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Research article

The correlation between obesity and other cardiovascular disease risk factors among adult patients attending a specialist clinic in Kumasi. Ghana

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Abstract: Background: Obesity is a complex and multifactorial disease marker, which has become a major threat to cardiovascular health. We sought to assess the correlation of obesity and other cardio-metabolic risk factors in patients seen at the outpatient specialist clinic in Ghana. **Methods:** A prospective cross-sectional study was conducted on 395 patients at Precise Specialist Clinic in Kumasi, Ghana. A standardized questionnaire was used to obtain demographic, anthropometric and clinical data of patients. Fisher's exact test for statistical significance at a 95% confidence interval was used to evaluate associations between categorical variables. The associations between obesity indices and cardiovascular disease risk factors were analyzed by Pearson's correlation. **Results:** Of the 395 participants, 187 were males and 208 were females. The mean (± standard deviation) age of study participants was 59.29 (± 13.93); more than half of the participants were between 50 and 69 years. The mean BMI of male participants was significantly lower than the mean BMI of female participants (28.18 kg/m^2 vs 31.16 kg/m^2, *P-value* < 0.0001). Gender was significantly associated with the weight categories ($P = 0.0144$). Obesity was seen more in females (49.0%) than in males (35.8%). The Pearson correlation analysis also showed a significant positive correlation between obesity, increasing systolic blood pressure ($r = 0.1568$, *P-value* = 0.0018) and increasing diastolic blood pressure ($r = 0.2570$, *P-value* < 0.0001). **Conclusions:** Obesity was found to be significantly associated with female gender, increasing age, increasing systolic blood pressure, and increasing diastolic blood pressure. Efforts to step-up preventive measures to reduce the increasing prevalence of obesity in Ghana are highly recommended.

Keywords: obesity; overweight; cardiovascular risk factors; blood pressure; dyslipidaemia cardiovascular diseases

1. Introduction

Overweight and obesity are complex and multifactorial disease marker, which has become a major threat to cardiovascular health in both economically endowed and less economically endowed countries of the modern world [1,2]. The World Health Organisation (WHO) defines overweight as a body mass index (BMI) $\geq$ 25 kg/m^2; and obesity as a BMI $\geq$ 30 kg/m^2 [3]. Raised BMI is a major risk factor for cardiovascular diseases (CVD) which remains the leading cause of death globally [4]. The increasing proportion of overweight and obesity in youth and adult life is likely to result in a high burden of obesity-mediated cardiovascular diseases worldwide.

Accordingly, the increasing emergence of overweight and obesity and its cardio-metabolic diseases may be stemming from increasing urbanization and unhealthy lifestyles, which in turn has led to the emergence of a nutrition transition characterized by a shift to a higher calorie diet [5,6] This epidemic of obesity is paralleled by an alarming increase in the incidence of non-communicable comorbidities such as CVD and other chronic diseases such as type 2 diabetes mellitus, chronic kidney disease and many cancers [7–10]. Indeed, the risk factors that have been investigated and commonly recognized as also contributing significantly and independently to the global increase of overweight and obesity include hypertension, type 2 diabetes mellitus and dyslipidemia. However, several of the CVD risk factors are linked to each other, for example, physical inactivity contributes to overweight, which is a major risk factor for developing hypertension and type 2 diabetes mellitus.

In sub-Saharan African countries such as Ghana, the trend in overweight and obesity is increasing as excess weight is often considered to reflect healthy living, prestige, and affluence whilst the lean are perceived to be unhealthy or financially handicapped [4–6]. The work done by Ofori-Asenso et al is of particular interest for our knowledge of current trends in obesity-related disease incidence, and potentially also of what to expect in the future with increasing numbers of overweight and obesity among Ghanaian adults [11].

The increasing burden of overweight and obesity is a key risk factor and cardio-metabolic diseases in Ghana. Indeed, the high and rising burden of overweight and obesity should be relevant to nutritional scientists, health workers and the government of Ghana due to the impact on health and a high propensity of an explosion of chronic diseases such as metabolic syndrome, heart failure and stroke [3,11,12].

Numerous studies have shown a relationship between obesity and other cardiovascular disease risk factors. However, a regional-based evaluation of the relationship between obesity indices and cardio-metabolic risk factors is recommended, due to the regional variations observed by previous studies [13]. To provide current data and to support evidence-based policymaking, this study was done to determine the correlation between obesity and other common cardio-metabolic risk factors in Ghana.

2. Materials and methods

A prospective cross-sectional study was conducted at the Precise Specialist Clinic, which provides specialist medical and cardiac healthcare for adults in the Kumasi metropolitan of Ghana. Out-patients aged 18 years and above who presented at the clinic over a period of three (3) months were approached for voluntary participation.

We excluded children, patients on cancer treatment, and patients with congenital heart diseases. A Standardized questionnaire was used in obtaining the socio-demographic characteristics, disease history and physical examination findings of all the study participants. History of cardio-metabolic risk factors such as hypertension, type 2 diabetes mellitus, and dyslipidemia were also obtained.

Body weight and height were measured with light clothes and bare feet using a combined weighing scale and stadiometer. Blood pressure was measured using the OMRON M6 devices with appropriate cuff sizes. Three blood pressure readings were taken from the left arm, with participants in the sitting position after a 10-minutes rest. The mean of the recorded readings was taken as the participant's blood pressure. Venepuncture was done from the antecubital veins in a recumbent position on all the participants, and 10mls of blood was collected into appropriate bottles for the determination of fasting blood glucose and lipid profile using an auto-analyzer at the biochemistry laboratory.

Hypertension was defined as the presence of a persistent elevated systolic blood pressure ≥140 mmHg and/or diastolic blood pressure ≥90 mmHg in patients aged 15 years and above, and/or the presence of hypertensive retinopathy and/or the use of antihypertensive drugs and/or past medical history of hypertension [12]. Diabetes mellitus was defined as a random blood glucose level of 11.1 mmol/L or greater, and/or fasting blood glucose level of 7.0 mmol/L or greater and/or use of insulin or an oral hypoglycemic agent [13]. Dyslipidemia was defined as low levels of high density lipoproteins (HDL) cholesterol (men ≤1.036 mmol/L, women ≤1.295 mmol/L) and/or high levels of low density lipoproteins (LDL) cholesterol ≥3.0 mmo/L and/or hypertriglyceridaemia ≥1.7 mmol/L [14]. Obesity/overweight was determined using the body mass index (BMI). The BMI was calculated as the weight of patients in kilograms divided by the square of the height in meters. Obesity and overweight were defined as a BMI ≥ 30 kg/m^2, and a BMI ≥ 25 kg/m^2 but <30 kg/m^2 respectively [3].

2.1. Ethical consideration

Ethical approval (CHRPE/336/21) for the study was obtained from the Committee on Human Research, Publication and Ethics, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana. Informed consent was also obtained from all the study participants.

2.2. Statistical analysis

Data from the standardized questionnaire were entered into a Microsoft Excel (2016) sheet. Data were cleaned and abnormal variables and wrong entry removed or changed. Data were then exported into SPSS version 25.0 software and GrapPad Prism version 8.0 for statistical analysis. A descriptive analysis of baseline parameters was provided. Measure of central tendency using the mean was calculated, and measure of spread using standard deviation and range were also calculated. For all categorical valuables, bivariate analysis was done using Fisher's exact test for statistical significance. Pearson's correlation analyses were employed to determine the relationship between obesity indices and other cardiovascular risk factors. For all analyses *P*-values less than 0.05 were considered statistically significant.

3. Results

3.1. Sociodemographic, anthropometric and cardiovascular risk factors of study participants stratified by gender

Table 1 shows the sociodemographic, anthropometric and cardiovascular risk factors of the study participants stratified by gender. Of the 395 participants, 187 were males and 208 were females. The mean (± standard deviation) age of study participants was 59.29 (± 13.93); more than half of the study participants were between 50 and 69 years. Three-quarters (75.5%) of the study population were either overweight or obese. The mean BMI of male participants was significantly lower than the mean BMI of female participants (28.18 kg/m^2 vs 31.16 kg/m^2, $P < 0.0001$). Gender was significantly associated with the weight categories ($P = 0.0144$). Obesity was seen more in females (49.0%) than in males (35.8%). The prevalence of type 2 diabetes mellitus (DM) was higher in the female population (26.9%) than the male population (17.6%), with a significant association between DM and the participant's gender ($P = 0.0276$). HDL-C level was significantly associated with the gender of participants ($P = 0.0193$), with the proportion of females having a low HDL-C level (23.6%) being higher than that of the males (12.3%).

Table 1. Sociodemographic, anthropometric and cardiovascular risk factors of study participants stratified by gender.

Variables	Total (n = 395)	Male (n = 187)	Female (n = 208)	Statistics	*P*-value
Mean age (Years)	59.29 ± 13.93	57.98 ± 13.81	60.6 ± 14.09		0.0619
24–39	40 (10.1)	21 (52.5)	19 (47.5)		
40–49	55 (13.9)	29 (52.7)	26 (47.3)		
50–59	101 (25.6)	52 (51.5)	49 (48.5)		
60–69	107 (27.1)	48 (44.9)	59 (55.1)		
70–79	71 (18.0)	29 (40.8)	42 (59.2)		
80–89	21 (5.3)	8 (38.1)	13 (61.9)		
Mean SBP (mmHg)	130.1 ± 19.36	131.3 ± 19.21	129.2 ± 20.71	t = 0.7534	0.4519
Mean DBP (mmHg)	80.0 ± 12.41	80.1 ± 12.32	79.96 ± 12.61	t = 0.0819	0.9348
Mean BMI (kg/m^2)	29.67 ± 5.84	28.18 ± 5.289	31.16 ± 7.618	t = 4.459	**<0.0001**
BMI status				8.483, 2	**0.0144**
Normal weight	97 (24.6)	56 (57.7)	41 (42.3)		
Overweight	129 (32.7)	64 (49.6)	65 (50.4)		
Obese	169 (42.8)	67 (39.6)	102 (60.3)		
TG	1.15 ± 0.45	1.15 ± 0.44	1.15 ± 0.52	t = 0.0290	0.9769
HDL-C	1.35 ± 0.46	1.29 ± 0.42	1.41 ± 0.51	t = 1.848	0.0659

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Variables	Total (n = 395)	Male (n = 187)	Female (n = 208)	Statistics	*P*-value
LDL-C	2.96 ± 1.05	2.84 ± 1.09	3.07 ± 1.26	t = 1.395	0.1645
TC	4.72 ± 1.21	4.63 ± 1.24	4.80 ± 1.20	t = 0.6946	0.4885
TG levels				0.2516, 1	0.6160
High	33 (8.4)	17 (51.5)	16 (48.5)		
Desirable	362 (91.6)	170 (47.0)	192 (53.0)		
HDL-C level				5.474, 1	**0.0193**
Low	72 (18.2)	23 (31.9)	49 (68.1)		
Desirable	349 (88.4)	164 (47.0)	185 (53.0)		
Dyslipidaemia				0.1515, 1	0.6971
Yes	47 (11.9)	21 (44.7)	26 (55.3)		
No	348 (88.1)	166 (47.7)	182 (52.3)		
HTN				3.530, 1	0.0603
Yes	241 (61.0)	105 (43.5)	136 (56.4)		
No	154 (39.0)	82 (53.2)	72 (46.8)		
DM				4.854, 1	**0.0276**
Yes	89 (22.5)	33 (37.1)	56 (62.9)		
No	306 (77.5)	154 (50.3)	152 (49.7)		

Note: *P*-value: Probability value; SBP: Systolic blood pressure; DBP: Diastolic blood pressure; BMI: Body mass index; TG: Triglycerides: HDL-C: High density lipoprotein cholesterol; LDL-C: Low density lipoprotein cholesterol; TC: Total cholesterol; HTN: Hypertension; DM: Type 2 diabetes mellitus.

3.2. Prevalence of hypertension and type 2 diabetes mellitus in participants with normal weight, overweight and obesity

Table 2 shows the prevalence of hypertension and DM in participants with normal weight, overweight and obesity. Hypertension was significantly associated with the weight categories (P = 0.0001) with 74.6% of obese patients and 53.5% of overweight patients having a history of hypertension. DM was not significantly associated with the weight categories with only 20.9% of DM patients being overweight and 25.4% of DM patients being obese. Systolic blood pressure (SBP) increased with an increasing BMI (P = 0.0443), with obese individuals having the highest SBP (Table 2). Diastolic blood pressure (DBP) also shows a significant elevation as the BMI increased ($P < 0.0001$).

Table 2. Prevalence of hypertension and diabetes in healthy weight, overweight and obese categories.

Variables	Normal (n = 97)	Overweight (n = 129)	Obese (n = 169)	Statistics	*P-value*
Mean age	61.66 ± 16.32	58.16 ± 13.42	58.81 ± 12.93	*F,* 1.91	0.1494
Age range n (%)				χ22.40,10	**0.0132**
34–39	14 (14.4)	13 (10.1)	13 (7.7)		
40–49	6 (6.2)	19 (14.7)	30 (17.8)		
50–59	19 (19.6)	38 (29.5)	42 (24.9)		
60–69	23 (23.7)	33 (25.6)	50 (29.6)		
70–79	23 (23.7)	19 (14.7)	28 (16.6)		
80 and above	12 (12.4)	7 (5.4)	6 (3.6)		
Gender n (%)				χ8.483, 2	**0.0144**
Male	56 (57.7)	64 (49.6)	67 (39.6)		
Female	41 (42.3)	65 (50.4)	102 (60.4)		
SBP	125.3 ± 22.48	129.7 ± 20.64	132 ± 20.64	*F,* 3.141	**0.0443**
DBP	75.19 ± 12.37	81.09 ± 12.80	82.51 ± 11.32	*F,* 11.78	**<0.0001**
History of HTN n (%)				χ17.92, 2	**0.0001**
Yes	49 (50.5)	69 (53.5)	126 (74.6)		
No	48 (49.5)	60 (46.5)	43 (25.4)		
History of DM n (%)				χ1.487, 2	0.4753
Yes	18 (18.6)	27 (20.9)	43 (25.4)		
No	79 (81.4)	102 (79.1)	126 (74.6)		

Note: *P*-value: Probability value; SBP: Systolic blood pressure; DBP: Diastolic blood pressure; HTN: Hypertension; DM: Type 2 diabetes mellitus.

3.3. Prevalence of dyslipidaemia in normal weight, overweight and obesity

Table 3 shows the lipid profile characteristics of participants. Mean triglyceride (TG) level, mean HDL-cholesterol (HDL-C), mean LDL-cholesterol (LDL-C) and mean total cholesterol (TC) were not significantly different among the 3 weight categories ($P > 0.05$). Obese patients had higher proportions of high TG levels (10.7%) and low HDL status (21.9%) as compared to overweight patients (9.3% and 20.2%) and normal weight patients (3.1% and 8.2%) respectively. Both TG level and HDL status were however not associated with patient weight category $P > 0.05$). Dyslipidaemia s was significantly associated with weight category ($P = 0.0104$) with higher proportions (30.2%) among the obese patients than the overweight patients (26.4%) and patients with normal weight (1.0%).

Table 3. Lipid profile Characteristics among outpatients.

Variables	Normal (n = 97)	Overweight (n = 129)	Obese (n = 169)	Statistics	*P*-value
TG (mmol/l)	1.04 ± 0.37	1.20 ± 0.56	1.16 ± 0.46	*F,* 1.326	0.2677
HDL-C (mmol/l)	1.42 ± 0.40	1.32 ± 0.45	1.36 ± 0.50	*F,* 0.5647	0.5647
LDL-C (mmol/l)	3.04 ± 1.19	2.84 ± 1.22	2.99 ± 1.17	*F,* 0.4892	0.4892
TC (mmol/l)	4.92 ± 1.19	4.65 ± 1.37	4.86 ± 1.35	*F,* 0.7191	0.4884
TG levels n (%)				χ2.061, 2	0.3568
High	3 (3.1)	12 (9.3)	18 (10.7)		
Desirable	94 (96.9)	117 (90.7)	151 (89.3)		
HDL-C status n (%)				χ3.213, 2	0.2006
Low	8 (8.2)	26 (20.2)	37 (21.9)		
Desirable	89 (91.8)	103 (79.8)	132 (78.1)		
Dyslipidaemia n (%)				χ9.125, 2	**0.0104**
Present	1 (1.0)	34 (26.4)	51 (30.2)		
Absent	96 (99.0)	95 (73.6)	118 (69.8)		

Note: *P*-value: Probability value; TG: Triglycerides; HDL-C: High density lipoprotein cholesterol; LDL-C: Low density lipoprotein cholesterol; TC: Total cholesterol.

3.4. Pearson correlation of BMI with lipid markers and blood pressure characteristics among the study participants

Table 4 shows the Pearson correlation of BMI with lipid markers and blood pressure characteristics among the study participants. BMI showed a significant positive correlation with systolic blood pressure (r = 0.1568, P = 0.0018), diastolic blood pressure (r = 0.2570, P < 0.0001). The correlation of BMI with total cholesterol, triglycerides, high density lipoprotein cholesterol and low density lipoprotein cholesterol was however not significant.

Table 4. Pearson correlation between BMI and lipid markers and blood pressure characteristics among study participants.

Pearson correlation	R	95% confidence interval	R squared	*P*-value
BMI vs. SBP	0.1568	0.0591 to 0.2516	0.0246	**0.0018**
BMI vs. DBP	0.2570	0.1624 to 0.3468	0.0660	**<0.0001**
BMI vs. TC	−0.0109	−0.1445 to 0.1231	0.0001	0.8736
BMI vs.TG	0.0364	−0.0985 to 0.1700	0.0013	0.5969
BMI vs. HDL-C	−0.0285	−0.1620 to 0.1060	0.0008	0.6787
BMI vs. LDL-C	−0.0085	−0.1427 to 0.1261	7.14E-05	0.9024

Note: *P*-value: Probability value; R: Pearson correlation coefficient; BMI: Body mass index; SBP: Systolic blood pressure; DBP: Diastolic blood pressure; TC: Total cholesterol; TG: Triglycerides; HDL-C: High density lipoprotein cholesterol; LDL-C: Low density lipoprotein cholesterol.

4. Discussion

This study provided a detailed finding of the correlation between obesity and other cardio-metabolic risk factors in an outpatient specialist clinic. Overweight or obesity is a strong risk factor for CVD and tends to be associated with other cardio-metabolic risk factors [15–17]. In this study, associations were identified between obesity and increasing age, female gender, increasing SBP and DBP. These findings are essential in aiding healthcare professionals and policymakers in healthcare planning and for improving healthcare services in Ghana and other sub-Saharan African countries.

A total of 395 patients (male 48% and female 52%) were recruited for the study. The findings of this study show that three-quarters (75.5%) of the adults who visited the clinic during the study period had high BMI and about 43% were classified as obese by the WHO definition [3]. The very high prevalence rate of overweight and obesity observed in this study compares well with the findings of similar studies by Cil et al. [18] and Kossaify et al. [19] who recorded 76% and 72% in their respective study populations. A recent systematic review reported that about 43% of the Ghanaian population is either overweight or obese [11], which is comparable to the prevalence rate worldwide.

Consistent with the findings of previous studies in other countries [20–22], this study found that the prevalence of obesity increased with age but started to decline at 70 years in women and at 60 years in men. Studies by Yusuf et al. [23] showed that after middle age, body fat accumulation began to increase with age and tended to accumulate in certain areas of the body. Although the pattern of body fat accumulation is similar in different countries, there are still some differences. Body fat percentages differ among countries depending on genetic factors, eating patterns, regular exercise, and other lifestyle habits [24]. Previous research work reported that weight gain in adulthood appears to increase the risk for colon cancer [25]. Valdes et al. [26] pointed out that obesity is not only related to shortened life expectancy, but also it accelerates aging. Therefore the promotion of healthy lifestyles in order to prevent weight gain is very essential.

It has been shown by previous studies that the gender effect on obesity varies from population to population, irrespective of the anthropometric measurement used for its assessment [27–29]. This study found that the female gender was strongly associated with obesity. This pattern is consistent with findings from a previous series by Ofori-Asenso et al. [11] and Abubakari et al. [30] in which the female gender was strongly related to obesity than their male counterparts. The higher prevalence of obesity among females than males shown in this study is also consistent with globally observed gender differences among obesity subjects [3].

Even though the reason for this gender difference is not immediately obvious, these differences might be due to the fact that females generally tend to gain weight as a result of the hormonal effect on the redistribution of body fat [27,28]. Furthermore, studies have documented that many Ghanaian communities show great admiration towards obese individuals [31,32]. Often overweight or large body size is regarded as a sign of "affluence" and women also tend to perceive this as signifying "good nutrition, healthy life, beauty and marital happiness" [33]. Needless to mention, among Ghanaian women, "plumpness" tends to be the culturally preferred body size seen as a symbol of well-being. Further epidemiological studies will be needed to fully elucidate the sex differences in the prevalence of obesity.

Overweight and obesity are major risk factors for the development of DM, and many epidemiological studies have suggested a progressive increase in the prevalence of DM with obesity [34]. Even though DM was not significantly associated with overweight and obesity, it was seen in 20.9% and 25.4% of overweight and obese individuals in this study. The absence of a correlation between overweight/obesity and DM in our study could be due to the sample size not being large enough to be empowered to detect a significant association.

Hypertension prevalence rates of 74.6% and 53.5% were seen among obese and overweight individuals respectively. A strong positive association between obesity and increasing SBP and DBP was found in this study using Pearson's correlation analysis. A variety of population studies have clearly established that obesity is strongly correlated with high blood pressure [16,17,35,36]. Poston et al. found that obesity was consistently related to high blood pressure, but not other CVD risk factors, in a cohort of 478 Missouri Valley firefighters [36]. Hypertension was demonstrated to be strongly associated with obesity in a study involving South African adolescents aged 13–17 years [37]. There is a strong established link between obesity and hypertension [16,38–41]; and hypertension has been found to be the main driver of CVD morbidity and mortality [41–43]. Studies have shown that obese individuals who are aged 65 years and above are more likely to be hypertensive compared with individuals aged 40 years or less [32].

The growing prevalence of obesity is increasingly recognized as one of the most important risk factors for the development of hypertension. Currently, hypertension is driving the high burden of CVD, and this is partly due to the increasing burden of the global obesity prevalence rate [3]. Several mechanisms have been postulated as potential explanations for the mechanisms contributing to the development of higher blood pressure in obese individuals. These include activation of the renin–angiotensin–aldosterone system, hyperinsulinemia, sympathetic stimulation, leptin resistance. stimulation of procoagulatory activity and endothelial dysfunction [44–47]. However, the exact mechanisms of the relationship between obesity and hypertension are still not fully understood.

Dyslipidemia is one of the most important causal risk factors for atherosclerotic vascular disease. Our study however did not show a positive association between obesity and dyslipidemia. In contrast with this study, epidemiologic studies establishing and describing the relationship between obesity and dyslipidemia are extensive and well documented [39,40,48]. Several studies have demonstrated the evidence of dyslipidemia as an important CVD risk factor; a major cause of atherosclerosis and adverse cardiovascular events [49,50]. Dyslipidemia acts synergistically with other risk factors, substantially increasing the risk of cardiovascular events. There is substantial evidence demonstrating that the trajectory of atherosclerotic vascular disease can be greatly improved by lowering blood lipid levels [50,51].

The authors acknowledge some limitations in this study. First, some potential confounding factors that were not obtained in our study might have affected the study's findings. Secondly, the study design was cross-sectional, and thus cannot determine causal relationships, though the sample was quite diverse and large enough.

Overall, the high and rising prevalence of obesity should be a major wake-up call for stakeholders including nutritional scientists and healthcare workers due to the impact on health and a possibility of an explosion of Cardio-metabolic risk factors and disease.

5. Conclusions

This study found a significant correlation between obesity and increasing age, female gender, increasing SBP, and increasing DBP, which are compendiums of key risk factors for cardiovascular events. Strategies including health promotion programs and lifestyle changes such as healthy eating and increased physical activity are highly recommended.

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Authors' contributions

All authors made a significant contribution to this study, whether that is in conception, study design, execution, data collection, data analysis and interpretation. All authors also took part in the drafting, revising, and gave approval for the publication of this manuscript.

Conflict of interest

The authors confirm that there are no conflicts of interest in this article's content.

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