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Epidemiology of body mass index in Ghana: evidence from WHO Study on global ageing and adult health, Wave 2

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Abstract

Background: The increased prevalence of overweight and obesity are directly related to economic development, eating habits and changes in physical activity levels.

Objective: This study aimed to examine population-level body mass index (BMI) and associated factors.

Methods: Data from World Health Organization Study on global AGEing and adult health Ghana Wave 2 conducted in 2015 among adults 18 years and older was used for the analysis. Body mass index was used as the main outcome measure. Inferential statistics involving ordered logistic regression models were carried out to assess risk predictors of obesity.

Results: The prevalence of overweight and obesity BMI were 24.7% and 12.9% respectively. The prevalence of obesity varied across the regions, with relatively higher rates in southern regions (highest in the Greater Accra region, 28.3%) and was higher in women than men (20.4% versus 3.9%). Significant predictors [adjusted odds ratio (aOR) with 95% confidence interval (CI)] of obesity included female sex (aOR = 2.94, 95% CI = 2.25 – 3.86), adults aged 50 – 59 years (aOR = 3.95, 95% CI = 2.68 – 5.83), dwellers in the capital region, Greater Accra (aOR = 3.58, 95% CI = 2.02 – 6.36) and ≥ 5 fruit intake [3.12 (1.74 – 5.63)].

Conclusion: The prevalence of obesity among adult Ghanaians (≥ 18 years) has increased over two-fold in a decade based on analysis using similar methods and survey data. Increasing age and place of residence are significantly associated with high BMI. Our findings support the implementation of Ghana's 2012 national policy for the prevention and control of chronic non-communicable diseases (NCDs). The policy aims to change the trajectory of factors that contribute to NCD and fulfil WHO's NCD Target 7 for halting the growth in obesity and diabetes by 2025.

Keywords: Prevalence, Body Mass Index, obesity, Ghana

INTRODUCTION

Overweight and obesity are major public health issues [1]. The prevalence of obesity globally has tripled since 1975 [2] with most of the burden seen in high-income countries [3], while underweight has been a burden in sub-Saharan Africa (SSA) among younger age groups [4]. However, these SSA countries are now facing obesity among adults as well [5]. Increasing abnormal BMI is an abnormal fat accumulation that may influence health conditions like cardiovascular diseases; musculoskeletal disorders like osteoarthritis; and some cancers affecting; endometrial, breast, ovarian, prostate, liver, and kidney [2,6–10]. An unhealthy dietary lifestyle is a predictor of a high body mass index (BMI) [11]. It is thus highly recommended that individuals with high BMI levels should engage in weight loss activities to reduce the risks associated with obesity [12]. In developing countries, factors associated with overweight or obesity include; sex, age, socio-economic status, diet, physical activity and geographic location, as well as the existence of rural and

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urban differences [5,13,14]. In the developed countries, however, high income and other demographic characteristics (such as age and sex) are associated with overweight or obesity [5,15,16]. Globally, an estimated 23% of the world's population is overweight [15]. A multi-country cross-sectional study conducted among four African countries showed that South Africa (SA) had the highest prevalence of overweight and obesity combined (85%) [13]. In Ghana, a recent cross-sectional study conducted in the most urbanized area of metropolitan Accra indicated the prevalence of obesity to be as high as 65% [17]. The Ghana Demographic Health Survey (GDHS) 2003 reported an overweight prevalence of 25% among reproductive-age women, increasing to 40% in the 2014 GDHS [18,19]. Biritwum and colleagues in 2005 reported a nationwide combined overweight and obesity prevalence of 25.2% among older adults Ghanaians 18 years and above [20]. The increased prevalence of overweight and obesity are directly related to economic development, eating habits and changes in physical activity levels [17]. A nationwide study on the epidemiology of obesity based on BMI evaluation in Ghana was conducted over a decade ago by Biritwum et al in 2005 (WHO SAGE Wave 0) and also by Wu et al in 2015 (WHO SAGE Wave 1) [20,21]. This current analysis was conducted to evaluate the epidemiology of BMI in Ghana using SAGE wave 2 and further assessed the factors associated with high BMI among the older adult population aged 18 years and above.

MATERIALS AND METHODS

Data from WHO's Study on global AGEing and adult health (SAGE) Ghana Wave 2 was used for this analysis. SAGE is a longitudinal study on the health and well-being of adult populations, and the ageing process. SAGE Wave 2 was implemented from 2014 to 2015 in six lower-to-middle income countries including China, Ghana, India, Mexico, Russian Federation and South Africa [22].

Study participants

The two target populations included in this study were a national representative sample of persons aged ≥ 50 years, and a smaller comparative sample of persons aged 18 – 49 years. A multistage cluster sampling design was used to select 250 primary sample units and 20 strata [22]. Details about the study design and procedures for data collection have been published elsewhere [23]. In all, the SAGE Ghana Wave 2 sample totalled 4735 respondents. A final sample of 4490 respondents was used in this study due to some non-response to weight and height questions.

Dependent variables

Anthropometric measurements involving measured height and weight were obtained. Respondent's height was measured without shoes, with feet and heels close together, standing straight and looking forward with back and head and heels touching a wall. The measurement was read in centimetres (cm), which was then converted into meters (m). Weight was measured with shoes off on a measuring scale in kilograms (kg). Body Mass Index was calculated using the formula below: BMI = [Weight (kg)] / [Height (m)]^2 [20]. The BMI was then classified into four levels as underweight, normal, overweight and obesity: < 18.50, 18.50 – 24.90, 25.00 – 29.90 and > 30.00 respectively [20] (Supplementary Data 1)

Independent variables

Demographic variables. Sex (male or female), age (≤ 49, 50 – 59, 60 – 69, 70 – 79, ≥ 80 years), marital status (never married, married, separated/divorced, widowed), religion (none, Christian, Islam, primal indigenous), place of residence (urban or rural), region (the then 10 administrative regions in Ghana), educational level [none, primary, senior high school (SHS), tertiary], and lifestyle variables including (tobacco and alcohol use, fruit and vegetable intake on a typical day, as well as the conduct of vigorous and moderate physical activities).

Lifestyle variables. Variables under this category included 'ever smoked' and 'ever used alcohol' which were categorized as 'yes' or 'no'. Alcohol consumption among participants was assessed by asking, 'Have you ever consumed a drink that contains alcohol (such as beer, wine, spirits)?' Those who answered 'yes' were classified as 'ever consumers'. The 'ever consumers' were further asked, 'Have you consumed alcohol in the last 30 days?' with responses 'yes' or 'no'. Those who answered 'yes' were classified as 'current consumers' and 'otherwise' for those who answered 'no'. Regarding fruit and vegetable intake, participants were asked, 'How many servings of fruit do you eat on a typical day? This may include a slice or bowl of fresh fruit' and 'How many servings of vegetables do you eat on a typical day? This may include Kontomire leaves, carrots, garden eggs (aubergine/eggplant), cabbage and green beans)'. The number of servings was classified into none, 1 serving, 2 servings, 3 – 4 servings, and ≥ 5 servings a day. For physical vigorous work activity, participants were asked 'Does your work involve vigorous-intensity activity that causes large increases in breathing or heart rate? This may include heavy lifting, digging, or chopping wood for at least 10 minutes continuously'. Responses were classified as 'yes' or 'no'. For physical moderate work activity, participants were asked 'Does your work involve moderate-intensity activity that causes small increases in breathing or heart rate? This may include brisk walking, carrying light loads, cleaning, cooking, or washing clothes for at least 10 minutes continuously'. Responses were classified as 'yes' or 'no'.

Statistical analysis

The Rao-Scott $\chi 2$ test of independence was used to assess the association between the dependent variable (BMI levels) and covariate. This was done by adjusting for the design effect of SAGE to correct for normal Pearson $\chi 2$. Factors influencing BMI were estimated by adopting two statistical models: Ordinary Least Square and Ordered Logistic Regression models were carried out to assess the predictors of increasing BMI. Data was exported into STATA Statistical Software (Version 14, Stata Corp LLC, Texas, USA) for further management and analysis.

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Table 1: Prevalence (%) of Body Mass Index by demographic characteristics

Demographic variable	Total	BMI evaluation				Design-based $\chi 2$
	N = 4464	Underweight N = 498	Normal N = 2467	Overweight N = 960	Obesity N = 539	
Prevalence (95% CI)		7.2 (5.9 – 8.7)	55.2 (52.1 – 58.2)	24.7 (22.3 – 27.2)	12.9 (11.1 – 14.8)	
	n	Weighted %	Weighted %	Weighted %	Weighted %	
Sex						34.26***
Male	1854	9.10	66.12	20.77	3.94	
Femle	2610	5.66	45.90	27.98	20.45	
Age group (years)						7.76***
≤49	1114	6.34	55.59	25.20	12.82	
50 – 59	1248	6.05	52.03	25.72	16.20	
60 – 69	1062	11.54	53.32	22.74	12.40	
70 – 79	704	16.03	57.20	18.65	8.12	
> 80	336	20.83	59.87	13.55	5.75	
Marital status						5.15***
Never married	476	9.02	63.35	17.37	10.26	
Married	2521	5.69	53.96	27.38	12.98	
Divorced	500	9.42	41.04	34.21	15.32	
Widowed	967	9.52	49.17	21.46	19.85	
Religion						2.71***
None	126	17.13	55.94	25.54	1.39	
Christian	3254	7.38	54.94	23.63	14.05	
Islam	842	5.65	53.65	29.82	10.87	
Primal indigenous	242	6.02	70.55	18.36	5.07	
Place of residence						14.34***
Urban	1821	5.13	50.08	26.77	18.02	
Rural	2643	9.43	60.46	22.52	7.58	
Region						4.75***
Ashanti	760	2.42	52.13	30.24	15.22	
Brong Ahafo	501	10.66	64.78	21.25	3.31	
Central	562	9.83	60.85	20.02	9.29	
Eastern	334	8.01	51.02	26.60	14.38	
Greater Accra	439	2.06	45.05	24.60	28.30	
Northern	456	9.44	63.09	21.52	5.96	
Upper East	244	3.37	62.46	26.45	7.72	
Upper West	206	9.62	80.60	9.51	0.27	
Volta	391	12.39	48.06	28.91	10.64	
Western	571	11.84	55.03	22.72	10.40	
Educational level						1.5
None	1864	8.83	54.48	25.61	11.10	
Primary	1294	7.94	53.44	24.91	13.72	
SHS	1165	5.96	58.71	22.86	12.47	
Tertiary	141	2.54	42.68	34.93	19.85	
Tobacco use						6.30***
Yes	273	7.13	72.97	12.00	7.70	
No	4176	7.25	54.15	25.38	13.20	
Missing	15	0.80	89.67	5.94	3.60	
Alcohol use						1.42
Yes	1306	7.13	56.96	23.79	11.92	
No	3143	7.25	54.21	25.18	13.37	
Missing	15	0.80	89.67	5.94	3.60	
Fruit intake						3.78***
None	422	16.45	66.61	12.09	4.85	
1 Only	1023	9.42	58.10	23.78	8.69	
2 times	1316	7.36	53.45	26.36	12.83	
3 – 4 times	1062	5.39	51.37	27.93	15.31	
> 5 times	265	2.70	57.98	19.58	19.74	
Missing	376	3.21	52.24	27.85	16.70	
Vegetable intake						0.6
None	21	9.76	85.36	2.45	2.44	
1 Only	840	8.34	55.51	24.34	11.80	
2 times	1288	6.12	55.89	25.70	12.29	
3 – 4 times	1339	8.22	54.21	23.50	13.00	
> 5 times	704	7.40	51.50	24.57	13.81	
Missing	272	3.96	55.20	28.14	16.39	
Undertake Vigorous exercise						10.25***
Yes	1363	7.06	61.02	25.36	6.56	
No	3085	7.39	51.80	24.54	16.39	
Missing	16	0.59	92.30	4.42	2.68	

p value notation: *, *p* value < 0.05; **, *p* value < 0.01; ***, *p* value < 0.001; CI, confidence interval; $\chi 2$, Chi-square; %, percentage

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Patients and public involvement statement

Modification from the SAGE wave 1 questionnaire was used for the SAGE Wave 2 due to patient experiences and priority lessons learnt to collect the data. The design of SAGE Wave 2 was informed by the involvement of patients in Wave 1, modifications made were based on patient priorities. Recruitment of patients and conduct of the study was by the WHO SAGE Ghana Team. The WHO SAGE Ghana Team organizes national stakeholders meeting to disseminate the findings of the national survey. A report of the national survey based on all data collected is provided to the public and available on the WHO SAGE website.

RESULTS

Overall, the prevalence of obesity in Ghana for the population ≥ 18 years was 12.91% [95% confidence interval (CI): 11.20 – 14.83] and varied across the regions (Table 1). Sex differentials showed females experienced the highest prevalence of obesity (20.45%). The Volta and Western Regions approximately had an equal prevalence of 10.40% and 10.64%. Rural-urban differential showed a higher prevalence among urban residents (18.02% versus 7.58%). Obesity was more common among the widowed (19.85%) than the married (12.985%), never married (10.26%), and separated/divorced (15.32%).

In addition, obesity was highest among Christians (14.02%). The prevalence of obesity was higher (16.20%) among participants aged 50 – 59 years and significantly decreased as the age of respondents increased up to > 80 years. Respondents who had tertiary education were relatively more obese (19.85%). In addition, obesity was more common in the population in the southern part of the country compared to the northern part. It was highest in Greater Accra (28.30%) and lowest in Upper West (0.27%) and Brong Ahafo (3.3%). Tobacco use was observed to be associated with obesity and overweight. Obesity was relatively higher in those who did not smoke (13.20%). However, the prevalence of obesity was relatively lower in those who consumed alcohol (11.92%). Obesity was less among individuals who engaged in vigorous and moderate work (6.56% and 10.26% respectively) (Table 1). Regarding diet (Table 2), the obese took in more servings of fruits compared to the amount eaten by the other groups. The average number of vegetable servings was observed to be high among the obese (3.10 per day). Counter-intuitively, intake of fruits was observed to be associated with obesity. Concerning physical activities, the average number of days in a week when vigorous activity was performed was 3.85 days compared to 4.37 days for the respondent classified as normal.

Obesity was observed to be less in those with more hourly vigorous activities. The overall mean value of BMI by regional differential from meta-analysis was approximately 23.9 kg/m^2 (95% CI = 23.6 – 24.1) and it ranged from 23.30 kg/m^2 among participants in the Northern region to 27.4 kg/m^2 among those in Greater Accra region. Meanwhile, the rural-urban differential showed a higher mean value of BMI among urban residents than their rural counterparts (25.6 kg/m^2 versus 23.4 kg/m^2 respectively). Generally, the mean value of BMI showed highly significant heterogeneity between region-specific and rural-urban-specific ($p < 0.001$ from I^2 test statistics) (Figure 1). Table 3 demonstrates that females sex increases BMI score by approximately 3 fold (aβ = 2.97, 95% CI = 2.37 – 3.56), however, the risk of being obese compared to males was 2.94 (aOR = 2.94, 95% CI = 2.25 –3.86).

Age was a significant predictor where adults aged 50 – 59 years had the highest increased risk (3.95) of being obese compared with those ≥ 80 years. All these age groups: ≤ 49 years (aOR = 3.76, 95% CI = 2.48 – 5.71); 50 – 59 years (aOR = 3.95, 95% CI = 2.68 – 5.83), 60 – 61 years (aOR = 2.54, 95% CI = 1.75 – 3.71), and 70 – 79 years (aOR = 1.50, 95% CI = 1.06 – 2.13) were statistically significant predictors of obesity. Adults Ghanaians who resided in rural areas were at 35% decreased odds to be obese compared to urban dwellers (aOR = 0.65, 95% CI = 0.50 – 85). There were disparities in the geographical location of the adults, with those in the Ashanti, Eastern, Greater Accra, and Upper East, and Volta regions having, respectively, odds of 2.60 (aOR = 2.65, 95% CI = 1.65 –

Table 2: Mean level of selected lifestyle characteristics according to Body Mass Index categories

Variable	BMI categories				*p* value
	Underweight	Normal	Overweight	Obesity	
Servings of fruits per day					< 0.001
Mean (SD)	1.82 (0.06)	2.08 (0.03)	2.38 (0.05)	2.68 (0.09)	
95% CI	(1.69 – 1.95)	(2.01 – 2.14)	(2.28 – 2.50)	(2.50 – 2.86)	
Servings of vegetable					0.001
Mean (SD)	2.68 (1.57)	2.92 (1.81)	3.03 (2.07)	3.10 (2.33)	
95% CI	2.54 – 2.83	2.85 – 2.99	2.89 – 3.17	2.90 – 3.30	
Days vigorous activity					0.014
Mean (SD)	4.51 (0.14)	4.37 (0.06)	4.21 (0.1)	3.85 (0.2)	
95% CI	(4.24 – 4.78)	(4.27 – 4.49)	(4.01 – 4.40)	(3.47 – 4.24)	

CI, confidence interval; SD, standard deviation;

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4.09), 2.30 (aOR = 2.30, 95% CI = 1.23 – 4.31), 3.58 (aOR = 3.58, 95% CI = 2.02 – 6.36), 2.68 (aOR = 2.68, 95% CI = 1.44 – 4.97), and 2.02 (aOR = 2.02, 95% CI = 1.15 – 3.55) to be classified as obese compared to those in the Upper West region (Table 3). An increasing number of fruits intake were identified as a significant predictor of obesity where those who take one (aOR = 1.71, 95% CI = 1.11 – 2.64), two (aOR = 2.16, 95% CI = 1.37 – 3.40), three to four (aOR = 2.68, 95% CI = 1.71 – 4.21), and five and above (aOR = 3.12, 95% CI = 1.74 –5.63) had higher odds of obesity compared to older adults with no fruits intake (Table 3).

DISCUSSION

The current analysis found an over two-fold increase in the prevalence rate of obesity (12.91%) among Ghanaian adults compared with that (5.5%) reported 14 years ago [24]. This in addition to the relatively higher prevalence of obesity reported in more recent studies in Ghana highlight the growing burden of overweight and obesity in Ghana [25–27]. This analysis pointed to variations in the prevalence of obesity across regions in Ghana, where generally the regions in the southern part of the country had a relatively higher prevalence of obesity than those in the northern parts. The prevalence of obesity was highest in Greater Accra in the south and lowest in the Upper West in the north. This observation aligns with the findings from a study by Nuertey et al. in 2017 who noted that Greater Accra had the highest prevalence of obesity whiles the Upper West region had the least prevalence of Obesity [27]. This conforms to the socioeconomic disparities between the southern and northern parts of the country, highlighted by the Living standards survey of the Ghana Statistical service [28]. Sex differentials in the levels of obesity were demonstrated by the analysis (obesity was more common in females compared to males (20.4% versus 3.9%). The high percentage of body fat in women compared to men [29] may play a part in this finding. This trend is consistent with results from previous studies [24,30]. The prevalence of obesity by age increased up to 50 years and decreased as the ages of respondents increased. Individuals who were aged 50 – 59 years had higher odds of being obese. This finding from our analysis supports the observation that the prevalence of obesity increased with age, with those in the middle ages (46 – 55 years) being most vulnerable [31]. In addition, our analysis found that individuals with tertiary education were more obese. This corroborates the findings

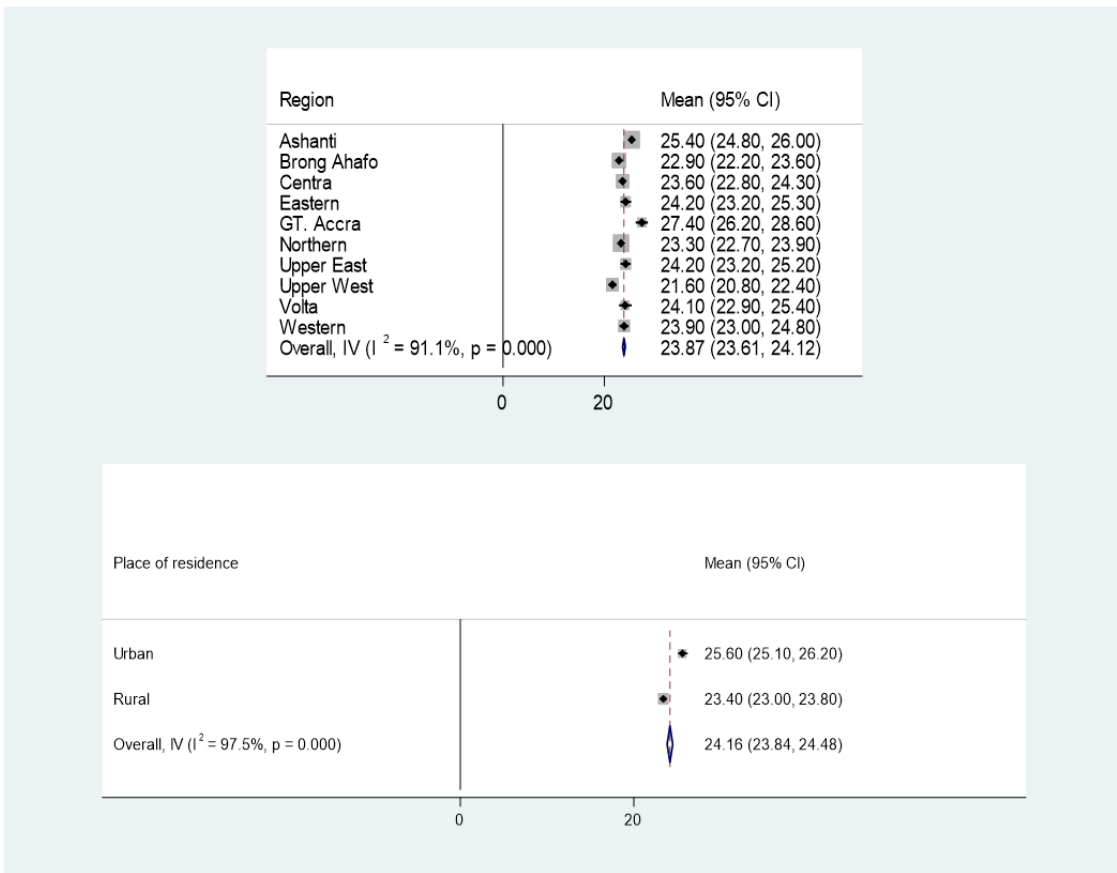

Figure 1: Regional and rural-urban-specific means of Body Mass Index among Ghanaian adults.

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of Amoah and colleagues, that individuals with tertiary education had the highest prevalence of obesity compared with less literate and illiterate individuals [32]. Those who are more educated may be able to afford food and other delicacies and may indulge in other unhealthy sedentary lifestyles regarding occupation. Increased health education is imperative for the general population, particularly for individuals at higher risk of developing obesity [33]. Along similar lines, urban dwellers were relatively more obese than rural dwellers and this observation conforms with findings made by Ofori-Asenso et al. in 2016 [30]. This rural-urban disparity is also reported in studies from other countries [13,34–36]. Obesity was found to be less in those who smoked and individuals who consumed alcohol had a low proportion of obesity, and this is similar to findings from a study by Nuertey et al. in 2017 [27]. Counter-intuitively, an increase in fruit intake was associated with a high prevalence of obesity. This finding disagreed with what Biritwum et al. reported in 2018 [24]. They indicated that the obese took in fewer servings of fruits compared to the amount eaten by the other groups. The cross-sectional nature of the study upon which our analysis was based, makes it difficult to determine temporality; it may well be that obese individuals have been educated or asked by their health providers to take in healthier diets with more fruits and vegetables.

Table 3: Risk factors associated with high Body Mass Index and obesity

Predictors	aβ (95% CI) *p* value	aOR (95% CI) *p* value
Sex		
Male	Ref	Ref
Femle	2.97 (2.37– 3.56)***	2.94[2.25 – 3.86]***
Age		
> 80	Ref	Ref
≤49	2.76 (1.87 – 3.66)***	3.76 (2.48 – 5.71)***
50 – 59	2.90 (2.07 – 3.74)****	3.95 (2.68 – 5.83)***
60 – 69	1.94 (1.15 – 2.72)***	2.54 (1.75 – 3.71)***
70 – 79	0.80 (0.12 – 1.47)*	1.50 (1.06 – 2.13)*
Marital status		
Married	Ref	Ref
Never married	-1.56 (-2.38 – 0.74)***	0.45[0.33 – 0.61]***
Divorced	-0.20 (-0.96 – 0.55)	0.95[0.65 – 1.39]
Widowed	0.02 (-0.91 – 0.94)	0.95[0.69 – 1.31]
Religion		
Christian	Ref	Ref
None	-0.76 (-2.16 – 0.63]	0.75[0.31 – 1.80]
Islam	0.55 (-0.10 – 1.19]	1.35 (01.84)
Primal indigenous	-0.42 (-1.32 – 0.49]	0.80 (0.49 – 1.30)
Place of residence		
Urban	Ref	Ref
Rural	-1.15 (-1.73 – 0.57)***	0.65 (0.50 – 0.85)**
Region		
Upper West	Ref	Ref
Ashanti	2.47 (1.47 – 3.47)***	2.60 (1.65 – 4.09)***
Brong Ahafo	0.31 (-0.74 – 1.37)	1.01(0.63 – 1.64)
Central	1.03 (-0.17 – 2.24)	1.34 (0.77 – 2.32)
Eastern	1.52 (0.21 – 2.89]*	2.30 (1.23 – 4.31)**
Greater Accra	3.91 (2.37 – 5.44)***	3.58 (2.02 – 6.36)***
Northern	0.73 (-0.32 – 1.78)	1.14 (0.66 – 1.97)
Upper East	2.47 (1.17 – 3.77)***	2.68 (1.44 – 4.97)**
Volta	2.02 (0.77 – 3.27)**	2.02 (1.15 – 3.55)*
Western	1.51 (0.24 – 2.78)*	1.60 (0.89 – 2.88)
Educational level		
None	Ref	Ref
Primary	0.16 (-0.46 – 0.80)	0.99 (0.73 – 1.33)
SHS	0.23 (-0.47 – 0.94)	1.09 (0.80 – 1.49)
Tertiary	1.89 (0.35 – 3.43)*	2.12 (1.10 – 4.09)*
Ever smoke		
No	Ref	Ref
Yes	0.25 (-1.02 – 1.52)	1.39 (0.92 – 2.12)
Ever had alcohol		
No	-0.48 (-1.10 – 0.13)	1.27 (1.01 – 1.60)*
Yes		Ref
Fruit intake		
None	Ref	Ref
One	0.83 (0.02 – 1.65)*	1.71 (1.11 – 2.64)**
Two	1.12 (0.26 – 1.98)**	2.16 (1.37 – 3.40)***
3 – 4	1.77 (0.84 – 2.67)***	2.68 (1.71 – 4.21)***
> 5	3.01 (1.12 – 4.90)**	3.12 (1.74 – 5.63)***
Vegetable intake		
None	Ref	Ref
One	0.71 (-2.59 – 4.01)	1.47 (0.61 – 3.52)
Two	0.72 (-2.62 – 4.06)	1.51 (0.62 – 3.68)
3 – 4	0.95 (-2.45 – 4.34)	1.41 (0.58 – 3.44)
> 5	0.28 (-3.09 – 3.66)	1.19 (0.47 – 3.02)
Vigorous work		
Yes	Ref	Ref
No	0.48 (-0.04 – 1.00)	1.18 (0.93 – 1.50)

p value notation: *, *p* value < 0.05; **, *p* value < 0.01; ***, *p* value < 0.001; CI, confidence interval; aOR, adjusted odds ratio

Intuitively, however, the prevalence of obesity was less among individuals who engaged in vigorous and moderate work. Even though obesity can exist, vigorous physical activity has been identified to be significantly associated with a lower prevalence of obesity [37–40]. In addition, vigorous activities analysis shows a higher prevalence of obesity, however, risk assessment showed statistically insignificant findings. This, as well, agreed with previous studies on obesity [41,42]. Some limitations of this study should be noted. This analysis used only subjective reporting by the participants, a combination of other methods of ascertainment could have yielded different results. The study design does not allow us to establish causation. Evaluating the epidemiology in Ghana is key for developing strategies to achieve the WHO prevention and control of chronic non-communicable diseases (NCD) in Ghana. The strength of the study lies in the use of nationwide data, which provides a better understanding of BMI in Ghana.

Conclusion

The prevalence of obesity among adult Ghanaians (18 years and above) has increased from 5.5% in 2005 to 12.9% in 2015 (over a two-fold increase in a decade) in analysis based on similar methods and survey data. the prevalence of obesity was relatively higher among females and residents of urban areas and southern Ghana. Overall sex, age, marital status, level of education, place and region of residence were predictors of obesity. Vigorous activities were associated with a reduced risk of obesity, however, statistically insignificant. These results provide concrete evidence for intensified action across the country on the 2012 national policy for the prevention and control of chronic non-communicable diseases in Ghana. This approach will help to shift the trajectory of factors contributing to the rise in NCD and meet WHO's NCD target 7 to halt the rise in obesity and diabetes by 2025.

DECLARATIONS

Ethical considerations

SAGE Wave 2 was approved by the World Health Organization's Ethical Review Board with reference number RPC149, and the Ethical and Protocol Review Committee, of the College of Health Sciences, University of Ghana, Accra, Ghana. Written informed consent was obtained from all study participants.

Consent to publish

All authors agreed to the content of the final paper.

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None

Competing Interests

No potential conflict of interest was reported by the authors.

Author contributions

JT, AOY, AEY conceptualized the study and sought approval for access to the SAGE wave 2 data. RB, GM, NM, NN, SC, PK, AEY are members of the WHO SAGE Wave 2 Ghana Team. JT undertook the statistical analysis. JT, AOY, RB, DG, AEY drafted the initial manuscript. GM, NM, NN, SC, PK read and provided intellectual content revisions and suggestions for clarity and precision on the subject matter. All authors read and approved the final review manuscript.

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Availability of data

The dataset used to support the findings of this study is available upon request through the WHO website: https://apps.who.int/healthinfo/systems/surveydata/index.php/catalog/sage/about.

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Supplementary Data 1: Variable description, measurements, and scale of measurements

Variable	Type of variable	Description	Measurement	Scale of measurement
Depression	Primary outcome variable	Respondent were asked to rate how much they agree with the statements on a five-point Likert scale response format	The index variables with raw scores are: 1 = fully agree, 2 = partially agree, 3 = hard to say, 4 = I partially disagree, and 5 = fully disagree	Discrete Binary Ordinal
Social support	Primary outcome variable	Respondent were asked to rate how much they agree with the statements on a seven- point likert scale response format	The index variables with raw scores are: 1 = very strongly disagree to 7= very strongly agree Index variable with raw scores	Discrete Binary Ordinal
Sex of participant,	Explanatory variable	Sex definition of the participant	Male or Female	Binary
Age group	Explanatory variable	Age group of participants as at data collection	< 50 and > 50 years	Categorical
Marital status	Explanatory variable	Current marital status of participants marital status, educational status, working status, self-rated income, years of illness and complications	Married, never married, divorced, and widowed	Categorical
Educational level	Explanatory variable	Highest educational level of participants	None, primary, secondary, and tertiary	Categorical
Working status	Explanatory variable	The type of work participants are engaged in	Public servant, unemployed, self-employed, and other	Categorical
Self-rated income	Explanatory variable	Respondents were asked to rate their income status	Low, medium, and high	Categorical
Years of illness	Explanatory variable	Respondents were asked how long they have lived with their illness	Raw ages	Discrete Categorical
Complications	Explanatory variable	Complications of diabetes condition	Categorized into eye condition, loss of feeling and others (hypolycaemia, hyperglycaemia ulcers and kidney problems)	Categorical