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Metabolic Syndrome in Relation to Body Mass Index and Waist to Hip Ratio; A Study in Kumasi Metropolis

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Abstract

The purpose of this study was to determine the prevalence of metabolic syndrome and examine the risk associations between obesity indexes [body mass index (BMI), waist circumference (WC) and Waist-to-Hip Ratio (WHR)], cardiovascular risk factors [plasma glucose, cholesterol and blood pressure] and morbidity conditions (type 2 diabetes mellitus, hypertension and dyslipidemia) in the Kumasi metropolis. Three hundred and eighty seven Penteco-Charismatic Ghanaian subjects (18–85 years of age) were recruited from Pentecost Church Santasi, and the Bantama and Old Tafo Assembly of God Churches in Kumasi, Ghana. The parameters determined on the subjects included: height; weight; waist and hip circumferences; blood pressure; fasting plasma glucose and cholesterol.

There were 267 females (69%) and 120 (31%) males with mean age 41.36 ± 13.59 years. Mean BMI was 25.85 ± 5.89 kg/m^2 and 22.61 ± 3.48 kg/m^2 in male and female subjects respectively. Mean WC measurement was 35.41 ± 4.93 in and mean WHR was 0.86 ± 0.11. The prevalence of metabolic syndrome was 8.0%, while in females and males were 10.86% and 1.67% respectively. The prevalence of diabetes was 5.0%, while in females it was 6.4% and 3.3% in males. The overall prevalence of hypertension was 32.04%, 39.0% in females and males of 16.7%.

There were increasing trends between obesity indices and the severity of cardiovascular risk factors and the prevalence of morbidity conditions (all P-values for trend <0.05). Patients with a greater number of comorbidities also had higher BMI, WC, and WHR measurements (all P-values for the trend were <0.05 with adjustment for age and gender). Hence, despite Penteco-Charismatic Ghanaian subjects being less obese than Caucasians and Western countries, the intimate relationships among obesity, cardiovascular risk factors and morbidity conditions remain.

Our data support using BMI and WC as part of routine clinical evaluation of patients to define obesity and its associated health risks. The results suggest that prevention of obesity, particularly central obesity; healthy living, lifestyle modification and exercising could be the most direct route to prevention of Metabolic Syndrome and its complications.

Keywords: Obesity; Comorbidities; Pentecostal; Hypertension; Metabolic syndrome

Abbreviations: AACE: American Association of Clinical Endocrinologists; ADA: American Diabetes Association; ATP III: Adult Treatment Panel III; ASCVD: Atherosclerotic Cardiovascular Disease; BMI: Body Mass Index; BP: Blood Pressure; CAD: Coronary Artery Disease; CHD: Coronary Heart Disease; CVD: Cardiovascular Disease; DCCT: Diabetes Control and Complications Trial; ECF: Extracellular Fluid; EGIR : European Group for the Study of Insulin Resistance; GDM: Gestational Diabetes Mellitus; IFG: Impaired Fasting Glucose; IGT: Impaired Glucose Tolerance; IDDM: Insulin Dependent Diabetes Mellitus; IDF: International Diabetes Foundation; MS: Metabolic Syndrome; NCD's : Non-Communicable Diseases; NCEP: National Cholesterol Education Program; NIDDM: Non-Insulin-Dependent Diabetes Mellitus; SPSS: Statistical Package for Social Sciences; T2DM: Type 2 Diabetes Mellitus; WC: Waist Circumference; WHR: Waist to Hip Ratio; WHO: World Health Organization; WHtR: Waist to Height Ratio

Introduction

Metabolic syndrome in relation to body mass index and waist to hip ratio; a study in Kumasi metropolis with the discovery of insulin in 1922, the study of diabetes was changed forever. From that time forward, it has been difficult to discuss the pathophysiology of diabetes without in some way referring to this critical metabolic hormone, which is a life-saving treatment in patients who lack it. The role of insulin in diabetes proved to be far more complex than its absence, however research over the past 60 years has gradually revealed that disease caused by resistance to insulin (type 2, or non-insulin-dependent, diabetes) is more prevalent than that due to the absence of insulin (type 1 diabetes). But the problem of insulin resistance extends far beyond type 2 diabetes mellitus (T2DM), in ways that were totally unanticipated.

For most of the 20th century, cardiovascular disease (CVD) was identified as the major cause of morbidity and mortality in the developed world. During this period there was considerable effort to understand the underlying biology of the disease and to identify the contributing risk factors. As risk factors were identified, it became apparent that more than one was often present in the same individual. Toward the end of the century, the clustering of CVD risk factors was first described, most notably the simultaneous presence of obesity, T2DM, hyperlipidaemia, and hypertension [1]. Although insulin resistance as a feature of T2DM was first described many years earlier, hyperinsulinaemia was also found to be a key feature of T2DM, as well as hyperlipidaemia, obesity, and hypertension [2].

This risk factor clustering, and its association with insulin resistance,

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led investigators to propose the existence of a unique pathophysiological condition, called the "metabolic syndrome" or "insulin resistance". This concept was unified and extended with the landmark publication of Reaven's 1988 Banting Medal award lecture. Reaven postulated that insulin resistance and its compensatory hyperinsulinaemia predisposed patients to hypertension, hyperlipidaemia, and diabetes and thus was the underlying cause of much CVD. Although obesity was not included in Reaven's primary list of disorders caused by insulin resistance, he acknowledged that it, too, was correlated with insulin resistance or hyperinsulinaemia, and that the obvious "treatment" for what he termed "syndrome X" was weight maintenance (or weight loss) and physical activity.

This risk factor clustering, and its association with insulin resistance, led investigators to propose the existence of a unique pathophysiological condition, called the "metabolic syndrome" or "insulin resistance". This concept was unified and extended with the landmark publication of Reaven's 1988 Banting Medal award lecture. Reaven postulated that insulin resistance and its compensatory hyperinsulinaemia predisposed patients to hypertension, hyperlipidaemia, and diabetes and thus was the underlying cause of much CVD. Although obesity was not included in Reaven's primary list of disorders caused by insulin resistance, he acknowledged that it, too, was correlated with insulin resistance or hyperinsulinaemia, and that the obvious "treatment" for what he termed "syndrome X" was weight maintenance (or weight loss) and physical activity.

The term "metabolic syndrome" has now taken hold in the medical literature. It has been defined and institutionalized, principally by the World Health Organization (WHO) and the Third Report of the National Cholesterol Education Program's Adult Treatment Panel (ATP III), albeit with different definitions. In addition, other organizations have developed similar, but again not identical, definitions.

There is evidence to suggest that non-communicable diseases (NCD's) are already a major burden in some sections of the population especially those living in urban areas in sub Saharan Africa [3]. It is predicted that NCD's will become the major cause of death in the African continent as a whole within the next 20 years and that together diabetes and cardiovascular disease will account for over half of those deaths. Studies by Oheneet al. [4] indicate an increase in the prevalence of hypertension in Ghana. In addition hypertension has been identified as the most common cause of heart failure, stroke, chronic renal disease and spontaneous sudden death in Ghana. Over the past decade Hypertension, Diabetes mellitus and Hypercholesterolemia are becoming increasingly common and a global health challenge. Most patients with one or more of these disorders have a markedly worsened risk for premature microvascular and macrovascular complication [5]. It has been established that around 20 million people in Africa have hypertension [6]. It is estimated that with good blood pressure control 250,000 deaths per year from complications like stroke and kidney failure could be prevented in Africa [6].

The Diabetes Control and Complications Trial (DCCT) has indicated that intensive drug therapy that focuses on keeping glucose concentration at near normal levels for 5 years or more reduces both the onset and progression of retinopathy (up to 63%), nephropathy (by up to 54%), and neuropathy (by up to 60%) [7]. The implication of this is that people need to be screened on a regular basis. There is still uncertainty whether this should be done on a population-wide basis or just for those people who can be shown to have a high risk. It is also uncertain at what age the screening programs should be introduced, if at all.

Prevalence of diabetes mellitus in adults worldwide was estimated to be 4.0% in 1995 and is set to rise to 5.4% by the year 2025 [5]. The major part of this numerical increase will occur in developing countries from 84 million to 228 million individuals. Figures for 2000, estimate that the prevalence of diabetes in the African region is 1.2% with Ghana having an urban prevalence rate of 5.0% [3]. Data on the prevalence of the condition in rural areas are rather out dated (1982) and the estimated prevalence is 1-2%. It has been estimated that as much as 60 – 90% of diabetes is undiagnosed and that much diabetes is discovered only when patients seek medical attention because they are suffering from complications of the disease [3].

T2DM is a common disease with substantial associated morbidity and mortality [8]. Most adverse diabetes outcomes are a result of vascular complications, both at a macrovascular level (coronary artery disease, cerebrovascular disease, or peripheral vascular disease) and a microvascular level (retinopathy, nephropathy, or neuropathy) [8]. Macrovascular complications are more common; up to 80% of patients with T2DM will develop or die of macrovascular disease, and the costs associated with macrovascular disease are in order of magnitude greater than those associated with microvascular disease.

The prevalence of hypertension has increased dramatically in developing countries during the past several decades affecting approximately 1 billion individuals' worldwide [9]. In 2002 the prevalence rate was estimated at about 35% of Ghanaians in the 40 – 55 years age group and 40% in those above 55 years of age [4]. Below 40 years the prevalence of hypertension was approximately 6% and in this age group the prevalence was higher in males than in females. Hypertension has been identified as the most common cause of heart failure, stroke, chronic renal disease and spontaneous sudden deaths in Ghana [4]. It is also suspected that many Ghanaians living with the disease are unaware that they have the condition.

Obesity which is defined as the excess of body fat in relation to lean mass has been shown to be both an independent direct risk factor for cardiovascular disease and an indirect risk factor because of its effects on diabetes, hypertension, and hyperlipidaemia [10]. However, the effect of obesity on risks for hypertension, diabetes, and hypercholesterolemia has been shown to be more pronounced in individuals aged 20 to 45 years than among those aged 45 to 75. The BMI is a simple reproducible measurement commonly used to classify adults as obese. Some studies in elderly populations have also shown a correlation between body weight or body mass index (BMI) and severe blood pressure, particularly in men [10]. Few data are available from elderly minority populations, particularly Asians. Studies from China showed that BMI is significantly associated with BP in young and middle-aged lean populations [9].

Although different anthropometric indices of obesity are generally connected with hypertension and diabetes [4,11], the mechanisms and independent roles of these indices are not clear. The most commonly used anthropometric index of obesity is the body mass index (BMI). BMI is a height-adjusted measure of overall body heaviness that is highly correlated with adiposities measured by computerized tomography, dual-energy X-ray absorptiometry, and doubly labeled water [12]. However, BMI has been found to lack sufficient explanatory power for many cardiovascular disorders. The regional body habitus most commonly linked to obesity are waist girth and skinfolds, such as subscapular and triceps. Waist-to-hip ratio (WHR) is also sometimes used as an anthropometric measure of abdominal fat accumulation [12].

However, WHR is not universally useful as a surrogate for predicting the visceral amounts of adipose tissue that are most metabolically responsible for the obesity-related disease risk or incidence of disease.

Hypertension and T2DM are interrelated metabolic disorders that strongly predispose an individual to atherosclerotic cardiovascular disease (ASCVD) and to renal failure [12]. Most diabetes mellitus and hypertension data depend on self-reports [13] and the estimated prevalence of diabetes and hypertension may be affected by an increase in the proportion if diagnosed. As much as 60 – 90% of diabetes is undiagnosed, also many Ghanaians living with hypertension are unaware that they have the condition. Besides most of the time data on these conditions are urban centered.

The people of Kumasi used to be mainly subsistent farmers, traders and industrial workers with a very simple diet. In recent years the city of Kumasi has grown enormously and the population now mostly uses public transport and other forms of transportation. Walking which represented one of the main forms of exercise is now rarely practiced. Associated with this economic development and increasing urbanization is obesity and physical inactivity [14]. These socio-economic changes coupled with increasing urbanization with associated lifestyle changes, promotion of tobacco and "western" diet or consumption of saturated carbohydrate and fats, reduction in physical activity, environmental factors and increase in survival or ageing [15] is at the heart of this emerging pandemic of diabetes and cardiovascular diseases. Hypertension shares many of the risk factors of diabetes.

There is enough evidence suggesting the increase in hypertension, diabetes and cardiovascular diseases in Ghana. Metabolic syndrome which has these conditions as risk factors has seen very little exposure in Ghana; hence there is very little data on metabolic syndrome. It is therefore of importance that whiles looking at the prevalence of hypertension and diabetes in the Kumasi metropolis metabolic syndrome is given an attention, hence the need for this project to ascertain the prevalence of metabolic syndrome in the Kumasi metropolis.

This study therefore aims to determine the prevalence of the metabolic syndrome among the people of Kumasi in the Ashanti Region of Ghana. Blood pressure, fasting glucose level and waist circumference will be used as the 3 criteria to confirm the diagnoses of metabolic syndrome. Cholesterol level will also be measured and relating it to metabolic syndrome instead of triglycerides. Body Mass Index (BMI) and Waist to Hip Ratio (WHR) will also be determined in relation to diabetes and hypertension to establish which one is a good indicator of these conditions.

Materials and Methods

Subjects

Data from 387 residents of suburbs of the Kumasi metropolis (Bantama, Old Tafo and Santasi) were obtained from 23rd September 2005 to 29th October 2005. This consisted of 196 from Bantama, 101 from Santasi and 90 from Old Tafo all suburbs of Kumasi. The participation of the respondents was voluntary and informed consent was obtained from each of them.

Both diabetes and hypertension were diagnosed according to the current World Health Organization (WHO) criteria. Metabolic Syndrome was diagnosed using a modified version of USA National Cholesterol Education Program (NCEP) Adult Treatment Panel III (ATP III).

Sample collection and preparation

Venous blood samples were taken from subjects after an overnight fast (12 – 16 hours). About 5 ml of venous blood was collected and dispensed into fluoride oxalate tubes and plain tubes without anticoagulant for separation into plasma and serum respectively. This was then taken to the laboratory and centrifuged at 1,000 g for 15 minutes at room temperature; the plasma was then used for the assay of glucose and the serum for cholesterol determination.

Anthropometric variables

Mercury sphygmomanometer was used to estimate the blood pressure. Participants were made to rest for about 10 minutes and the pressure taken in a sitting position. Tape measure was used for the measurement of hip and waist circumference, while a tape measure on a wall was used for the height measurement. Waist circumference was measured at the lowest point of the costal margins and hip circumference at the widest point of the hip. Weight was measured with the person's clothes on but without footwear using a bathroom scale. Other data like age, sex, and other personal data were obtained by the use of a questionnaire.

Results

Data entry and analysis were carried out through the use of SPSS 11.5 for windows software (SPSS Inc., Chicago IL, USA). Descriptive statistics are given as mean values and standard deviations. Bivariate

	N	Range	Min.	Max.	Mean		SD
	Statistics	Statistics	Statistics	Statistics	Statistics	SE	Statistics
Age (years)	387	67	18	85	41.32	0.68	13.469
Weight (kg)	387	80	40	120	67.23	0.71	13.882
Height (m)	387	0.99	1.04	2.03	1.6160	0.0050	0.09883
Waist (in)	387	37	18	55	35.41	0.25	4.925
Hip (in)	387	46	18	64	41.26	0.28	5.438
BMI (kg/m^2)	387	51.9	10.1	62.0	25.847	0.3	5.8946
WHR	387	1.00	0.55	1.55	0.8637	0.0054	0.10525
Systolic (mm Hg)	387	114	80	194	123.36	1.05	20.593
Diastolic (mm Hg)	387	70	50	120	76.17	0.65	12.832
FBS (mmol/L)	387	21.8	3.2	25.0	4.996	0.084	1.6560
Cholesterol (mmol/L)	265	8.4	2.1	10.5	5.578	0.44	1.860
Valid N (listwise) 265							

SE – Standard Error, SD – Standard Deviation

Table 1: Descriptive Statistics of the study population.

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Age Group (years)	Frequency	Percentage (%)
18-25	49	12.7
26-33	69	17.8
34-41	88	22.7
42-49	85	22.0
50-57	52	13.4
58-65	20	5.2
> 65	24	6.2
Total	387	100
Female	267	69.0
Male	120	31.0

Table 2: Age group and gender frequency.

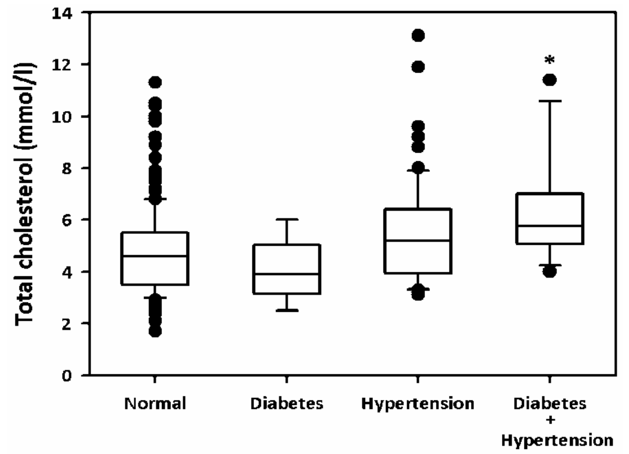

Figure 1: Cholesterol levels and comorbidities.

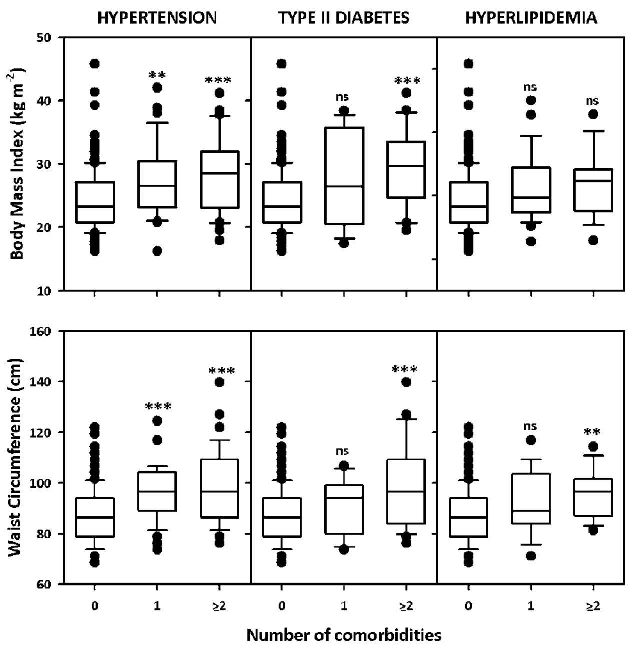

Figure 2: BMI, WC and Comorbidities.

analysis in the form of Pearson Correlation was carried out to determine the sex and age distribution of the respondents as well as the pattern of disease. The data were grouped into 7 age classes with class interval of 8. The class interval or age group and the number of classes were arrived at using Sturges Rule. The class ranged from 18-25, 26-33, up to 58-65 and those above 65 years.

A total of 387 respondents took part in the exercise from Bantama, Old Tafo and Santasi all suburbs of Kumasi. There were 267 females representing 69% compared to 120 males representing 31% and the mean age was 41.36 ± 13.59 years (Tables 1 and 2).

Cholesterol levels between patients with a different number of comorbidities in cohorts of patients with a primary diagnosis of type 2 diabetics, hypertension and diabetes with hypertension. The potential morbidity conditions for diabetic patients included hypertension and hypercholesterolemia; those for hypertensives included diabetes mellitus and hypercholesterolemia; and those for hypercholesterolemics included diabetes mellitus and hypertension. The lower and upper margins of the box represent the 25th and 75th percentiles, with the extended arms representing the 10th and 90th percentiles, respectively. The median is shown as the horizontal line within the box. Outlying points are shown individually. All *P*-values: *<0.05, **<0.001, ***<0.0001 and ns = not significant, using polynomial analysis of covariance with adjustment for age and gender (Figure 1).

Comparisons of body mass index and waist circumference between patients with a different number of comorbidities in cohorts of patients with a primary diagnosis of type 2 diabetics, hypertension and dyslipidaemia. The potential morbidity conditions for diabetic patients included hypertension and dyslipidaemia; those for hypertensives included diabetes mellitus and dyslipidaemia; and those for dyslipidaemics included diabetes mellitus and hypertension. The lower and upper margins of the box represent the 25th and 75th percentiles, with the extended arms representing the 10th and 90th percentiles, respectively. The median is shown as the horizontal line within the box. Outlying points are shown individually. All *P*-values: *<0.05, **<0.001, ***<0.0001 and ns = not significant, using polynomial analysis of covariance with adjustment for age and gender (Figure 2).

Discussion

Today there is growing interest in a cluster of synergistically interacting cardiovascular risk factors called "metabolic syndrome" (or "insulin resistance syndrome"), which is mainly characterized by insulin resistance, glucose intolerance, dyslipidemia, hypertension, and obesity. Metabolic Syndrome (MS) is normally diagnosed by the presence of any 3 of the following parameters – elevated blood pressure, raised blood fasting glucose, elevated waist circumference, elevated serum triglycerides, reduced HDL-C and insulin resistance.

There has not been any comprehensive study so far into the incidence and prevalence of metabolic syndrome in any part of Ghana, yet the national prevalence have been estimated at about 25.0% by Kahn et al. [16] based on studies done elsewhere in Africa. This study therefore seeks to provide relevant data by estimating the prevalence of metabolic syndrome using Waist Circumference (WC), Blood Pressure and Fasting Blood Glucose. In this study a report on anthropometric measures of overall and central obesity as predictors of type 2 diabetes mellitus and hypertension risk in Kumai is made.

The study included 387 individuals from Kumasi metropolis (Bantama, Old Tafo and Santasi). There were 267 females representing 69% and 120 males representing 31% of the respondents (Table 2). The mean age was 41.36 ± 13.59 years with the highest number of respondents being in the age group of 34-41 years with 22.7% of the respondents. This is followed by the age group of 42-49 years with 22.0%. The least was in the age group of 58-65 years representing 5.2%.

Age group (years)	Frequency	Percentage (%)
18- 25	0	0
26 -33	0	0
34-41	7	22.6
42-49	9	29.0
50-57	6	19.4
58-65	4	12.9
> 65	5	16.1
Total	31	8.01
Male	2	1.67
Female	29	10.86

Table 3: Metabolic syndrome and age group.

Age Group (years)	Systolic Hypertension			Diastolic Hypertension		
	Frequency (%)	M	F	Frequency (%)	M	F
18- 25	3 (2.8)	1	2	1 (1.0)	0	1
26-33	4 (3.7)		4	3 (3.0)	0	3
34-41	16 (15.0)	4	12	20 (20.2)	3	17
42-49	24 (22.4)	2	22	29 (29.3)	3	26
50-57	28 (26.2)	6	22	18 (18.2)	5	13
58-65	12 (11.2)	3	9	10 (10.1)	3	7
> 65	20 (18.7)	1	19	18 (18.2)	1	17
Total	107			99		
Male	17 (14.2)			15 (12.5)		
Females	90 (33.71)			84 (31.46)		

Of the 124 Hypertensive 41 knew of their condition forming 33.1%

Table 4: Hypertension and age group and gender.

Age Group (years)	Normal			IFG			Diabetic		
	Freq.	M	F	Freq.	M	F	Freq.	M	F
18-25	**41**	18	23	**7**	6	1	**1**	1	0
26-33	**58**	18	40	**10**	2	8	**1**	0	1
34-41	**70**	26	44	**16**	5	11	**2**	1	1
42-49	**71**	22	49	**8**	1	7	**6**	1	5
50-57	**40**	12	28	**8**	2	6	**4**	0	4
58- 65	**15**	4	11	**3**	0	3	**2**	0	2
> 65	**16**	2	14	**3**	0	3	**5**	1	4
Total	**311**	102	209	**55**	16	39	**21**	4	17

Table 5: Fasting venous blood glucose and age group.

	Frequency	%	Male		Female	
			Frequency	(%)	Frequency	(%)
Diabetics	21	5.4	4	3.3	17	6.4
IFG	55	14.2	16	13.3	39	14.6
Normal	311	80.4				

Of the 21 Diabetics five (5) knew of their conditions representing 24% of the Diabetics

Table 6: Prevalence of diabetes and IFG and gender.

This study produced an overall prevalence rate of 8.0% for metabolic syndrome with a prevalence of 1.67% and 10.86% for males and females respectively (Tables 3-10). The percentage obtained for females showed an increase over the overall prevalence rate while males showed a decrease with respect to the overall prevalence. A similar study done by Rquibi and Belahsen [17] among Moroccan Sahraoui women reported a prevalence of 16.3%. Another study also carried out in Tunisia by Bouquerra et al. [18] reports a prevalence of 18.0% for females and 13.0% for males. The low prevalence obtained for our study is basically due to the drawback of this study in the use of 3 parameters in the diagnosis of the condition whiles insulin resistance, reduced HDL-C or elevated triglycerides were not considered in this study. These other parameters if combined with the three parameters used may alter the prevalence. Ntyintyane et al. [19] reported a prevalence of 60% of MS among black patients with established CAD, who had no previously known diabetes mellitus. A similar study by Isezuo and Ezunu [20] in Nigeria among type 2 diabetic patients produced a prevalence of 20.5%. These are not a population based study and are likely to give a higher prevalence. In all these studies the MS was more prevalent in obese individuals with central obesity appearing to be the key determinant. Ghanaians generally associate fatness with beauty and wellbeing especially in females and it is not surprising that the prevalence of the females far exceeds that of males. This indicates the tendency for females in the metropolis to develop metabolic syndrome.

	Frequency	%	Met. Syn.	Hypertensive	Diabetic	IFG
Underweight Below 18.5 kg/m²	19	4.90	0	4	1	1
Normal or Ideal 18.5 – 24.9 kg/m²	188	48.60	3	40	7	20
Overweight 25.0 – 29.9 kg/m²	90	23.25	9	32	2	20
Obese ≥30.0 kg/m²	90	23.25	19	48	11	14

Table 7: Body Mass Index (BMI) classification of the study population .

Age Group (years)	Underweight			Normal			Overweight			Obese		
	Freq.	M	F	Freq.	M	F	Freq.	M	F	Freq.	M	F
18 – 25	**4**	3	1	**38**	21	17	**5**	1	4	**2**	0	2
26 – 33	**4**	1	3	**36**	15	21	**14**	2	12	**15**	1	14
34 – 41	**4**	2	2	**42**	21	21	**24**	7	17	**18**	2	16
42 – 49	**6**	2	4	**31**	14	17	**18**	6	12	**30**	2	28
50 – 57	**1**	1	0	**21**	7	14	**17**	5	12	**13**	1	12
58 – 65	**0**	0	0	**10**	3	7	**5**	0	5	**5**	1	4
> 65	**0**	0	0	**10**	2	8	**7**	0	7	**7**	0	7
	19	9	10	**188**	83	105	**90**	21	69	**90**	7	83

Table 8: BMI and age group.

	Frequency	%	Met. Syn.	Hypertensive	Diabetic	IFG
Ideal or Normal Female ≤ 0.80	68	25.5	4	12	3	6
Males ≤ 0.95	111	92.5	2	20	4	15
Moderate Risk Female 0.81 – 0.85	45	16.9	1	11	1	4
Male 0.96 – 1.00	3	2.5	0	1	0	1
High Risk Female > 0.85	154	57.7	24	80	13	29
Male > 1.00	6	5.0	0	0	0	0
Total	387		31	124	21	55

Table 9: Waist-to-Hip Ratio (WHR) classification of the study population.

Age Group (years)	Normal			Low Risk			High Risk		
	Freq.	M	F	Freq.	M	F	Freq.	M	F
18 – 25	**39**	23	16	**5**	1	4	**5**	0	5
26 – 33	**35**	19	16	**9**	0	9	**25**	1	24
34 – 41	**44**	30	14	**9**	0	9	**35**	2	33
42 – 49	**34**	22	12	**17**	2	15	**34**	0	34
50 – 57	**19**	12	7	**4**	0	4	**29**	3	26
58 – 65	**5**	3	2	**1**	0	1	**14**	0	14
> 65	**3**	2	1	**3**	0	1	**18**	0	18
	179	111	68	**48**	3	45	**160**	6	154

Table 10: Waist-to Hip Ratio and age group.

	Frequency	%	Hypertensive	Diabetic
Ideal or Normal Female < 35 in	104	39.0	22	3
Male < 40 in	112	93.3	17	4
High Risk Female ≥ 35 in	163	61.0	82	14
Male ≥ 40 in	8	6.7	3	0
Total	387		124	21

Table 11: Waist Circumference (WC) classification of the study population.

	Frequency	Percentage (%)
Males	1	0.8
Females	15	5.6
Total	16	4.1

Table 12: Individuals with both Hypertension and Diabetes.

Age Group (years)	Normal (<5.2mmol/L)			Low Risk (5.2-6.2mmol/L)			High Risk (>6.2mmol/L)		
	Freq.	M	F	Freq.	M	F	Freq.	M	F
18–25	25	14	11	5	3	2	1	0	1
26–33	37	9	28	9	2	7	3	1	2
34–41	37	13	24	16	5	11	13	5	8
42-49	32	11	21	15	4	11	9	1	8
50- 57	16	5	11	6	2	4	9	2	7
58- 65	6	2	4	4	0	4	4	1	3
> 65	6	0	6	4	0	4	8	2	6
Total	**159**	**54**	**105**	**59**	**16**	**43**	**47**	**12**	**35**

Table 13: Cholesterol classification of the study population.

In most parts of the world, there is an increasing trend of obesity [21]. The mean BMI, waist circumference and waist-to-hip ratio for this study were 25.85 ± 5.89 kg/m^2, 35.41 ± 4.93 inches and 0.86 ± 0.11 respectively. These values are similar to that reported in a section of the Ghanaian population by Amoah [22]. A similar study carried out by Alebiosu and Odusan [23] in Nigeria reported a mean BMI of 25.5 ± 5.4, which is similar to ours. Table 11 shows that 77.4% of individuals with metabolic syndrome were in the high risk category of WHR with 25.8% being in the normal group. There were 19 individuals representing 61.3% with metabolic syndrome who were obese according to BMI classification with 9.7% being normal (Table 7). Fezeu et al. [24] concluded that central obesity was more tightly associated with components of the metabolic syndrome than other obesity indices. This is in conformity with our findings and other reports on the use of WC instead of BMI as a factor of metabolic syndrome.

Essential hypertension and type 2 diabetes share certain common predisposing risk factors, for example overweight and obesity, resulting from the effects of a sedentary lifestyle, excessive consumption of refined carbohydrate and fatty foods, increased alcoholic consumption and cigarette smoking. MS is characterized by obesity, hyperlipidaemia, hyperinsulinaemia and insulin resistance, hypertension and glucose intolerance and clearly demonstrates a possible common aetiologic basis for type 2 diabetes and essential hypertension (Table 12).

Ghanaians also appear to be taking exercise less regularly. In the past, people walked long distances (sometimes miles) to work and to school. Nowadays, more and more Ghanaians are walking less frequently and are using a *tro* (cheap means of public transport in the city) or car at the slightest opportunity, sometimes for journeys of less than a quarter of a mile. In addition, many more families now own a car and so are more likely to drive than walk. Most homes now have television with at least three channels that offer 12 to 18 hours' viewing a day. Even individuals who do not have television in their homes will often congregate around television sets belonging to their neighbors. In the 1960s, television was very uncommon in most homes; homes with television had only one channel that was available at 18.00 in the evening to 22.00 at night. The stage is thus set for an obesity epidemic in Ghana.

In about 10 years the rate of obesity in Ghanaians has increased several times, from less than 1% to 14% [25]. It has been observed that an increase in the prevalence of obesity within a population is often noted before a rise in the occurrence of chronic non-communicable diseases such as diabetes, hypertension, stroke, coronary artery disease and some forms of cancer [26]. With the increasing rate of obesity, the stage is thus set for non-communicable diseases to emerge and threaten the health of Ghanaians. Already we are seeing an increase in the prevalence of some of these diseases.

Besides the high degree of obesity, there were clear relationships between BMI and multiple cardiovascular risk factors and comorbidities, consistent with the 1998 WHO recommended BMI cut-off value of ≥ 25 kg/m^2 for overweight [7]. The data showed that a BMI of ≥ 25 kg/m^2, a WC of ≥ 35 inch in females and ≥ 40 inch in males, WHR of ≥ 0.85, were associated with increased health risks. This study therefore independently support the recent WHO/IASO/IOTF suggestion to consider using lower obesity measurements in Asian and other places to guide health care professionals to promote healthy lifestyles and weight control [7].

In view of the non-random nature of the selection, our findings may not be generalized easily. Given the small sample size, and the fact that the sample subjects were all members of a Penteco-Charismatic church where smoking and alcohol intake are preached against in the presence of regular fasting sessions. Nonetheless, in this cohort of Pentecost Charismatic Ghanaian subjects with an age-range of 18–85 years, the similar increasing trends of cardiovascular risk factors and comorbidities across ascending BMI, WC, and WHR categories were generally observed (Table 13). Despite these limitations, our data still support the continuous relationship between morbidities and BMI, WC, and WHR.

The association with parameters of body composition may be strong for some metabolic risk factors but weak for others. While there is a close association between WC and blood pressure (systolic and diastolic), these associations are weaker for total cholesterol and blood sugar (Table 14). Additionally, different aspects of body composition may affect different types of risk factors. For example, central obesity (WC) is less closely related to fasting blood sugar and total cholesterol than general obesity in this study (Table 15).

A major component of the Metabolic Syndrome is altered lipid metabolism. Specifically, patients with the metabolic syndrome manifest high serum triglycerides and low HDL concentrations while serum cholesterol tends to be normal [22]. In this study, the serum cholesterol concentrations were measured in an attempt to find if it has any link to metabolic syndrome in place of triglycerides. The mean serum cholesterol was 5.58 ± 8.6 mmol/L for the study. Table 14 shows

	Frequency	(%)	Metabolic Syndrome Frequency and (%)
Normal <5.2 mmol/L	159	60.0	9 (29.0)
Low Risk 5.2 – 6.2 mmol/L	59	22.3	10 (32.3)
High Risk >6.2 mmol/L	47	17.3	4 (12.9)

Table 14: Cholesterol classification and metabolic syndrome.

	Age	Weight	Height	WC	HC	BMI	WHR
Age	-	0.35**	0.52**	0.48**	0.22*	0.52**	0.52**
Weight	0.12*	-	0.41**	0.82**	0.62**	0.65**	0.41**
Height	-0.10	0.28**	-	0.31**	0.11	0.93**	1.00**
WC	0.32**	0.83**	0.13*	-	0.55**	0.53**	0.31**
HC	0.10	0.81**	0.17**	0.75**	-	0.34**	0.10
BMI	0.14*	0.77**	-0.38**	0.70**	0.65**	-	0.93**
WHR	0.40**	0.20**	0.00	0.51**	-0.18**	0.21**	-

*. Correlation is significant at the 0.05 level (2-tailed).
**. Correlation is significant at the 0.01 level (2-tailed).

Table 15: Pearson correlation coefficients between anthropometric variables and age for women (lower left-hand side) and men (upper right-hand side).

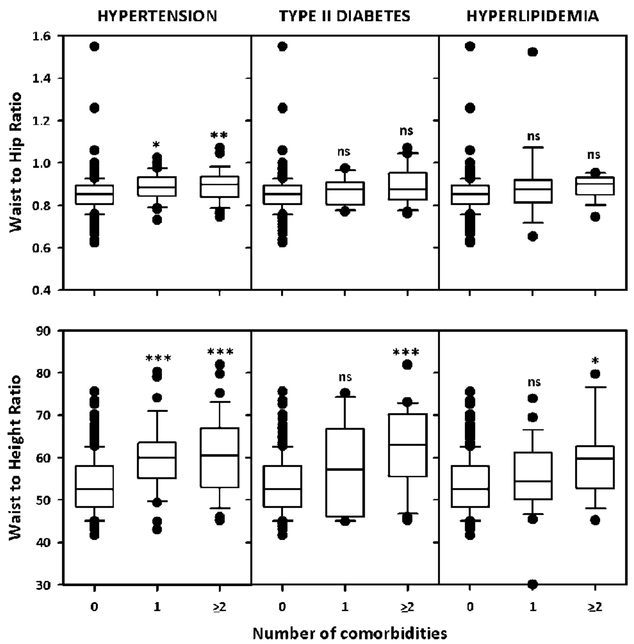

Figure 3: WHR, WHtR and Comorbidities.

the data on metabolic syndrome and serum total cholesterol, 29.0% of those individuals with metabolic syndrome had normal serum cholesterol with 12.9% being in the high risk category. There were 32.3% with low risk cholesterol values whiles for 25.8% of the subjects, the cholesterol concentration was not estimated.

Even though females formed the bulk of the data it may be inferred that females are of greater risk when it comes to this syndrome. Tables 7 and 8 adds more value to this analysis as from Table 7 out of the 31 with metabolic syndrome 19 were obese with 17 of them being females and only 2 being males. The link between BMI and metabolic syndrome can be said to be strong as out of the 31 with metabolic syndrome 28 had their BMI above the cut-off point for being considered normal with 26 of them being females.

With reference to the WHR, out of the 31 metabolic syndrome cases 6 were individuals with normal or ideal WHR with 4 and 2 being females and males respectively. There was only 1 female with the syndrome that had a moderate risk WHR. One striking result here is that of the 2 metabolic syndrome males they all had a normal WHR whiles 24 females had a high risk WHR with metabolic syndrome. This still buttresses the point that females in Kumasi are at an increased risk of developing this syndrome. This may be due to the fact that most women in this part are either house wives or traders with very little physical activity (Figure 3).

Diabetes mellitus and hypertension have become a major public health problem in Ghana because of reported increase in its prevalence [4,27]. Most patients with one or both of the disorder have a markedly worsened risk for premature microvascular and macrovascular complications [5]. This study contributes important information on the prevalence of diabetes mellitus and hypertension in our society. Hypertension, type 2 diabetes mellitus and obesity are clinical features with a multifactoral and complex pathophysiology [12].

According to the WHO a number of prospective, cross sectional and case-control studies suggest that a preponderance of abdominal fat might increase the risk of type 2 diabetes mellitus and hypertension. Although the relationship of obesity with hypertension and diabetes is not completely clear, it is well known that excess fat leads to increased insulin resistance [12] and that insulin resistance predisposes to diabetes. Most of these assertions about the role of obesity are based on overall fatness. However, it is clear that various regional fat distributions may have different metabolic implications. However studies on the association of risk factors, especially those related to body mass index (BMI), waist-to-hip ratio (WHR) and waist circumference (WC) with diabetes and hypertension are limited for Ghanaians.

Hypertension was defined as BP ≥ 140 and/or ≥ 90 mm Hg or being on hypertensive drug therapy. The study revealed a total hypertension prevalence of 32.0% of the 387 persons for the study. The prevalence for systolic hypertension was 27.6% whiles that of diastolic was 25.6%. This corresponds to a figure of 124 persons in which 104 representing 83.9% were females whiles 20 representing 16.1% were males. The overall hypertension prevalence of 32.0% corresponds to that reported by Ohene et al. [4] (prevalence of 35% in the age group of 40-55).

In relation with BMI (Table 7), out of the 124 with high blood pressure a total of 80 representing 64.5% had a BMI above the cut of point of 24.9kg/m^2. Out of this 32 were overweight (BMI of 25.0-29.9 kg/m^2) representing 25.8% with 48 representing 38.7% were obese (BMI of above 30.0 kg/m^2). 32.3% of persons with high blood pressure had an ideal or normal BMI of between 18.5 and 24.9 kg/m^2 whiles 3.2% were hypertensive yet were underweight (BMI below 18.5 kg/m^2). This confirms that obesity and overweight contributes significantly to the increased prevalence of hypertension.

Of the 124 with high blood pressure only 41 representing 33.1% knew of their condition and that 66.9% were unaware that they had the condition, this corresponds to a WHO report [3] that indicates that between 60-90% of hypertension is undiagnosed until complications sets in.

WHR showed a prevalence of 74.2% (92 individuals) of the hypertensive whose WHR were above the ideal or normal range of below 0.81 for females and below 0.96 for males. There were 32 representing 25.8% whose WHR were within the ideal value yet still had a high blood pressure. This finding also buttresses the fact that overweight and obesity contributes to the increased incidence of hypertension.

Diabetes predisposes an individual to hypertension and vice versa and in this study there were a total of 16 persons representing 4.1% who had both conditions. This was made up of 15 females (5.6%) as compared to 1 male (0.8%). Figure 4 shows the various age groups in association with both hypertension and diabetes. The highest age group with both conditions was those above 65 years of age with those below

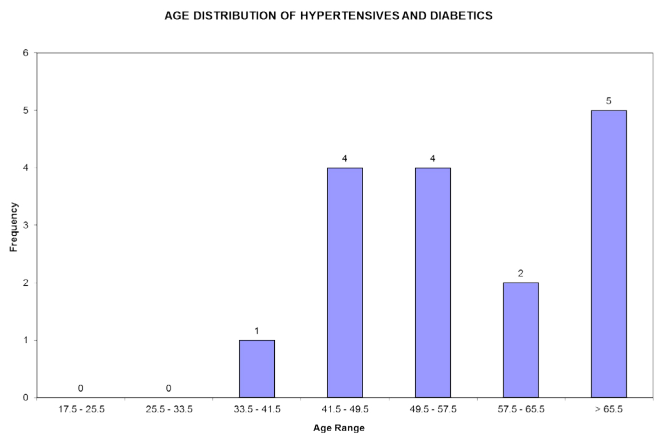

Figure 4: Age distribution of hypertensives and diabetics.

34 years recording zero in the study. The coexistence of these two non-communicable diseases in the over 65 year age group may be attributed to poor management probably resulting from loss of income due to retirement. This trend may hopefully be reversed if the National Health Insurance Scheme becomes well entrenched.

An investigation of diabetes mellitus is suggested when the fasting blood glucose level is 6.1 mmol/L or more and/or random blood glucose taken 2 hours after a meal or 75 g glucose load (1.75 g/kg body weight in children) [29] is 10.0 mmol/L or more.

Using the WHO criteria the data on fasting blood glucose was divided into three categories of Diabetic, Impaired Fasting Glucose (IFG) and Normal subjects. The mean FBS of the study population was 5.00 ± 1.66 mmol/L with the prevalence of diabetes for the study being 5.4% (Table 8). This 5.4% prevalence represents 21 diabetics with 81% [17] being females whiles 19% [4] were males. As shown in Table 8 the prevalence for males and females were 3.3% and 6.4% respectively. 55 individuals had impaired fasting glucose representing 14.2% with the prevalence for males and females being 13.3% and 14.6% respectively (Table 6). There were 311 normal individual representing 80.4%.

In the late 1950s, the prevalence of diabetes was estimated at 0.2–0.4% in urban areas in Ghana [28]. In a recent study the prevalence of type 2 diabetes in adult Ghanaians from the city of Accra and its environs was 6.3% [29]. In this study, the prevalence of type 2 diabetes among the study population was found to be 5.4%. Although this prevalence rate was not directly comparable as a result of different sampling methods, they were in accordance with the rising trend of diabetes in our population. With the overall prevalence of 5.4% whiles females had a prevalence of 6.4% and males with 3.3% indicates a reduction in the male prevalence whiles that of females showed an increase. This indicates that females are at increase risk as compared to males, which can be attributed to the sedentary lifestyle with very little physical activity with increase westernization among females. A cross-sectional, diagnostic study undertaken by Soma and Rheeder [30] in Pretoria Academic Hospital found the overall incidence of diabetes to be 11.7%. Our study prevalence is low compared to this basically because ours is a population base study whiles that of Soma and Rheeder was done on in-patients.

The age group of 42-49 years had the highest incidence of diabetes mellitus with 28.6% of the overall diabetics. This was followed by those above 65 years as shown in Figure 4 with those between the ages of 18-25 and 26-33 having a percentage of 4.8% and 4.8% respectively. This shows a general increase in diabetes with increasing age.

Out of the 21 (5.4%) with diabetes only 5 representing 24% knew of their status and this really confirms the assertion that a lot of people were unaware of their diabetic status and will only get to know when symptoms and signs appears. And this contributes to the high incidence of its complications and difficulty in management.

11 of the diabetics representing 52.4% had a BMI of above 30.0 kg/m^2 i.e. obese with 9.5% being overweight (BMI of 25.0-29.9 kg/m^2). In all 61.9% of those with diabetes had a BMI above the cut off value for an ideal or normal person i.e. BMI above 24.9 kg/m^2. 33% of the diabetic subjects had a normal or ideal BMI. This finding also confirms the assertion that overweight and obesity are contributory to the high incidence of non-communicable diseases.

Table 11 shows the relationship of diabetes with WHR. There were a total of 14 respondents with diabetes representing 66.7% whose WHR is considered as high risk or above the ideal or normal WHR. This was made up of 1 person in the moderate risk category with 13 being in the high risk category. However there were 7 respondents representing 33.3% of the diabetics with an ideal WHR.

From Table 9 it is observed that a total of 34 persons with IFG were having a BMI of above 24.9 kg/m^2 i.e. the ideal BMI representing 61.8%. This is made up of 20 persons for overweight and 14 persons for obese. 20 individuals in this group had a normal BMI alongside having an IFG representing 36.4% whiles there was 1 person with IFG and being underweight with a BMI of below 18.5 kg/m^2.

A total of 34 persons with IFG had a WHR above the ideal value representing 61.8% with 14.7% being in the moderate risk category (WHR of 0.81-0.85 for females and 0.96-1.00 for males) whiles 85.3% were in the high risk category (Table 11). There were a total of 21 individuals with IFG representing 38.2% who had a normal WHR. There is not much difference with IFG and BMI on one hand and IFG and WHR on the other as both had a predictive percentage of 61.8%.

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