Association Between Dietary Consumption, Anthropometric Measures And Body Composition Of Rural And Urban Ghanaian Adults; A Cross Sectional Study.

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Abstract

Background Overweight and obesity have become threats to public health in all regions across the globe including sub-Saharan Africa where prevalence used to be low. Policies to regulate the food environment and promote healthy food consumption look promising to reducing the prevalence obesity but in Ghana there is not enough data to elicit a policy response. This study assessed the association between dietary consumption, Body Mass Index (BMI) and body composition among rural and urban Ghanaian adults.

Methods This was a cross-sectional study involving 565 Ghanaian adults. Structured interviewer-administered questionnaires were used to collect information on socio-demographics. Dietary consumption was assessed using household food frequency questionnaire and 24-hour recall. Height, weight, BMI, waist circumference and body composition of all participants were determined. Mann Whitney U test was used to analyze differences in anthropometric measures, body composition and consumption among rural and urban participants. Principal component analysis was used to analyze household food frequency data. Chi-square was used to measure differences in obesity prevalence by community and gender. Multinomial logistic regression was used to model the risk factors associated with obesity.

Results The prevalence of overweight and obesity using BMI were 29.9 and 22.9 respectively. Use of waist circumference measurement resulted in the highest overall obesity prevalence of 41.5%. Prevalence of obesity was higher among females compared to males across all measures with the exception of visceral fat that showed no significant difference. Four different patterns were derived from principal component analysis. Vegetable convenience dietary pattern showed significant negative correlation with visceral fat (r=-0.142, p 0.002), body fat (r=-0.102, p 0.209) and BMI (r=-0.136, p 0.003). Multinomial logistic regression revealed that males (OR 21.968, CI 10.876-44.373, p-value < 0.001) and rural participants (OR 1.684, CI 1.039-2.729, p-value <0.05) had higher odds of being of normal weight.

Conclusion Prevalence of overweight and obesity continue to rise in Ghana, especially among females. Public education and screening as well as interventions that regulate the food environment and makes affordable and available healthy food options are needed to control the rise in obesity prevalence.

Background

Obesity is a major cause of cardiovascular and chronic diseases which contribute to about 71% of all global deaths [1]. Obesity continues to increase across all ages and regions all over the world and children are also an important risk group [2]. In sub-Saharan Africa where about 42% of the population live below the poverty line, prevalence of obesity continues to rise although a strong positive association has consistently been observed between socio-economic status and obesity [3]. Annually, about 2.8 million people die from overweight or obesity [1]. Once a problem of the developed world, obesity is now on the increase in developing countries and Ghana is no different. It is forecasted that by 2030, obesity will be more prevalent in developing countries [4] and Dake [5] projects prevalence among Ghanaian women aged 15–49 years to reach 15.1% by 2023. Developing countries are faced with a double burden of disease not only at country and community levels but also within households. This implies that in a household where adults are obese, it is possible to find undernourished children who struggle to achieve optimum growth z-scores for their age [1]. Stunting and wasting are risk factors for obesity in later years and this situation creates a cycle of malnutrition in the sub region [6].

Genetic susceptibility, high socio-economic status, excess caloric consumption among other factors predict obesity but the current transition and trend is mainly driven by increased caloric intake and reduced physical activity levels that are associated with urbanization coupled with lack of policies to control an obesogenic food environment [7, 8]. Urbanization leads to reduced consumption of healthy staples and an obesogenic food environment makes readily available cheaper priced energy dense foods [9]. Energy balance is key to the maintenance of body weight and consumption of more calories than what is utilized through metabolic and physical activities leads to weight gain. These excess calories, stored in the body as fat can impair proper health and function [10]. Additionally, inadequate intakes and deficiencies of micronutrients such as zinc are linked to obesity [11].

Consistently, studies have reported a higher prevalence of obesity among urban populations compared to rural ones. Part of this may be due to differences in physical activity levels, socio-economic status and food consumption patterns among rural and urban dwellers [12, 13]. Gender differences have also been observed with females been more susceptible than males. Parity is one factor that puts women at higher risk than men [14, 15].

Body mass index is the usual screening tool for determining obesity among populations [15]. Build-up of body fat positively correlates with total body mass and hence weight gain indices are used as determinants of body fat [16]. It however, has limitations of not been able to accurately predict adiposity [17]. BMI, when used in combination with other diagnostic tools such as waist circumference and Body Impedance Analysis (BIA) provides in-depth information about adiposity as well as presumed cardio-metabolic risk. Increased body fat is a prominent risk factor for type 2 diabetes, stroke, hypertension and heart disease [18, 19]. Combining these tools to screen for obesity among populations may reveal higher prevalence than what is reported by most studies.

In Ghana, some studies have been conducted within various populations to ascertain the prevalence of overweight and obesity but these studies have mainly focused on urban females [5,20]. Most of these studies have also been done in Greater Accra region which is the capital of Ghana. An example is the Women's Health survey which found a 62.2% prevalence of overweight and obesity among urban women living in Accra [20]. Few studies have assessed consumption patterns associated with obesity, compared rural and urban individuals as well as included body composition measurements. Assessment of all these parameters will provide more insight in to the obesity menace and consumption patterns associated with it.

The main aim of this study was to compare the prevalence of obesity among rural and urban dwellers using BMI, waist circumference and body composition measures and to determine consumption factors associated with obesity.

Methods

This was a cross-sectional study that involved the use of interviewer-administered structured questionnaires to collect information on socio-demographics. Sociodemographic data collected included age, sex and level of education. Weight, height, waist circumference and body composition measurements of all participants were taken. The height of each participant was entered in to the body composition analyzer which was used to measure the weight and other body components. BMI was generated from the weight and height measurement (weight in kilograms/ height in metres^2).

Study site

The study was conducted in two communities in the Ashanti region of Ghana; Ahodwo an urban community and Ejuratia a rural community. Data collection was done by visiting households within the selected communities

Sample size and sampling

The study involved a total of 565 participants. Systematic sampling was used to select households and any household member either male or female eighteen years and above was included. One household was randomly selected within each house. For each household, only one member was included and where there were both a male and a female who qualified, the male was selected to ensure gender balance as it was more difficult to find males in households. For the rural community after a random start, every third house qualified to be included in the study and every fifth house was chosen for the urban community. The difference in intervals was due to the smaller sample frame in the rural area compared to the urban area. Households who declined to participate in the study were excluded.

Dietary consumption

Twenty four-hour recall and household food frequency was used to collect information on food consumption. The household food frequency consisted of commonly consumed food groups with specific foods listed under each food group. Participants were also asked of any likely food under each of the food groups they had consumed that were not captioned. Participants were to indicate how often they consumed each food item. One twenty-four-hour recall was taken for each participant to assess previous day food consumption. Nutrient analysis template; a food composition table consisting of only Ghanaian foods was used to estimate nutrient intakes and dietary diversity from the 24-hour recall.

Body composition and anthropometric measurement

Participants were made to remove their footwear and put on light clothing prior to the taking of anthropometry. Height was taken using Seca stadiometre, model 213 with participants standing up right with feet together and hands at the sides. Weight and body composition were measured using the Omron body composition monitor, model HBF–514. Height, gender and age of participants were entered into the body composition monitor before participants were made to stand on it. This generated body composition results as well as BMI of participants. Body mass index (kg/m^2) was classified using WHO criteria for adults; < 18.5 underweight, 18.5–24.9 normal, 25–29.9 overweight and > 30 obese. Visceral fat of > 9% was definitive of central obesity and body fat cut offs were based on gender and age of participants as suggested by Gallager [19, 21]. Waist circumference was taken with a flexible tape measure. Central obesity was defined as waist circumference of >88cm for females and > 102cm for males.

Ethical clearance

Ethical clearance for the study was granted by the Council for Scientific and Industrial Research (CSIR), Ghana; RPN 011/CSIR-IRB/2017. Written permission was sought from local government officials before data collection and all participants signed an inform consent form to indicate voluntary participation.

Statistical Analysis

Statistical Package for Social Sciences (IBM SPSS) 23 was used for data analysis. Normality test revealed that data was positively skewed. Mann Whitney U test was used to compare the median age, body composition and nutritional intakes among rural and urban participants. Kruskal Wallis test was used to compare the median nutrient intakes among underweight, normal, overweight and obese participants. Spearman correlation was used to determine the relationship between BMI and body composition measures. Principal component analysis was used to determine the patterns of consumption. Multinomial logistic regression was used determine the predictors of obesity measured by waist circumference. Waist circumference was used because it determined the highest prevalence of obesity and strongly correlated positively with all other body composition measures. A p-value of < 0.05 was set as statistically significant.

Results

A total of 565 participants took part in the study; 292 from rural and 272 from urban. The median age of participants was 40(26) years and there was no statistical difference between rural and urban participants. The overall median body mass index of participants was 25.6(7.4) with urban dwellers recording a significant higher value. Visceral fat was also significantly higher for urban dwellers compared to rural participants. Calorie, carbohydrate and fibre intakes were significantly higher among rural participants while urban participant consumed higher vitamin A. Other nutrients did not show any significant difference. Table 1 shows socio-demographics, nutritional intake and body composition characteristics of study participants.

Table 1. Descriptive Statistics

DESCRIPTIVE VARIABLES	Total N=565	STATISTICS AND BALANCE CHECK		
		RURAL n=292 n(%)or Median(IQR)	URBAN n=272 n(%)or Median(IQR)	P-VALUE
Age	40(26)	40(26)	38(26)	0.737
Gender				
Male	113(19.8)	43(14.7)	70(25.7)	0.001*
Female	452(79.2)	249(85.3)	202(74.3)	
Level of Education				
No formal education	98(17.2)	60(21.4)	38(16.7)	<0.001*
Primary	50(8.8)	27(9.6)	23(10.1)	
Junior secondary	176(30.8)	120(42.9)	56(24.7)	
Senior secondary	132(23.1)	64(22.9)	66(29.1)	
Tertiary	53(9.3)	9(3.2)	44(19.4)	
Weight (kg)	65.9(20.2)	62.4(18.3)	69.9(20.65)	<0.001*
Height (cm)	159.3(9.83)	158.0(8.60)	160.5(11.2)	<0.001*
BMI (kg/m^2)	25.6(7.40)	25.0(6.7)	26.1(7.65)	0.016*
Waist circumference (cm)	87.4(19.80)	87.0(17.55)	89.0(22.0)	0.115
Muscle mass	26.9(6.13)	26.8(5.05)	27.0(6.95)	0.526
Body fat	35.7(15.22)	35.2(14.33)	36.9(16.35)	0.341
Visceral fat	7.0(4.0)	7.0(4.0))	7.0(5.0)	0.015*
Energy intake (Kcal)	1434.0(951.1)	1601.4(999.04)	1330.7(899.84)	0.004*
Fat (g)	42.5(44.08)	44.2(50.8)	41.0(39.2)	0.781
Protein (g)	42.6(32.5)	42.6(32.7)	42.9(33.06)	0.838
Carbohydrate (g)	208.0((137.0)	223.5(128.8)	187.9(137.6)	0.001*
Fibre (g)	18.3(13.3)	20.0(13.8)	16.9(13.5)	0.001*
Sugar (g)	29.6(41.4)	28.0(35.6)	33.9(50.04)	0.242
Folate (µg)	225.6(240)	234(241.2)	216.4(237.0)	0.222
Iron (mg)	9.2(6.6)	9.5(6.33)	8.8(6.8)	0.569
Zinc (mg)	5.92(4.7)	6.1(4.9)	5.7(4.7)	0.860
Vitamin B_{12} (µg)	1.76(3.2)	1.92(3.81)	1.73(2.64)	0.296
Vitamin A (µg)	120.6(139.8)	111.2(121.6)	128.8(165.3)	0.022*
Vitamin E (mg)	5.6(6.4)	5.6(6.4)	5.5(6.3)	0.658
Saturated fat (g)	12.2(15.3)	11.1(15.8)	13.1(14.6)	0.143
Monounsaturated fat (g)	14.7(18.3)	14.8(20.33)	14.7(17.0)	0.930
Polyunsaturated fat (g)	7.9(8.4)	8.37(9.17)	7.3(7.7)	0.285
Dietary diversity score	6.0(2.01)	6(3)	6(2.01)	0.118

Some variable responses were missing and therefore does not sum up to 565. *Significant at p-value <0.05

Using BMI, there was no difference in the prevalence of obesity among rural and urban participants. Visceral and body fat cut offs showed a higher prevalence of obesity in urban compared to rural participants. Prevalence of obesity by all parameters was higher among females compared to males with the exception of visceral fat that showed no difference. Table 2 and 3 show the prevalence of obesity by community and gender respectively.

Table 2. Prevalence of obesity by different parameters

Variable	Total	Rural n=292	Urban n=272	p-value
BMI				
Underweight	9(1.6)	5(1.7)	4(1.5)	0.110
Normal	247(43.3)	140(48.3)	104(39.4)	
Overweight	171(29.9)	87(30.0)	83(31.4)	
Obese	131(22.9)	58(20.0)	73(27.7)	
Visceral fat				
Normal	434(76.0)	246(85.1)	184(71.0)	<0.001*
Obese	118(20.7)	43(14.9)	75(29.0)	
Body fat				
Underweight	48(8.4)	29(10.0)	19(7.3)	0.023*
Normal	198(34.7)	117(40.3)	80(30.8)	
Overweight	130(22.8)	66(22.8)	64(24.6)	
Obese	175(30.6)	78(26.9)	97(37.3)	
Waist circumference				
Normal	171(29.9)	95(33.3)	76(33.0)	0.976
Overweight	107(18.7)	60(21.1)	47(20.4)	
Obese	237(41.5)	130(45.6)	107(46.5)	

Some variable measurements were missing and may therefore not sum up to 565. *Significant at p-value <0.05.

Table 3. Prevalence of obesity by gender

Variable	Male n=113	Female n=452	P-value
BMI			
Underweight	0(0)	9(2.0)	
Normal	74(67.3)	171(38.4)	<0.001*
Overweight	25(25.7)	145(32.6)	
Obese	11(10.0)	120(27.0)	
Visceral fat			
Normal	84(77.1)	347(78.9)	0.385
Obese	25(22.9)	93(21.1)	
Body fat			
Underweight	22(20)	26(5.9)	
Normal	49(44.5)	149(33.8)	<0.001*
Overweight	20(18.2)	110(24.9)	
Obese	19(17.3)	156(35.4)	
Waist circumference			
Normal	81(79.4)	90(21.8)	<0.001*
Overweight	9(8.8)	98(23.7)	
Obese	12(11.8)	225(54.5)	

*Significant at p-value <0.05.

Participants who were obese by BMI had significantly higher intakes of total calories, fat, carbohydrate protein, fibre and sugar prior to the day of data collection. Using BMI categories, the obese consumed higher quantities of all fats and micronutrients but no difference was observed in dietary diversity among the groups. Table 4−6 shows the difference in nutrient intakes among BMI, waist circumference and body composition categories.

Table 4. Nutrient intakes for BMI, waist circumference and body composition categories.

Variables	Energy	Fat	Protein	Carbohydrate	Fibre	Sugar
BMI	**Median (IQ)**	**Median (IQ)**	**Median (IQ)**	**Median (IQ)**	**Median (IQ)**	**Median (IQ)**
Underweight	1056.5(759.1)	34.8(24.6)	38.8(30.5)	164.4(129.0)	11.4(8.4)	12.1(24.4)
Normal	1277.4(849.3)	37.9(41.0)	38.0(31.6)	188.6(123.6)	17.6(12.2)	25.1(32.5)
Overweight	1516.5(978.6)	45.0(46.0)	45.4(35.3)	217.6(132.0)	19.3(14.0)	33.3(54.8)
Obese	1816.4(1038.1)	52.9(52.6)	49.5(30.4)	255.8(167.3)	20.8(15.7)	42.1(57.0)
p-value	**<0.001**	**<0.001**	**<0.001**	**<0.001**	**<0.001**	**<0.001**
Visceral fat						
Normal	1405.9(955.7)	39.9(43.0)	41.1(33.7)	202.9(133.0)	18.2(13.6)	28.2(41.0)
Obese	1630.7(1036.7)	50.2(53.2)	45.4(29.6)	236.8(156.6)	19.5(13.5)	37.5(55.5)
p-value	**0.001**	**0.028**	**0.038**	**0.009**	0.060	**0.026**
Body fat						
underweight	1386.5(944.7)	34.3(39.6)	43.7(40.6)	188.1(132.9)	14.5(15.1)	21.4(33.3)
Normal	1313.5(864.8)	40.9(45.1)	38.0(31.6)	195.9(131.5)	16.9(12.3)	26.0(36.3)
Overweight	1458.6(912.0)	38.5(39.9)	48.1(35.6)	209.2((131.1)	19.9(12.2)	35.2(37.6)
Obese	1676.7(1026.5)	47.1(50.4)	46.0(27.6)	242.2(152.3)	19.1(15.3)	36.1(57.3)
p-value	**<0.001**	**0.014**	**0.005**	**0.001**	**0.006**	**0.008**
Waist circumference						
Normal	1384.2(871.7)	38.9(42.7)	39.3(32.1)	196.6(136.5)	17.8(13.5)	26.1(36.1)
overweight	1373.0(908.6)	39.4(42.9)	39.8(41.5)	209.1(153.0)	18.5(14.4)	31.0(41.9)
Obese	1567.8(1066.6)	46.9(49.7)	45.9(28.9)	222.9(136.8)	19.1(14.6)	35.0(47.4)
p-value	**0.001**	**0.028**	**0.049**	**0.024**	**0.260**	0.080

Significant p-values are in bold.

Table 5. Differences in micronutrient intakes for BMI, waist circumference and body composition categories.

Variables	Folate	Iron	Zinc	Vitamin B12	Vitamin A	Vitamin E	Dietary diversity score
BMI	**Median (IQR)**	**Median (IQR)**	**Median (IQR)**	**Median (IQR)**	**Median (IQR)**	**Median (IQR)**	**Median (IQR)**
Underweight	120(166.7)	6.7(5.9)	4.3(3.6)	1.81(3.1)	45.0(101.0)	4.5(5.1)	6.0(3.0)
Normal	203.3(205.0)	8.4(6.5)	5.2(4.7)	1.7(3.2)	107.6(123.1)	4.7(6.4)	6.0(3.0)
Overweight	240.8(270.7)	9.8(6.3)	6.4(5.0)	2.0(3.5)	128.9(159.0)	5.8(6.7)	6.0(2.0)
Obese	261.6(255.6)	11.11(6.8)	6.8(4.8)	1.7(2.8)	133.9(138.8)	6.6(5.6)	6.0(3.0)
p-value	**0.001**	**<0.001**	**<0.001**	**0.026**	**<0.001**	**0.011**	0.212
Visceral fat							
Normal	225.3(243.3)	8.9(6.7)	5.8(5.0)	1.8(3.3)	115.0(143.4)	5.6(6.5)	6.0(3.0)
Obese	231.6(220.2)	10.4(5.6)	6.6(4.1)	1.8(2.8)	133.6(132.8)	5.5(5.1)	6.0(2.0)
p-value	0.463	**0.016**	**0.047**	0.380	0.102	0.953	0.630
Body fat							
underweight	193.3(214.7)	9.4(6.9)	5.6(5.2)	1.5(3.2)	91.7(148.8)	4.9(5.2)	6.0(3.0)
Normal	205.3(215.1)	8.5(7.1)	5.1(4.6)	1.8(3.7)	108.3(23.8)	4.9(6.9)	6.0(2.0)
overweight	242.4(248.8)	9.7(6.3)	6.5(5.2)	2.1(3.6)	129.3(145.7)	5.7(6.7)	6.0(3.0)
Obese	246.1(241.1)	10.1(6.6)	6.6(4.0)	1.7(2.6)	130.6(147.0)	6.4(5.5)	6.0(2.0)
p-value	**0.041**	**0.007**	**0.013**	0.665	**0.008**	0.186	0.774
Waist circumference							
Normal	209.5(230.6)	9.0(6.9)	5.6(4.9)	1.8(3.0)	113.2(133.7)	5.3(6.7)	6.0(3.0)
overweight	214.9(223.0)	8.9(6.5)	5.9(5.1)	1.6(3.6)	130.1(147.2)	5.3(6.0)	6.0(4.0)
Obese	247.0(251.0)	10.0(6.3)	6.4(4.8)	1.8(3.4)	120.6(143.6)	5.8(6.1)	6.0(2.0)
p-value	0.098	0.058	0.160	0.489	0.356	0.310	0.511

Table 6. Differences in fat intake by body weight category.

Variables	Saturated fat (g)	Monounsaturated fat (g)	Polyunsaturated fat (g)
BMI			
Underweight	11.7(11.9)	11.9(9.4)	6.1(4.2)
Normal	10.9(13.0)	12.8(16.4)	6.2(7.6)
Overweight	12.5(17.5)	14.9(19.8)	8.4(9.0)
Obese	15.6(16.2)	19.8(23.6)	9.6(10.6)
p-value	**0.010**	**0.002**	**0.002**
Visceral fat			
Normal	12.1(15.0)	14.4(17.8)	7.5(8.0)
Obese	13.1(18.4)	15.5(19.9)	8.9(9.6)
p-value	0.434	0.332	0.168
Body fat			
underweight	11.7(12.0)	13.5(14.9)	6.8(7.2)
Normal	11.0(15.7)	13.6(18.7)	6.3(7.6)
overweight	12.2(15.0)	13.9(17.1)	7.3(8.5)
Obese	13.6(17.0)	16.4(21.5)	9.5(9.3)
p-value	0.346	0.080	**0.009**
Waist circumference			
Normal	12.0(13.5)	13.7(18.5)	6.0(3.0)
overweight	11.6(15.6)	13.8(14.7)	6.0(4.0)
Obese	13.0(17.2)	16.1(20.9)	6.0(2.0)
p-value	0.370	0.074	0.064

Significant p-values are in bold

Table 7 shows principal component analysis of household food frequency. A total of four components were extracted. The four components explained 30.5% of the total variance. Table 8 shows partial spearman correlation between the four components and body composition measures. Component 2 showed a significant negative correlation with BMI, body fat and visceral fat while component 1 showed a positive correlation with body fat and BMI.

Table 7. Principal component analysis (PCA) of household food frequency

od items in the A	Component 1 Diverse diet	Component 2 Vegetable convenience pattern	Component 3 Snack pattern	Component 3 Staple food pattern
gs	0.611			
gar sweetened verages	0.559			
lk	0.528			
ocessed milk	0.509			
stant noodles	0.498			
ocessed meat	0.495			
eat	0.467			
mmercial bread	0.465			0.342
argarine or butter	0.445			
ce	0.414			
nfectionery	0.389			
icken	0.382			
sta	0.381			
gan meat	0.364			
veets	0.358	0.3		
getables fried		0.596		
et beverages		0.569		
st food		0.522		
staurant meals		0.434		
w vegetables	0.3	0.337		
lted dried fish		0.327		
ied potatoes		0.315		
oked vegetables			0.644	
ts			0.615	
gar			0.558	
eakfast cereal			0.47	
a or coffee	0.305		0.443	
lty snacks			0.398	
sh				0.577
gumes				0.484
ied fish				0.448
uit				0.394
ady to eat meals		-0.323		0.38
aize				0.363
ots and tubers				0.347

Kaiser-Meyer-Olkin Measure of Sampling Adequacy **0.771,** Bartlett's Test of Sphericity **<0.001**

Table 8. Partial correlation between body measures and PCA

Variables	Component 1 Diverse diet r(p-value)	Component 2 Vegetable convenience pattern	Component 3 Snack pattern r(p-value)	Component 3 Staple food pattern r(p-value)
visceral fat	0.090(0.053)	-0.142**(0.002)**	0.018(0.695)	-0.027(0.567)
body fat	0.107**(0.022)**	-0.102**(0.029)**	-0.056(0.227)	-0.015(0.751)
BMI	0.099**(0.034)**	-0.136**(0.003)**	-0.008(0.862)	-0.009(0.842)
waist circumference	0.063(0.178)	-0.089(0.057)	-0.034(0.468)	-0.066(0.158)

*controlled for age and gender

Table 9 shows a partial spearman correlation adjusted for age and gender between waist circumference, BMI and body composition measures. All variables showed significant correlations but the strongest correlations were between visceral fat and BMI r = 0.905(p<0.001), body fat and BMI r = 0.851 (p<0.001) and BMI and waist circumference r = 0.845(p<0.001).

Table 9 Partial correlation between body composition, waist circumference and BMI.

Control Variables	Variables	visceral fat r(p-value)	body fat r(p-value)	BMI r(p-value)	waist circumference r(p-value)
Age in years, Gender	**visceral fat**		0.746(<0.001)	0.905(<0.001)	0.799(<0.001)
	body fat	0.746(<0.001)		0.851(<0.001)	0.766(<0.001)
	BMI	0.905(<0.001)	0.851(<0.001)		0.845(<0.001)

Table 10 shows multinomial logistic regression for risk factors of central obesity determined by waist circumference. Multicollinearity was checked and carbohydrate and fibre had strong correlations with energy intake and protein respectively and were therefore excluded from the model. The obese group was set as reference for the outcome variable and urban and female were set as reference for the explanatory variables, community and gender respectively. Males had about 22 times odds of being normal compared to females at p-value <0.001. Rural dwellers had odds of about 1.7 times of being normal compared to urban participants and this was significant at p<0.01.

Table 10. Multinomial logistic regression of predictors of obesity

waist circumference category	Explanatory variables	Odds ratios
Normal		
	Energy	0.999(0.999-1.000)**
	Protein	1.008(0.997-1.019)
	Fat	0.996(0.987-1.005)
	Sugar	0.998(0.992-1.004)
	Community	
	Rural	1.684(1.039-2.729)**
	Urban[a]	
	Gender	
	Male	21.968(10.876-44.373)***
	Female[a]	
Overweight	Intercept	
	Energy	0.999(0.999-1.000)**
	Protein	1.004(0.994-1.015)
	Fat	0.999(0.990-1.007)
	Sugar	1.002(0.995-1.008)
	Community	
	Rural	1.198(0.741-1.936)
	Urban[a]	
	Gender	
	Male	1.991(0.790-5.018)
	Female[a]	

*p<0.05, **p<0.01, ***p<0.001. [a]Variable set as reference. Reference for weight category is obesity. Cox and Snell R-Squared is 0.243 and Naglekerke R-Squared is 0.277.

Discussion

This study evaluated the association between nutrient consumption and body composition of rural and urban adults in Ghana. The study had a higher number of female participants compared to males and this was because it was mostly females who were met at the households. This finding that is comparable to reports from the 2014 Ghana Demographic and Health survey [22]. The prevalence of overweight and obesity using BMI was 29.9% and 22.9% respectively with a total prevalence of 52.8%. The prevalence of overweight and obesity found in this study is comparable to what has been reported by some studies even though others have reported slightly higher or lower prevalence [22–25]. Several studies have reported a significantly higher prevalence of obesity by BMI among urban compared to rural dwellers but in this study, no significant difference was found [23, 26]. This implies that rural communities are gradually catching up with urban communities and there is therefore the need for further investigation and interventions to curb this menace. Total energy and carbohydrate intake were significantly higher among rural compared to urban participants. Though not statistically significant, sugar and saturated fat intake was higher among the urban sample. This finding supports data on high availability and consumption of sugary foods in urban centres and higher consumption of staple foods among rural dwellers [27]. Additionally, multinomial logistic regression results from the study indicates that rural communities are associated with normal weight compared to urban centres. This calls for policies that will regulate the availability of sugary foods notably sugar-sweetened beverages in urban communities as these are associated with weight gain and risk of type 2 diabetes. Central obesity determined by visceral fat was higher among urban participants;

central obesity is highly associated with cardiovascular diseases and poses a higher cardiometabolic risk compared to generalized obesity [18,19].

Prevalence of obesity determined by BMI, waist circumference and body fat were higher among females compared to males. Most studies have also reported a higher prevalence of obesity among women compared to men though most of these studies have only used BMI [28, 29]. In this study where visceral fat, BMI, total body fat and waist circumference were used, prevalence across all determinants was significantly higher for females compared to males with the exception of visceral fat that showed no significant difference. Several factors put women at higher risk of obesity compared to men. Sedentary behavior such as long hours watching television and parity have been documented to cause weight gain in women [30]. Even though pregnancy and childbirth are associated with weight gain and retention it is possible for women to lose almost all the weight gained during pregnancy and child birth [30, 31]. This calls for post-natal education and interventions to empower women to avoid obesogenic behaviors post-partum which are thought to aid in lactation but are rather fattening. High occurrence of obesity among women is related to adverse pregnancy outcomes such as pre-mature delivery and low birth weight babies. Low birth weight is a risk factor for obesity in adulthood and this trend has led to developing countries experiencing a double burden of disease [32]. The prevalence of central obesity was also higher among females and this also puts them at risk of chronic non-communicable diseases. High amount of total body fat is associated with elevated blood pressure and this was higher among women compared to men [30]. Multinomial logistic regression also revealed that female gender poses a significant risk to the development of obesity. Several interventions have been tailored toward socio-economic empowerment of women in Ghana but findings from this study calls for more interventions to be implemented to address the health challenges of women and also empower women toward taking charge of their health in order to achieve optimal health status.

Fat, protein, sugar and carbohydrate contribute to total energy intake and caloric intake positively associates with BMI. The intakes of the aforementioned nutrients were higher among obese participants and this was associated with higher intakes of micronutrients but not with higher dietary diversity score. Principal component analysis revealed four different patterns. Pattern 1 which comprised sugar sweetened beverages, egg, milk, instant noodles, processed meat among others showed a significant positive correlation with body mass index and body fat. This is not surprising as the component consisted of foods like sugar sweetened beverages, processed meat, commercial bread, pasta and vegetables. Frequent and high intakes sugar sweetened beverages, sweets, margarine, confectionery processed meat, instant noodles, pasta and meat promote obesity [30]. These findings call for the regulation of processed foods that currently dominate and make the food environment obesogenic.

Waist circumference is a reliable tool for determining abdominal obesity. Its strong positive correlation with other body composition measures supports the reliability of waist circumference as a measure of obesity and adiposity. This simple measurement can be used as a diagnostic tool to assess obesity and adiposity among populations and in clinical practice.

Conclusion

This study indicates that overweight and obesity continue to rise in Ghana, especially among females. Prevalence of obesity determined by BMI was similar among rural and urban dwellers. Interventions that regulate the food environment and makes affordable and available healthy food options such as vegetables are needed to control the rise in obesity rate and prevalence.

Limitation

This study was cross-sectional and hence conclusions about risk factors of obesity may be limited. The higher number of females compared to males is also a limitation to this study.

List Of Abbreviations

BMI-Body Mass Index

Declarations

Ethics approval and consent to participate

Ethical clearance for the study was granted by the Council for Scientific and Industrial Research (CSIR), Ghana; RPN 011/CSIR-IRB/2017. All participants signed an inform consent form to indicate voluntary participation.

Consent for publication

Not applicable.

Availability of data and materials

The datasets used during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare no conflict of interest.

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Authors' contributions

Nana Ama Frimpomaa Agyapong, Reginald Adjetey Annan, Charles Apprey and Elizabeth Catherine Swart made substantial contribution to the conception and design of the study. Nana Ama Frimpomaa Agyapong, Charles Apprey and Linda Nana Esi Aduku made substantial contributions to data collection and statistical analysis. Nana Ama Frimpomaa Agyapong and Reginald Adjetey Annan drafted the manuscript. Elizabeth Catherine Swart and Charles Apprey critically revised the manuscript. All authors have read and approved this final draft for submission

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