruit and vegetables (Table 2). Teachers therefore need to be educated on appropriate eating habits that will lower carbohydrate and protein intake but increase whole grain, fruits and vegetables.

3.5 Association between Hypertension and Anthropometry

A positive correlation was found between systolic and diastolic blood pressures with all the anthropometric measurements; weight, waist circumference, hip circumference and their derivatives (body mass index and waist-to-hip ratio). Among all the anthropometric indices, waist-circumference made the strongest contribution variations in both systolic and diastolic pressures (Table 6). The suggestion from the final model is that as waist circumference increases by 1cm, systolic blood pressure would tend to increase by about 0.3mmHg while diastolic blood pressure would tend to increase by 0.2mmHg adjusting for age. When systolic and diastolic blood pressures were based on BMI and waist-to-hip ratio, significant differences were observed at p-values <0.05, between all the categories of BMI except for overweight and obese individuals. The same applies to waist-to-hip ratio (Table 7). This implies that as body fat increases, blood pressure also increases among the female teachers.

3.5.1 Predictors of high blood pressure

Waist-to-hip ratio, age and hypertensive status of the female teachers appeared to be the greatest predictors of high blood pressure (Table 8) and these explained about 11.6% of the variations in blood pressure. Female teachers who were centrally obese (WHR >0.85) were 2 times more likely to develop hypertension than those who were not (WHR ≤ 0.85). Waist-to-hip ratio ≤ 0.85 is therefore protective against hypertension. This confirms the fact that body fat is the strongest predictor for hypertension in this sample of women. Female teachers who knew their hypertension status were 6 times more likely to be detected as hypertensive by this study [6.11 (2.37-15.78)] and participants who were above 35 years were 5.7 times at risk of developing hypertension [5.68 (2.10-15.38)] than those below 35 years.

4.0 **Conclusion**

There is a positive association between anthropometry and blood pressure. All the anthropometric measurements; weight, waist circumference, hip circumference and their derivatives (body mass index and waist-to-hip ratio) had a positive correlation with systolic and diastolic blood pressures. WHR was the strongest predictor of hypertension. Consumption of fruit and vegetables among the female teachers was low. This study recommends that healthy eating guidelines supported with vigorous physical activities must be in place in the various schools to help teachers maintain healthy body weights (that is BMI 19-25 normal range) throughout adulthood in order to prevent the risk of obesity and hypertension. This study provides a basis for testing overweight, obesity and its associated risk of hypertension among people in different professions.

Table 1: Socio-Economic and Hypertensive Status of Female Teachers Status (n=400).

Characteristic	Frequency (n)	Percent (%)
Educational Level		
Untrained teacher	57	14.25
[1]Trained teacher	266	66.50
[2]Trained graduate teacher		19.25
Total	77	100.00
	400	
Income Level (cedis)		
101,000-500,000	53	13.25
501,000-1,000,000	117	29.25
1,100,000-2,000,000	151	37.75
> 2,000,000	79	19.75
Total	400	100.00
Marital Status		
Single	123	30.75
Married	256	64.00
Divorced	13	3.25
Widowed	8	2.00
Total	400	100.00
Number of Children		
0	126	31.50
1-2	160	40.00
3-4	105	26.25
>4	8	2.00
No response	1	0.25
Total	400	100.00
Hypertensive status		
[3]Non-hypertensive	354	88.50
[4]Hypertensive	46	11.50
Total	400	100.00

[1] Teacher with a certificate in education [2-] Trained teacher with certificate in education plus a university degree. [3]Systolic blood pressure <140mmHg and diastolic blood pressure <90mmHg. [4] Systolic blood pressure ≥140mmHg and diastolic blood pressure ≥ 90mmHg.(Source: Chronic Disease Service, 2005)

Table 2: Food Frequency Table showing the consumption of some selected food in the week preceding the survey

Food	0-1x/week	2-3x/week	4-7x/week
Carbohydrates			
Rice	14.8	44.5	40.8
Yam	56.3	38.0	5.8
Cocoyam	97.6	1.8	0.8
Gari	82.3	5.3	2.0
Proteins			
Fish	4.0	19.3	76.8
Egg	59.6	29.8	1.8
Poultry	64.3	24.3	11.5
Fat/oils			
Vegetable oil	20.0	43.5	36.6
Palm oil	27.8	44.8	27.6
Butter	93.8	4.0	2.3
Fruits/Vegetables			
Orange	39.8	31.5	28.8
Pineapples	74.0	17.8	7.3
Apple	72.3	13.8	4.0
Garden Eggs	35.8	38.5	25.8
Kontomire	23.7	7.5	1.6
Okro	69.5	24.5	6.0
Alcohol			
Red wine	96.3	2.5	1.3
Stout	97.6	1.8	2.6
Beer	98.6	1.0	0.6

Table 3: Prevalence of Hypertension Based on Age, Body Mass Index and Waist-to-Hip Ratio.

Variables	n	Current Hypertension Status	
		Hypertensive	**Non-Hypertensive**
Age (yrs)			
<25	48	1 (2.2)	47 (13.5)
26-35	143	4 (8.9)	139 (39.9)
>35	202	40 (88.9)	162 (46.6)
Body mass index (kgm^{-2})			
Underweight	9	-	9 (2.5)
Normal	147	13 (28.2)	134 (37.9)
Overweight	136	14 (30.4)	122 (34.5)
Obese	108	19 (41.3)	89 (25.1)
Waist-to-hip ratio			
≤ 0.85	329	29 (63.0)	300 (84.7)
>0.85	71	17 (37.0)	54 (15.3)
Waist-circumference (cm)			
<80	164	156 (95.1)	198
≥80	236	8	(41.5)
		(4.9)	38 (16.1)

Waist-to-hip ratio: ≤0.85 (Lower risk), >0.85 (high risk). Waist-circumference: < 80 (lower risk), ≥80 (high risk). Body Mass Index: < 18.5(underweight), 18.5-25 (normal), >25-30 (over weight), >30 (obesity).

Table 4: Association between Hypertension, Anthropometric Indicators and Some Variables (significant p-values).

Variables	Hypertension	Body Mass Index	Waist-to-Hip Ratio	Waist Circumference
Income	0.049	0.003	*	<0.001
Parity	0.001	<0.001	<0.001	<0.001
Marital Status	*	<0.001	0.020	<0.001
[1]Educ. Level	*	*	0.003	*
[2]Hypt. Status	<0.001	*	*	*
[3]Special Dt Int.	0.024	*	*	*
Beer Intake	0.007	*	*	*

Chi-square test P-value < 0.005. * P-value not significant (Chi-square test). [1]Educational level. [2]Hypertension status. [3]Special diet intake.Hypertension: (Systolic blood pressure <140mmHg and Diastolic blood pressure <90mmHg =1; Systolic blood pressure ≥140mmHg and Diastolic blood pressure ≥ 90mmHg = 2). Body Mass Index (BMI): (BMI <25kg/m^2= 1; BMI > 25kg/m^2= 2).Waist-to-hip ratio (WHR): (WHR≤ 0.85 =1; WHR> 0.85 =2). Waist Circumference (WC): (WC <80cm =1; WC>80cm=2). Income: (<1million cedis =1; >1 million cedis = 2). Parity: (No child=1; One child=2; more than two children=3)

Table 5: Correlation between Anthropometry, Blood Pressure and Nutrient Intake Variables.

	Systolic	Diastolic	[1]BMI	[2]WHR	Weight	[3]WC	[4]HC
Calories	-0.075 0.133	-0.070 0.158	-0.138** 0.006	-0.047 0.352	-0.122** 0.015	-0.125* 0.012	-0.139** 0.005
Protein	-0.010 0.072	-0.069 0.167	-0.128* 0.010	-0.045 0.372	-0.108* 0.031	-0.107* 0.033	-0.112* 0.025
Carbohydrate	-0.037 0.465	-0.030 0.547	-0.087 0.082	-0.032 0.524	-0.084 0.093	-0.090 0.071	-0.103* 0.039
Total fat	-0.069 0.166	-0.070 0.163	-0.146** 0.003	-0.065 0.197	-0.128* 0.010	-0.135** 0.071	-0.139** 0.005
Saturated fat	-0.041 0.416	-0.030 0.559	-0.025 0.625	0.000 0.994	-0.037 0.464	-0.015 0.770	-0.020 0.690
Cholesterol	-0.139** 0.006	-0.140** 0.006	-0.113* 0.016	-0.190** 0.000	-0.094 0.064	-0.146** 0.004	-0.045 0.378
B-12	-0.031 0.539	-0.021 0.680	-0.101* 0.046	-0.013 0.798	-0.101* 0.047	-0.083 0.102	-0.110* 0.030
Folate	-0.084 0.096	-0.102* 0.044	-0.030 0.548	-0.068 0.181	-0.028 0.579	-0.061 0.231	-0.030 0.552
Fe	-0.035 0.486	-0.032 0.520	-0.156** 0.002	-0.036 0.471	-0.144** 0.004	-0.134** 0.008	-0.159** 0.002
Zinc	-0.100* 0.047	-0.076 0.132	-0.121* 0.015	-0.080 0.109	-0.096 0.056	-0.106* 0.034	-0.079 0.116

** Correlation is significant at 0.001 level (2-tailed) * correlation is significant at 0.05 level (2 tailed),
[1]Body Mass Index, [2]Waist-to-hip-ratio, [3]Waist-circumference, [4]Hip-circumference.

Table 6 Linear Regression Model Coefficients (95% C.I.) for Factors Associated with Systolic and Diastolic Blood Pressures.

Variable	Regression Coefficient (C.I.)	R^2
Systolic Blood Pressure		0.172
Waist circumference (cm)	0.29 (0.25-0.53)	
Age (years)	0.20 (0.19-0.60)	
Diastolic Blood Pressure		0.145
Waist circumference (cm)	0.23 (0.13-0.33)	
Age (years)	0.21 (0.16-0.46)	

C.I. (confidence interval). R^2 is the adjusted R square.

Table 7: Analysis of Variance Showing Differences in Mean Systolic and Diastolic Blood Pressures Based on Body Mass Index, Waist-to-Hip Ratio and Various Age Categories.

Variables	n	Systolic BP (mmHg)	Diastolic BP (mmHg)
		Mean ± S.D.	**Mean ± S.D.**
[1]Age(yrs)			
< 25	48	112.5^{a} ± 9.7	65.9^{a} ± 7.9
26-35	143	112.6^{a} ± 10.9	66.9^{a} ± 8.9
>35	202	123.5^{b} ± 18.8	74.3^{b} ±13.0
[1]Body mass index (kgm^{-2})			
Underweight	9	102.7^{a} ± 10.2	60.1^{a} ± 8.2
Normal	147	113.7^{b} ± 14.3	68.2^{b} ± 11.2
Overweight	136	$118.1^{b,c}$ ± 14.1	$70.0^{b,c}$ ± 10.4
Obese	108	125.7^{c} ± 18.4	75.5^{c} ± 12.6
[2]Waist-to-hip ratio			
≤ 0.85	329	116.1^{a} ±14.7	69.2^{b} ±11.0
>0.85	71	128.3^{a} ±19.1	77.0^{b} ±12.8

[1] Mean values with different superscripts in the same column are significantly different; Duncan's multiple range test ($p < 0.05$). [2] Mean values with different superscripts in the same column are significantly different; Independent T-test ($p < 0.05$)

Table 8: Binary Logistic Regression Model Showing Associated Variables of High Blood Pressure.

Variables	Odds ratio (95% C. I)	R^2
Waist-to-hip ratio		0.116
≤ 0.85	1.00	
>0.85	2.12 (0.99-4.51)	
Age		
<35 years	1.00	
>35years_	5.68 (2.10-15.38)	
Hypertensive Status		
[1]Not Hypertensive	1.00	
[2]Known Hypertensive	6.11(2.37-15.78)	

[1]Not diagnosed as hypertensive in any perspective. [2]Medically diagnosed as hypertensive

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