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Socioeconomic and behavioural determinants of overweight/obesity in Botswana: A cross-sectional study

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Abstract

Objective

To undertake a comprehensive assessment of socioeconomic and behavioural determinants of overweight/obesity in Botswana.

Design

The study adopted a cross-sectional design and was conducted in selected urban and rural areas of Botswana. Rural areas constituted 15 urban villages and 15 rural areas, while urban areas constituted 1 city and 2 towns. Body Mass Index (BMI) was categorized into; underweight ($\text{BMI} < 18.5 \text{ kg/m}^2$), normal weight ($18.5 \leq \text{BMI} < 25 \text{ kg/m}^2$), overweight ($25 \leq \text{BMI} < 30 \text{ kg/m}^2$) and obese ($\text{BMI} \geq 30 \text{ kg/m}^2$). We used binary logistic regression analysis to estimate determinants of overweight/obesity because overweight and obese were coded as: being overweight and obese ($\text{BMI} \geq 25$) = 1; not overweight and obese = 0 ($\text{BMI} < 25$). Analysis of questionnaire responses used logistic regression models.

Setting

Botswana

Participants

1178 males and females aged 15 years and above from the survey on 'Chronic Non communicable Diseases in Botswana: Chronic disease prevalence, Health Care Utilization, Health Expenditure and the Life course', conducted in March 2016.

Outcome Measures

Adjusted ORs for socioeconomic and behavioural determinants of overweight/obesity.

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Results

Prevalence of overweight/obesity in the study population was estimated at 41%. The adjusted odds of overweight/obesity were highest among women (AOR=2.74, 95% C.I. =1.92-3.90), in ages 55-64 years (AOR=5.53, 95% C.I. = 2.62-11.6), individuals with secondary (AOR=1.70, 95% C.I. = 1.11-2.61) and tertiary or higher education (AOR=1.99, 95% C.I. =1.16-3.38), smokers (AOR=2.16, 95% C.I. = 1.22-3.83) and poor physically active people (AOR=1.46, 95% C.I. =1.03-3.24).

Conclusion

Being female,elderly, of high education levels, a smoker and having poor physical activity were identified as key factors for prevalence of overweight/obesity.These findings suggest the need for broad based strategies encouraging physical activity among different socioeconomic groups.

Key words

Overweight, Obesity, socioeconomic, behavioral, Botswana

Strengths and Limitations of the study

- To our knowledge this is the first cross-sectional study in Botswana to comprehensively assess both the socioeconomic and behavioral determinants of overweight/obesity among adults.
- Data were collected from a large and randomly selected representative population. The data contained information on potential confounding factors, with a low proportion of missing information.
- A limitation for this study was that since a cross sectional design was employed, data on each participant was recorded only once making it difficult to infer the temporal association between an explanatory and an outcome variable.
- Only an association, and not causation, can be inferred from this study.

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3 **Introduction**
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6 The disease profile in Botswana is changing at an alarming rate, with most deaths
7 and disability in the foreseeable future likely to be accounted for by the ominous
8 epidemics of non-communicable diseases (NCDs) such as heart disease, stroke,
9 cancer and other chronic diseases. Children, adults and the elderly are all vulnerable
10 to the risk factors that contribute to NCDs especially overweight/obesity, due to
11 unhealthy diets, low physical activity, exposure to tobacco smoke and/or the effects
12 of the harmful use of alcohol¹⁻³. The key drivers of NCDs are ageing, rapid
13 unplanned urbanisation, and the globalisation of unhealthy lifestyles. For example,
14 globalization of unhealthy lifestyles like unhealthy diets may show up in individuals
15 as raised blood pressure, increased blood glucose, elevated blood lipids, and
16 overweight/ obesity¹.
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19 Several studies have recently shown that many low income and middle-income
20 countries (LMICs) are experiencing an increase in the prevalence of
21 overweight/obesity⁴⁻⁶. This prevalence is predicted to continue to increase in the
22 future. Much of the increase in prevalence levels for overweight/obesity is expected
23 in countries such as India, some parts of South-East Asia, China, most of South
24 America and some parts of Sub Saharan Africa⁷⁻⁸. Until recently, SSA was minimally
25 affected by the obesity/overweight epidemic due to under-nutrition and a major
26 burden of HIV and tuberculosis⁹. Meanwhile research on overweight/obesity has
27 started to gain significance in sub Saharan Africa¹⁰⁻¹⁴ due to its increasing
28 magnitude.
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31 It has been shown by previous studies that socioeconomic and behavioural factors
32 have a significant association with overweight/obesity¹⁵⁻¹⁶. These studies have
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shown that socioeconomic factors such as sex, age, education level, work status, place of residence and wealth status are significant determinants of overweight/obesity. It has also been found that women are more likely to be overweight/obese than men, while the odds of being overweight/obesity has been seen to increase with age¹⁷⁻¹⁹. Other studies have shown that being employed in a high income job, residing in urban areas, having high education and wealth status is significantly associated with overweight/obesity²⁰.

There is also available evidence which suggest significant correlation between behavioural factors and overweight/obesity. For example, there is significant evidence of a positive association between physical inactivity and the prevalence of overweight/obesity²¹. It has also been suggested that the relation between physical activity and health outcomes such as overweight/obesity may be moderated by a number of lifestyle factors, especially sedentary lifestyle^{15, 20, 21}. In many developing countries, there has been a substantial shift from jobs with high-energy expenditure such as farming, mining, and forestry, and employment is inclined towards the more-sedentary sectors of manufacturing, services and office based-work²². Moreover, there have been changes in lifestyle behaviours condoning alcohol consumption, poor diets and smoking. These are also key risk factors of overweight/obesity²³⁻²⁴.

Despite evidence indicating increasing burden of overweight/obesity in Botswana, there is little evidence of socioeconomic and behavioural determinants of overweight/obesity. To the best of our knowledge this is the first cross sectional study which takes into account both socioeconomic and behavioural factors for understanding the heterogeneity of overweight/obesity in Botswana. The reduction

of overweight/obesity prevalence should be a key goal of health-care policy because of its association with many NCDs. The main objective of this study was to assess socioeconomic and behavioural determinants associated with overweight/obesity prevalence in Botswana.

Methods

The study used cross sectional design by selecting respondents in three cities and towns, fifteen urban villages and fifteen rural areas across Botswana using a multistage probability sampling technique. The survey was carried out in March 2016. The survey collected self-reported data on several NCDs as classified by the WHO classification of diseases and their risk factors. Information collected from these respondents included social and behavioural characteristics, and anthropometric measurements (height and weight). Body Mass Index (BMI) was used to classify overweight/obesity in adults. BMI was derived from weight and height: $\text{weight (kg)} / (\text{height (m)} \times \text{height (m)})$. Participants removed their shoes and heavy outer clothing before weight and height were measured. Weight was measured, to the nearest 0.1kg, while height was measured in metres. BMI was categorized into; underweight ($\text{BMI} < 18.5 \text{ kg/m}^2$), normal weight ($18.5 \leq \text{BMI} < 25 \text{ kg/m}^2$), overweight ($25 \leq \text{BMI} < 30 \text{ kg/m}^2$) and obese ($\text{BMI} \geq 30 \text{ kg/m}^2$). Overweight and obese were used to create a binary outcome variable which was coded as: being overweight/obese ($\text{BMI} \geq 25$) =1; not overweight/obese =0 ($\text{BMI} < 25$).

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Patient and Public involvement

Since this was a cross-sectional study respondents were drawn from the general population rather than from healthcare settings, thereby providing access to all eligible people aged 15 years and above. As part of the study protocol all respondents were requested to sign a consent form and were told that participation in the study was voluntary. It was also highlighted to respondents that only the general findings of the study shall be shared to insure confidentiality.

Measurement of variables

Information for NCD risk factors was collected through self-reports. For tobacco smoking - the survey question asked respondent: 'Do you currently smoke any tobacco products such as cigarettes, cigars or pipes? This variable was coded such that yes=1 and no=0. Alcohol consumption was derived from the question: 'Have you ever consumed alcohol in the past 30 days?' This variable was used because in Botswana, it has been observed that alcohol consumers are heavy drinkers²⁵. The resultant variable was yes=1 and no=0. For poor physical activity, four key features of the quality of physical activity measures (e.g. activity type, intensity, frequency, and duration) are usually considered when choosing one for a research study. For this study the following two questions asking respondents about moderate and vigorous intensity physical activity were used. Activity at work asked the following questions: "Does your work involve vigorous-intensity activity that causes large increases in breathing or heart rate like [examples] for at least 10 minutes continuously?" and "Does your work involve moderate-intensity activity that causes small increases in breathing or heart rate such as brisk walking for at least 10 minutes continuously?". Different types of responses to the two levels of physical

activities have been grouped together and given a value based on the intensity of the activity. The resultant variable was coded such that those who responded ‘yes’=1 (physically active) and those who said ‘no’ were coded=0 (or poor physically active).

For the measurement of insufficient or non-consumption of fruits and vegetables the following question was asked to assess fruit and vegetable consumption in the population; “How many servings of fruits do you eat on one of those days (on a typical day)?” and “How many servings of vegetables do you eat on one of those days (On a typical day)”.The resultant variable was coded such that people who reported to have taken more than 5 servings of fruit and vegetables were given a code, sufficient intake=0 and those who reported to have taken less than 5 servings were given a code insufficient intake=1.This was done based on the general recommendation by the WHO panel on diet, nutrition and chronic disease prevention that considers poor fruit/vegetables intake as having less than 5 servings of fruits and vegetables in a day.

A wealth index (WI) was constructed to be a measure of wealth status. WI is a composite measure of, typically, indicators of ownership of consumer durables, housing characteristics, and access to public services. Information on a range of durable assets was collected during the survey (e. g. car, refrigerator, television,), housing characteristics (e. g. material of dwelling floor and roof, main cooking fuel), access to basic services (e. g. electricity supply, source of drinking water, sanitation facilities) and ownership of livestock (e.g. cattle, goats, sheep, horses, chickens). Further to collection of information on durable assets, information on land and livestock ownership was collected. Principal component analysis was employed to

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derive the wealth index variable, which had five categories from the 1st to the 5th quintile (poorest to richest).

Control variables

Age and place of residence were used as control variables. These variables were conceptualized to have an association with the outcome variable. Therefore to hold their likely association with the outcome variable, they are included in the combined effects model, so that the association between the independent variables becomes isolated and discernible.

Statistical analysis

Data analysis involved descriptive and multivariable analysis. Descriptive analysis provided some basis for further exploration of key determinants of overweight and obesity in Botswana. In the binary logistic regressions, outcome variables were coded as '1' if respondent was overweight/obese and '0' if they were not overweight/obese. Results of logistic regression analysis were presented together with adjusted odds ratios (AOR), 95% confidence intervals (CI) and significance levels. Data analysis was done using SPSS version 25 program. In order to control for cluster effects complex samples module in SPSS has been used since the NCDs survey used multistage sampling technique.

Results

Sample characteristics

Table 1 presents results on the sample description for the respondents. The results show that a total of 1,178 respondents between the ages of 15 years and above were successfully interviewed. The sample constituted a high proportion of females

(69.1%) than males (30.9%). The sample age distribution suggests a relatively young study population, with over half (59%) of the sample being less than 39 years of age, and almost three quarters (73.5%) being less than fifty years of age. As age increases, the sample sex distribution becomes more skewed in favour of females, from just fewer than 6 in every ten among those in the 20-24 years age group, to over 7 and 8 out of every ten among respondents over 40 years of age.

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Table 1: Sample Characteristics

Variable	%	N
Sex		
Male	30.9	364
Female	69.1	813
Total		1177
Age in years		
<24	26.4	270
25– 34	29.5	302
35 – 44	19.2	196
45– 54	12.7	130
55 – 64	7.3	75
65+ years	4.9	50
Total	100	1023
Locality Type		
Cities/Towns	30.2	355
Urban Villages	45.4	534
Rural Settlements	24.5	288
Total	100.0	1177
Marital Status		
Never Married	73.8	864
Currently married	17	199
Formerly married	9.2	108
Total	100.0	1171
Highest Level of Education Attained		
Primary or Less	35.5	410
Junior Secondary	27.2	314
Senior Secondary	17.3	200
Tertiary & Over	19.9	230
Total	100.0	1154
Work Status in past 12 months		
Public Sector	10.5	122
Private Sector	15.7	182
Self Employed	11.2	130
Not Employed	37.5	436
Homemaker-Student	18.8	218
Retired-Other	6.4	74
Total	100.0	1162
Wealth status		
Lowest	19.9	234
Second	20.1	237
Middle	19.9	235
Fourth	20.1	237
Highest	19.9	235
Total	100.0	1178

More than two fifths (45.4%) of the population resided in urban villages; just under a third (30.2%) resided in cities and towns while a quarter (24.5%) resided in rural areas and settlements. Almost three quarters (73.8%) of respondents were never married; over a third (35.5%) had primary education or less; over a quarter (27.2%) had junior secondary education while just under a fifth had senior secondary education (17.3%) and tertiary education and over (19.9%). Close to two fifth (37.5%) of respondents were not employed; while over a quarter were employed in either the public (10.5%) or private sector (15.7%). Just over one in every ten (11.2%) were self-employed, while close to a fifth (18.8%) were either home makers or students; while only 6.4 per cent were retired from work.

Table 2 below shows behavioural characteristics of the study population. It shows that prevalence of alcohol consumption was estimated at 17% while tobacco smoking was estimated at 11.5%. However, since prevalence rate for smoking represents active smokers and not passive (second-hand smokers) it may be a misrepresentation of the effects of tobacco smoking in the general population. Poor physical activity was also high in the study population with 48.9% of respondents indicating that they were physically inactive. Poor fruit and vegetable (FV) consumption calculated based on the general recommendation by the WHO panel on diet, nutrition and chronic disease prevention that considers poor fruit/vegetables intake as having less than 5 servings of fruits and vegetables in a week was estimated at 82.5%.

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Table 2: Behavioural characteristics of the study population

Variable	%	N
Smoking?		
Yes	11.5	136
No	88.5	1042
Total		1178
Alcohol consumption		
Yes	17.3	204
No	82.7	974
Total		1178
Poor physical activity		
Yes	48.9	576
No	51.1	602
Total		1147
Fruit and vegetable intake?		
Poor fruit/vegetable intake	82.5	1045
Sufficient intake	17.5	133
Total		1178

Prevalence of overweight/obesity

Estimated prevalence of overweight/obesity in the sampled study population was 41.3% (Table 3). There were significant gender differences in prevalence of overweight/obesity. It was found that women than men (48.6% in women, 25.5% in men) were found to be overweight/obese. It was observed that individuals residing in rural areas (46.8%), public sector employee (55.2%) and those with lower education (45%) showed high prevalence rates for overweight/obesity. However, it was found that wealth status was not significantly linked with overweight/obesity. Among

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behavioural factors this study offers evidence that non-smoker (42.9%) showed high prevalence rates of overweight/obesity. Meanwhile alcohol consumption, poor physical activity and poor FV consumption did not show any significant association with overweight and obesity.

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Table 3: Prevalence of overweight/obesity by socioeconomic and behavioural characteristics of the study population

Variable	%	N	P-value
Sex			
Male	25.5	364	0.000**
Female	48.6	813	
Age			0.000**
≤24	21.8	270	
25-34	36.8	302	
35-44	53	196	
45-54	54.5	130	
55-64	61.8	75	
65+	43.8	50	
Marital status			0.000**
Never-married	35.5	864	
Currently-married	62.2	199	
Formerly-married	54.1	108	
Education			0.019**
Primary or less	45.4	410	
Secondary	36.7	514	
Tertiary or higher	44.6	230	
Residence			0.008**
Cities and towns	37.9	355	
Urban villages	41	534	
Rural villages	46.8	288	
Work status			0.000**
Public sector	52.2	122	
Private sector	36.8	182	
self-employed	55	130	
Not employed	45.8	436	
Home-maker/student	29.4	218	
Retired/other	40.3	74	
Wealth status			0.765
Lowest	38.8	234	
second	43.2	237	
middle	41.1	235	
Fourth	39.7	237	
Highest	44.1	235	
Alcohol consumption			0.445
No	33.3	766	
yes	37.7	412	
Smoking			0.004**
Yes	29.7	136	

No	42.9	1042	
Poor physical activity			0.547
Yes	41.5	376	
No	39.6	771	
Poor fruit/vegetable consumption			0.832
No	41.9	133	
yes	43	1045	
Overall	41.3	1178	

Note: **Statistically significant at $p \leq 0.05$.

Determinants of overweight/obesity

Table 4 indicates results of the logistic regression model for overweight/obesity with socioeconomic and behavioural factors. One unadjusted and two adjusted models were run. Model I assessed the association between overweight/obesity and each of the socioeconomic variables and behavioural factors, Model II assessed the association between overweight/obesity adjusting for socioeconomic factors, while Model III assess the association between overweight/obesity adjusting for both socioeconomic and behavioural factors. It was observed that gender was a significant correlate of overweight/obesity when controlling for both socioeconomic and behavioural factors. Women were observed to be 2 times (AOR=2.74, 95% C.I. =1.92-3.90) more likely to be overweight/obese than men.

It was also found that the odds of being overweight/obese increased with age after controlling for socioeconomic and behavioural factors and were highest among individuals aged 55-64 years (AOR=5.53, 95% C.I. = 2.62-11.6), but declined at ages 65+ years (AOR=2.88, 95% C.I. = 1.21-6.86). Education was also a found to be a significant factor associated with overweight/obesity in the study population

after controlling for socioeconomic covariates. It was found that individuals who had secondary (AOR=1.70, 95% C.I. = 1.11-2.61) and tertiary or higher (AOR=1.99, 95% C.I. =1.16-3.38) education were more likely to be overweight/obese than individuals with primary or less education. Meanwhile, there was no significant relationship observed between work status, wealth status and overweight/obesity in the general study population.

It was found that in the crude model for the association between a risk factor and overweight/obesity only smoking (OR=0.56, C.I. =0.37-0.83) and alcohol consumption (OR=0.66, C.I. =0.47-0.91) were found to be negatively associated with overweight/obesity. Meanwhile, poor physical activity and fruit and vegetable consumption did not show any significant association with overweight/obesity. Adjustment for other socioeconomic variables and risk factors suggested that variations in smoking accounted for part of the socioeconomic variation in overweight/obesity. For instance it was noted the odds of overweight/obesity increased two times (AOR=2.16, 95% C.I. = 1.22-3.83) among smokers than non-smokers. Overweight/obesity was also significantly associated with poor physical activity (AOR=1.46, 95% C.I. =1.03-3.24) after adjustment for both socioeconomic and behavioural factors.

Table 4: Odds ratios for the association between overweight/obesity, socioeconomic and behavioural variables in the study population, NCD study 2016

Variable	Model I		Model II		Model III	
	Exp	C.I.	Exp B	C.I.	Exp B	C.I.
Sex						
Male	1.00		1.00		1.00	
Female	2.75**	(2.08-3.64)	3.01**	(2.12-4.26)	2.74**	(1.92-3.90)
Age						
≤24	1.00		1.00		1.00	
25-34	2.08**	(1.42-3.03)	1.77**	(1.12-2.77)	1.83**	(1.17-2.88)
35-44	4.02**	(2.67-6.08)	3.70**	(2.23-6.12)	3.87**	(2.34-6.42)
45-54	4.28**	(2.70-6.78)	3.04**	(1.66-5.55)	3.26**	(1.78-5.98)
55-64	5.78**	(3.26-10.2)	4.91**	(2.35-10.2)	5.53**	(2.62-11.6)
65+	2.78**	(1.46-5.28)	2.74**	(1.15-6.50)	2.88**	(1.21-6.86)
Marital status						
Never-married	0.46**	(0.30-0.71)	0.68	(0.34-1.34)	0.66	(0.33-1.32)
Currently-married	1.39	(0.84-2.29)	1.34	(0.66-2.71)	1.28	(0.63-2.61)
Formerly-married	1.00		1.00		1.00	
Education						
Primary or less	1.00		1.00		1.00	
Secondary	0.69**	(0.53-0.91)	0.49**	(0.29-0.83)	1.70**	(1.11-2.61)
Tertiary or higher	0.96	(0.69-1.35)	0.87	(0.58-1.32)	1.99**	(1.16-3.38)
Residence						
Cities and towns	1.00		1.00		1.00	
Urban villages	1.13	(0.86-1.50)	1.06	(0.74-1.50)	1.07	(0.75-1.52)
Rural villages	1.44**	(1.04-1.99)	1.37	(0.88-2.12)	1.37	(0.88-2.12)
Work status						
Public sector	1.61	(0.89-2.93)	1.30	(0.64-2.65)	1.22	(0.59-2.50)
Private sector	0.86	(0.49-1.51)	1.20	(0.61-2.36)	1.19	(0.60-2.35)
self-employed	1.18	(0.65-2.13)	1.24	(0.61-2.51)	1.29	(0.63-2.62)
Not employed	1.25	(0.75-2.08)	1.30	(0.70-2.40)	1.30	(0.70-2.41)
Home-maker/student	0.61	(0.35-1.07)	0.96	(0.48-1.92)	0.96	(0.48-1.92)
Retired/other	1.00		1.00		1.00	
Wealth status						
Lowest	0.80	(0.55-1.17)	0.60	(0.34-1.05)	1.03	(0.64-1.68)
second	0.96	(0.66-1.40)	0.67	(0.40-1.11)	1.12	(0.68-1.85)
middle	0.88	(0.60-1.28)	0.73	(0.45-1.19)	1.20	(0.71-2.01)
Fourth	0.83	(0.57-1.21)	0.79	(0.50-1.23)	1.53	(0.87-2.69)
Highest	1.00		1.00		1.00	

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Smoking		N.I	
Yes	0.56* (0.37-0.83)		2.16** (1.22-3.83)
No	1.00		1.00
Poor physical activity		N.I	
Yes	1.08 (0.83-1.40)		1.46** (1.03-3.24)
No	1.00		1.00
Poor fruit/vegetable consumption		N.I	
Yes	0.82 (0.55-1.22)		0.80 (0.28-2.24)
no	1.00		1.00
Alcohol consumption		N.I	
Yes	0.66* (0.47-0.91)		1.23 (0.53-2.83)
No	1.00		1.00

N.I- not included

Model I: Crude model; Model II: socioeconomic variables included; Model III: socioeconomic + behavioural characteristics included. **statistically significant at $p \leq 0.05$.

Discussion

Estimated prevalence of overweight/obesity in the study population was 41.3%. This high prevalence is similar to the growing prevalence of overweight/obesity sweeping across Southern Africa, with national prevalence rates ranging between 30 and 60% among populations over the age of 15 years in most countries^{10,26-31}. The high prevalence of overweight/obesity observed in Botswana may be attributed to: dietary shift away from high-fibre, low-calorie diets rich in fruits and vegetables towards refined, energy-dense foods high in fat, calories, sweeteners and salt²⁷ and to low physical activity due to transition from agrarian to a sedentary industrial society³².

The existence of socioeconomic differences in overweight/obesity prevalence is a well-established finding, and has been previously confirmed³³⁻³⁴. This study adds to those findings. In particular, this analysis suggests that more women than men were overweight/obese. For example, women were found to be two times more likely to be overweight/obese than men. Literature yields mounting evidence on the gender differential for overweight/obesity across and within countries³⁵⁻³⁷. While in some developed countries such as the US and the UK men have been observed to be more overweight than women³⁸, in developing countries women are noted to be overweight than men^{35,39}. However, although gender differences for overweight and obesity vary greatly within and between countries, overall women are likely to be overweight and obese than men. Similarly in this data it was noted that gender disparities in overweight and obesity were exacerbated among women, like elsewhere in developing countries, especially in the Middle East and SSA³⁵.

Gender differences in overweight/obesity observed between developed and developing countries with weight gain high among men in developed countries and

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high among women in developing countries indicate that gender disparities in excess weight gain are explained by myriad sociocultural dynamics. For instance, acculturation, through complex sociocultural pathways, affects weight gain among both men and women. Moreover, the nutrition transition taking place in many developing countries has also affected excess weight gain among both genders, but has had an even greater impact on the physical activity levels of women⁴⁰. Furthermore, in some countries, cultural values favour larger body size among women or men as a sign of fertility, healthfulness, or prosperity especially in SSA⁴¹. Other studies suggest that contextual factors drive gender differences in food consumption, and women often report consuming healthier foods, yet may consume more sugar-laden foods, than men⁴².

Similarly, in Botswana gender differences in overweight/obesity can be explained by a wide array of sociocultural dynamics. Firstly, although women are more likely to report eating or wanting to eat “healthier” foods, they seem to prefer and consume more foods high in added sugars than men including energy-dense processed foods such as cookies, chocolate, and ice cream. Secondly, overweight among women may also be attributed to comparatively low levels of physical activity⁴³. Moreover, like in other African settings, being overweight/obese among Botswana women is considered as a sign of social status, fertility, good health and prosperity³⁹.

The odds of being overweight/obese increased with age after controlling for socioeconomic and behavioural factors. This is quite indicative that age is a significant correlate of overweight/obesity independent of other covariates. It was found that odds of being overweight and obese increased with age and were highest among individuals aged 55-64 years but declined at ages 65+ years. This finding corroborates data from large population studies⁴⁴⁻⁴⁶ which shows that mean body

weight and BMI gradually increases during most of adult life and reach peak values at 50–59 years of age in both men and women and after the age of 60 years, mean body weight and BMI tend to decrease.

Clinically it has been found that aging is associated with considerable body changes in body composition⁴⁷. It has been suggested that after 20–30 years of age, fat-free mass (FFM) progressively decreases, whereas fat mass increases⁴⁸. Aging is also associated with a redistribution of both body fat and FFM whereby there is a greater relative increase in intra-abdominal fat than in subcutaneous or total body fat, and there is a greater relative decrease in peripheral than in central FFM because of the loss of skeletal muscle⁴⁹. This possibly explains the observed pattern noted in this data of having high odds of overweight/obesity among the elderly than the young population.

Education differences were also observed for overweight/obesity. It was found that individuals who had secondary and tertiary education were more likely to be overweight/obese than individuals with primary or less education. This finding corroborates other studies which have shown that education may be associated with overweight/obesity via socioeconomic status, literacy and health behaviors⁵⁰. Furthermore, studies which have used education as a proxy for socioeconomic status in developing countries have shown that individuals with high educational attainment were more likely to be obese⁵¹. The relationship between educational attainment and obesity also depends on the individual's level of development, such that positive associations are more common in more educated groups⁵².

There was no significant relationship observed between overweight/obesity and work status and wealth status in the general study population. The observed pattern of no association between overweight/obesity and work and wealth status may suggest

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that in Botswana, there is no diet differences based on the wealth and work status of individuals. Moreover, Botswana has over the decades moved from lower human development index (HDI) to middle HDI, consequently leading to nutrition transition where both the poor and non-poor have access to diets with more fat, more meat, added sugars and bigger portion sizes, and lower physical activity.

Adjustment for known risk factors suggested that variations in smoking accounted for part of the socioeconomic variation in overweight/obesity. It was noted the odds of overweight/obesity increased two times among smokers than non-smokers. Chiolero *et al.*⁴¹ based on literature review observed that heavy smokers tend to have greater body weight than do light smokers or non-smokers, which likely reflect a clustering of other risky behaviours (e.g. low level of physical activity, poor diet, and smoking) that is conducive to weight gain²³⁻²⁴. In this dataset it was observed that smoking, among men clustered with poor diet and alcohol consumption.

Overweight/obesity was significantly associated with poor physical activity. A decline in physical activity leads to adiposity. This has been established in literature⁵³⁻⁵⁴. It has been shown that although there is genetic predisposition to overweight/obesity, overweight/obesity can also result from an energy imbalance between calories consumed and calories expended⁵⁵. This may be due to lack of physical activity ultimately leading to decreases in energy expenditure (perhaps creating a chronic energy imbalance), than to increases in energy intake, strongly implicating physical inactivity in the aetiology of overweight/obesity. The relationship between overweight and obesity and poor physical activity can be bidirectional, whereby poor physical activity leads to overweight/obesity and also overweight/obesity may lead to further poor physical activity hence predisposing individuals to chronic diseases such as hypertension and diabetes²⁹.

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Conclusion

Findings from this study indicate high levels of overweight/obesity in Botswana. Key socioeconomic factors associated with overweight/obesity are being a woman, increasing age, and high education (secondary and tertiary level education). Behavioral factors found to be positively associated with overweight/obesity were smoking and poor physical activity. These results demonstrate that socioeconomic and behavioural factors play an important role in prevalence of overweight/obesity in Botswana. Consequently any programs and interventions for reduction and management of overweight/obesity should focus on women, adults, individuals with high education,smokers and physically inactive people.

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Contributors

MK conceived and undertook the study as part of his PhD research. KN was the lead investigator, while MK, GL, KB, SDR, LG, TM and RM were co-investigators and takes responsibility for the integrity of the data. KN, KB, and MK oversaw the NCD study design and data analysis. MK wrote the first draft of the article. All authors reviewed and approved the final draft of the article.

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Disclaimer

The funding body had no role in the design of the study, analyses, interpretation or decision to submit the manuscript for publication.

Competing Interests

None declared

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Participant consent

Obtained

Ethics Approval

All ethical clearance formalities were completed before the start of the study. The study proposal along with the necessary documents was submitted to Institutional Review Board of the University of Botswana and Ministry of Health and Wellness for ethical clearance.

Data sharing statement

The dataset used and/or analysed during the current study is available from the corresponding author (Mpho Keetile) on reasonable request from the Office of Research and Development, University of Botswana.

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Socioeconomic and behavioural determinants of overweight/obesity among adults in Botswana: A cross-sectional study

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Abstract

Objective

To undertake a comprehensive assessment of socioeconomic and behavioural determinants of overweight/obesity among adult population in Botswana.

Design

The study adopted a cross-sectional design by selecting adult respondents in three cities and towns, fifteen urban villages and fifteen rural areas across Botswana using a multistage probability sampling technique.

Setting

The study was conducted in selected rural and urban areas of Botswana.

Participants

The study sample consisted of 1178 adult males and females aged 15 years and above.

Primary Outcome Measures

Objectively measured overweight/obesity.

Results

Prevalence of overweight/obesity in the study population was estimated at 41%. The adjusted odds ratio (AOR) of overweight/obesity were highest among women (AOR=2.74, 95% C.I. =1.92-3.90), in ages 55-64 years (AOR=5.53, 95% C.I. = 2.62-11.6), among individuals with secondary (AOR=1.70, 95% C.I. = 1.11-2.61) and tertiary education (AOR=1.99, 95% C.I. =1.16-3.38), smokers (AOR=2.16, 95% C.I. = 1.22-3.83) and people with poor physically activity (AOR=1.46, 95% C.I. =1.03-3.24). These were statistically significant at 5% level.

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Conclusion

Being female, elderly, of high education levels, a smoker and having poor physical activity were identified as key factors for prevalence of overweight/obesity. These findings suggest the need for broad based strategies encouraging physical activity among different socioeconomic groups.

Key words

Overweight, Obesity, socioeconomic, behavioural, Botswana

Strengths and Limitations of the study

- To our knowledge this is the first cross-sectional study in Botswana to comprehensively assess both the socioeconomic and behavioural determinants of overweight/obesity among adults.
- Data were collected from a large and randomly selected representative population. The data contained information on potential confounding factors, with a low proportion of missing information making the study more comparable.
- As the cross sectional design was employed, the causal relationship between an explanatory and an outcome variable was not established.

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Introduction

The disease profile in Botswana is changing, with most deaths and disability in the foreseeable future likely to be accounted for by the ominous epidemics of non-communicable diseases (NCDs) such as heart disease, stroke, cancer and other chronic diseases. Children, adults and the elderly are all vulnerable to the risk factors that contribute to NCDs especially overweight/obesity, due to unhealthy diets, low physical activity, exposure to tobacco smoke and/or the effects of the harmful use of alcohol¹⁻³. The key drivers of NCDs are ageing, rapid unplanned urbanisation, and the globalisation of unhealthy lifestyles. For example, globalization of unhealthy lifestyles like unhealthy diets may show up in individuals as raised blood pressure, increased blood glucose, elevated blood lipids, and overweight/ obesity¹.

Several studies have recently shown that many low income and middle-income countries (LMICs) are experiencing an increase in the prevalence of overweight/obesity⁴⁻⁶. This prevalence is predicted to continue to increase in the future. Much of the increase in prevalence levels for overweight/obesity is expected in countries such as India, some parts of South-East Asia, China, most of South America and some parts of Sub Saharan Africa (SSA)⁷⁻⁸. Until recently, SSA was minimally affected by the overweight/obesity epidemic due to under-nutrition and a major burden of Human Immuno Deficiency Virus (HIV) and tuberculosis (TB)⁹. Meanwhile research on overweight/obesity has started to gain significance in SSA¹⁰⁻¹⁴ due to its increasing magnitude.

It has been shown by previous studies that socioeconomic and behavioural factors have a significant association with overweight/obesity¹⁵⁻¹⁶. These studies have shown that socioeconomic and demographic factors such as sex, age, education level, work

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status, place of residence and wealth status are significant determinants of overweight/obesity. It has also been found that women are more likely to be overweight/obese than men, while the odds of being overweight/obesity has been seen to increase with age¹⁷⁻¹⁹. Other studies have shown that being employed in a high income job, residing in urban areas, having high education and wealth status is significantly associated with overweight/obesity²⁰.

There is also available evidence which suggest significant correlation between behavioural factors and overweight/obesity. For example, there is significant evidence of a positive association between physical inactivity and the prevalence of overweight/obesity²¹. It has also been suggested that the relation between physical activity and health outcomes such as overweight/obesity may be moderated by a number of lifestyle factors, especially sedentary lifestyle^{15, 20, 21}. In many developing countries, there has been a substantial shift from jobs with high-energy expenditure such as farming, mining, and forestry, and employment is inclined towards the more-sedentary sectors of manufacturing, services and office based-work²². Moreover, there have been changes in lifestyle behaviours condoning alcohol consumption, poor diets and smoking. These are also key risk factors of overweight/obesity²³⁻²⁴.

The Botswana WHO STEPS surveys conducted in 2007 and 2014 have shown increasing levels of overweight/obesity in the general adult population of Botswana. Prevalence of overweight/obesity was 18.7% in 2007²⁵ and increased to 38.6 % in 2014²⁶. Despite evidence of the high prevalence of overweight/obesity in Botswana, there is little evidence of socioeconomic and behavioural determinants of overweight/obesity. To the best of our knowledge this is the first cross sectional study

which takes into account both socioeconomic and behavioural factors for understanding the heterogeneity of overweight/obesity in Botswana. The reduction of overweight/obesity prevalence should be a key goal of health-care policy because of its association with many NCDs. The main objective of this study was to assess socioeconomic and behavioural determinants associated with overweight/obesity prevalence in Botswana.

Methods

Sampling, recruitment and ethics

The study used cross sectional design by selecting respondents in three cities and towns, fifteen urban villages and fifteen rural areas across Botswana using a multistage probability sampling technique. A list of districts, localities and enumeration areas (EAs) together with their households was made based on the 2011 Botswana Population and Housing census to make sampling frame. At the first stage the population was stratified into cities and towns, urban villages and rural settlements. A listing of all 26 census districts in each strata was made and from these districts a total of all 4845 EAs were listed for rural and urban localities. At the second stage, localities in urban and rural districts were randomly selected. At the third and fourth stage a random selection of EAs and households, respectively was made. Lastly, individuals aged 15 years and over were selected for interview from the list of households with persons 15 years and over. The NCD study questionnaire was developed using the instruments from the WHO Study on Global Ageing and Adult Health (SAGE), and WHO STEPS Surveys.

All ethical clearance formalities were completed before the start of the study. The study proposal along with the necessary documents were submitted to and approved by the Institutional Review Board of the University of Botswana. Approval for conducting the study was also obtained from the Government of Botswana through the Ministry of Health and Wellness. Privacy and confidentiality of highest standard were maintained by treating all respondents as anonymous and no names of respondents are mentioned or implied when presenting findings of the study.

Patient and Public involvement

No patients were involved in developing the research question, outcome measures and overall design of the study. Since this was a cross-sectional study, respondents were drawn from the general population rather than from healthcare settings, thereby providing access to all eligible people aged 15 years and above. As part of the study protocol, all respondents were requested to sign a consent form and were told that participation in the study was voluntary. For participants aged 15-17 years both consent and assent were obtained. All individuals aged 15 years and above who had successfully completed the NCD study questionnaire were included in the analysis for this study.

Definitions and Measurement of variables

The outcome variable for the study is overweight/obesity. Body Mass Index (BMI) was used to classify overweight/obesity. BMI was derived from weight and height: weight (kg) / (height (m) x height (m))¹. The Charder MS7301 250Kg digital scale and the Muac measuring tape were used for anthropometric measurements. Weight was measured, to the nearest 0.1kg, while height was measured in metres. BMI was categorized into: underweight (BMI < 18.5 kg/m²), normal weight (18.5 ≤ BMI <25

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kg/m²), overweight ($25 \leq \text{BMI} < 30 \text{ kg/m}^2$) and obese ($\text{BMI} \geq 30 \text{ kg/m}^2$)¹. Overweight and obese were used to create a binary outcome variable which was coded as: being overweight/obese ($\text{BMI} \geq 25 \text{ kg/m}^2$) =1; not overweight/obese =0 ($\text{BMI} < 25 \text{ kg/m}^2$).

Information on NCD risk factors was collected through self-reports. Respondents were asked questions on NCD risk factors such as tobacco use, alcohol consumption, physical activity and fruit and vegetable consumption. For tobacco use, respondents were asked whether they currently smoke tobacco products and their response was coded as yes=1 and no=0. Alcohol consumption was measured based on the intensity of alcohol consumed in the past 30 days. Respondents who had consumed alcohol in the past 30 days were asked about the number of standard alcohol drinks they had each day in the past 7 days and if they reported to have had three or more drinks per day (of approximately 60g alcohol) it was considered to be excessive drinking=1 and 0=otherwise.

Based on WHO recommendations poor physical activity was calculated using an average typical types of activity undertaken¹³. It was calculated based on the time taken while doing physical activity in the past 7 days. Respondents were asked whether they do any moderate to vigorous intensity activities for at least 10 minutes continuously. This was considered for the domains of work and walking (includes at work and at home, walking to travel from place to place, and any other walking for recreation, sport, exercise, or leisure). Based on the time taken on work and walking the respondents were grouped into four categories of: no activity, low, moderate and high activity levels to show the intensity of their physical activity. The resultant variable was coded such that no and low activity (<10 minutes of physical activity) =1 and moderate and high activity (≥ 10 minutes of physical activity) were coded=0.

Poor fruit and vegetables consumption was created when an individual reported daily consumption of less than the recommended 5 servings of fruit and vegetables. Respondents reported the number of servings for fruits/vegetables they had in a typical day, and if the servings were less than 5 in a day, they were considered to be having poor fruit/vegetable consumption^{13, 27, 28}.

A wealth index (WI) was constructed to be a measure of wealth status. WI is a composite measure of, indicators of ownership of consumer durables, housing characteristics, and access to public services¹⁶. Information on a range of durable assets was collected during the survey (e. g. car, refrigerator, television,), housing characteristics (e. g. material of dwelling floor and roof, main cooking fuel), access to basic services (e. g. electricity supply, source of drinking water, sanitation facilities) and ownership of livestock (e.g. cattle, goats, sheep, horses, chickens). Further to collection of information on durable assets, information on ownership of land was also collected. Principal component analysis was employed to derive the wealth index variable, which had five categories from the 1st to the 5th quintile (poorest to richest).

Control variables

Age and place of residence were used as control variables. These variables were conceptualized to have an association with the outcome variable. Therefore, as control variables they are included in the combined effects model, so that the association between the independent variables of interest becomes isolated and discernible.

Statistical analysis

Data analysis involved descriptive and multivariable analysis. Descriptive analysis provided some basis for further exploration of key determinants of overweight and obesity in Botswana. In the multivariable binary logistic regression, outcome variable

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was coded as '1' if respondents were overweight/obese and '0' if they were not overweight/obese. Results of logistic regression analysis were presented together with adjusted odds ratios (AOR), 95% confidence intervals (CI) and 5% statistical significance level. Chi-square test was used for bivariate analysis. Data analysis was done using SPSS version 25 program. Since this was a population based study representative of the population, selection bias was minimal. Moreover the use of systematic random sampling across the population meant that selection bias was minimised further. In order to control for cluster effects complex samples module in SPSS has been used since the NCDs survey used multistage sampling technique.

Results

Sample characteristics

Table 1 presents results on the sample description for the respondents. The results show that a total of 1,178 respondents between the ages of 15 years and above were successfully interviewed. The sample constituted a high proportion of females (69.1%) than males (30.9%). The sample age distribution suggests a relatively young population, with over half (59%) of the sample being less than 39 years of age, and almost three quarters (73.5%) being less than fifty years of age. As age increases, the sample skewed in favour of females.

Table 1: Socio demographic characteristics

Variable	N	%
Sex		
Male	364	30.9
Female	813	69.1
Total	1177	100

Age in years		
<24	270	26.4
25– 34	302	29.5
35 – 44	196	19.2
45– 54	130	12.7
55 – 64	75	7.3
65+ years	50	4.9
Total	1023	100
Locality Type		
Cities/Towns	355	30.2
Urban Villages	534	45.4
Rural Settlements	288	24.5
Total	1177	100
Marital Status		
Never Married	864	73.8
Currently married	199	17.0
Formerly married	108	9.2
Total	1171	100
Highest Level of Education Attained		
Primary or Less	410	35.5
Junior Secondary	314	27.2
Senior Secondary	200	17.3
Tertiary & Over	230	19.9
Total	1154	100
Work Status in past 12 months		
Public Sector	122	10.5
Private Sector	182	15.7
Self Employed	130	11.2
Not Employed	436	37.5
Homemaker-Student	218	18.8
Retired-Other	74	6.4
Total	1162	100
Wealth status		
Lowest	234	19.9
Second	237	20.1
Middle	235	19.9
Fourth	237	20.1
Highest	235	19.9
Total	1178	100

More than two fifths (45.4%) of the population resided in urban villages; while the remaining proportion resided in cities and towns (30.2%), and rural areas (24.5%).

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3 Almost three quarters (73.8%) of respondents were never married; over a third
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5 (35.5%) had primary education or less; over a quarter (27.2%) had junior secondary
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7 education while just under a fifth had senior secondary education (17.3%) and tertiary
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9 education (19.9%). Close to two fifth (37.5%) in the sample were not employed; over
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11 a quarter were employed in either the public or private sector (26.2%) while the
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13 remaining proportion were either self-employed (11.2%) , home makers or students
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15 (18.2%) and retirees (6.4%).
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Table 2 below shows behavioural characteristics of the study population. It shows that prevalence of alcohol consumption was estimated at 17.3% while tobacco smoking was estimated at 11.5%. Poor physical activity was also high in the study population with 48.9% of respondents indicating poor physical activity. Poor fruit and vegetable intake was estimated at 82.5%.

Table 2: Behavioural characteristics of the study population

Variable	N	%
Smoking		
Yes	136	11.5
No	1042	88.5
Total	1178	100
Alcohol consumption		
Yes	204	17.3
No	974	82.7
Total	1178	100
Poor physical activity		
Yes	576	48.9
No	602	51.1
Total	1178	100
Poor fruit/vegetable intake		
Yes	1045	82.5
No	133	17.5
Total	1178	100

Prevalence of overweight/obesity

Estimated prevalence of overweight/obesity in the study population was 41.3% (Table 3). There were significant gender differences in prevalence of overweight/obesity. It was found that women than men (48.6% among women, 25.5% among men) were overweight/obese. It was observed that individuals residing in rural areas (46.8%), public sector employees (55.2%) and those with lower education (45%) showed high prevalence rates for overweight/obesity. Meanwhile it was found that wealth status was not significantly linked with overweight/obesity. Among behavioural factors this

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3 study offers evidence that non-smoker (42.9%) showed high prevalence rates of
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5 overweight/obesity. Alcohol consumption, poor physical activity and poor fruits and
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7 vegetable consumption did not show any significant association with
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Table 3: Prevalence of overweight/obesity by socioeconomic and behavioural characteristics of the study population

Variable	N	%	P-value
Sex			
Male	364	25.5	0.000**
Female	813	48.6	
Age			0.000**
≤24	270	21.8	
25-34	302	36.8	
35-44	196	53.0	
45-54	130	54.5	
55-64	75	61.8	
65+	50	43.8	
Marital status			0.000**
Never-married	864	35.5	
Currently-married	199	62.2	
Formerly-married	108	54.1	
Education			0.019**
Primary or less	410	45.4	
Secondary	514	36.7	
Tertiary or higher	230	44.6	
Residence			0.008**
Cities and towns	355	37.9	
Urban villages	534	41.0	
Rural villages	288	46.8	
Work status			0.000**
Public sector	122	52.2	
Private sector	182	36.8	
self-employed	130	55.0	
Not employed	436	45.8	
Home-maker/student	218	29.4	
Retired/other	74	40.3	
Wealth status			0.765
Lowest	234	38.8	
second	237	43.2	

middle	235	41.1	
Fourth	237	39.7	
Highest	235	44.1	
Alcohol consumption			0.445
No	766	33.3	
yes	412	37.7	
Smoking			0.004**
Yes	136	29.7	
No	1042	42.9	
Poor physical activity			0.547
Yes	376	41.5	
No	771	39.6	
Poor fruit/vegetable consumption			0.832
No	133	41.9	
yes	1045	43.0	
Overall	1178	41.3	

Note: **Chi-square test statistically significant at $p < 0.05$.

Determinants of overweight/obesity

Table 4 indicates results of the logistic regression model for overweight/obesity with socioeconomic and behavioural factors. One unadjusted and two adjusted models were run. Model I assessed the association between overweight/obesity and each of the socioeconomic variables and behavioural factors, Model II assessed the association between overweight/obesity adjusting for socioeconomic factors, while Model III assess the association between overweight/obesity adjusting for both socioeconomic and behavioural factors. It was observed that gender had a significant association with overweight/obesity when controlling for both socioeconomic and behavioural factors. Women were observed to have more than 2 times (AOR=2.74, 95% C.I. =1.92-3.90) greater odds for overweight/obesity than men.

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The odds of being overweight/obese increased with age after controlling for socioeconomic and behavioural factors and were highest among individuals aged 55-64 years (AOR=5.53, 95% C.I. = 2.62-11.6), but declined at ages 65+ years (AOR=2.88, 95% C.I. = 1.21-6.86). Education was also found to be a significant factor associated with overweight/obesity in the study population after controlling for socioeconomic covariates. Further, individuals who had secondary (AOR=1.70, 95% C.I. = 1.11-2.61) and tertiary or higher education (AOR=1.99, 95% C.I. =1.16-3.38) were found to have higher probability of being overweight/obese than individuals with primary or less education. Meanwhile, there was no significant relationship observed between work status, wealth status and overweight/obesity in the general study population.

The association between smoking and alcohol consumption with overweight/obesity was found to be negative in the crude model. However, controlling for other socioeconomic and demographic factors, the odds of overweight/obesity increased two times (AOR=2.16, 95% C.I. = 1.22-3.83) among smokers than non-smokers. Overweight/obesity was also significantly associated with poor physical activity (AOR=1.46, 95% C.I. =1.03-3.24) after adjusting for socioeconomic and behavioural factors.

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Table 4: Odds ratios (OR) for the association of Overweight/obesity with socioeconomic and behavioural variables factors in the study population, NCD study 2016.

Variable	Model I		Model II		Model III	
	OR	C.I.	OR	C.I.	OR	C.I.
Sex						
Male	1.00		1.00		1.00	
Female	2.75**	(2.08-3.64)	3.01**	(2.12-4.26)	2.74**	(1.92-3.90)
Age						
≤24	1.00		1.00		1.00	
25-34	2.08**	(1.42-3.03)	1.77**	(1.12-2.77)	1.83**	(1.17-2.88)
35-44	4.02**	(2.67-6.08)	3.70**	(2.23-6.12)	3.87**	(2.34-6.42)
45-54	4.28**	(2.70-6.78)	3.04**	(1.66-5.55)	3.26**	(1.78-5.98)
55-64	5.78**	(3.26-10.2)	4.91**	(2.35-10.2)	5.53**	(2.62-11.6)
65+	2.78**	(1.46-5.28)	2.74**	(1.15-6.50)	2.88**	(1.21-6.86)
Marital status						
Never-married	0.46**	(0.30-0.71)	0.68	(0.34-1.34)	0.66	(0.33-1.32)
Currently-married	1.39	(0.84-2.29)	1.34	(0.66-2.71)	1.28	(0.63-2.61)
Formerly-married	1.00		1.00		1.00	
Education						
Primary or less	1.00		1.00		1.00	
Secondary	0.69**	(0.53-0.91)	0.49**	(0.29-0.83)	1.70**	(1.11-2.61)
Tertiary or higher	0.96	(0.69-1.35)	0.87	(0.58-1.32)	1.99**	(1.16-3.38)
Residence						
Cities and towns	1.00		1.00		1.00	
Urban villages	1.13	(0.86-1.50)	1.06	(0.74-1.50)	1.07	(0.75-1.52)
Rural villages	1.44**	(1.04-1.99)	1.37	(0.88-2.12)	1.37	(0.88-2.12)
Work status						
Public sector	1.61	(0.89-2.93)	1.30	(0.64-2.65)	1.22	(0.59-2.50)
Private sector	0.86	(0.49-1.51)	1.20	(0.61-2.36)	1.19	(0.60-2.35)
self-employed	1.18	(0.65-2.13)	1.24	(0.61-2.51)	1.29	(0.63-2.62)
Not employed	1.25	(0.75-2.08)	1.30	(0.70-2.40)	1.30	(0.70-2.41)
Home-maker/student	0.61	(0.35-1.07)	0.96	(0.48-1.92)	0.96	(0.48-1.92)
Retired/other	1.00		1.00		1.00	
Wealth status						
Lowest	0.80	(0.55-1.17)	0.60	(0.34-1.05)	1.03	(0.64-1.68)
second	0.96	(0.66-1.40)	0.67	(0.40-1.11)	1.12	(0.68-1.85)
middle	0.88	(0.60-1.28)	0.73	(0.45-1.19)	1.20	(0.71-2.01)

Fourth	0.83 (0.57-1.21)	0.79 (0.50-1.23)	1.53 (0.87-2.69)
Highest	1.00	1.00	1.00
Smoking		N.I	
Yes	0.56* (0.37-0.83)		2.16** (1.22-3.83)
No	1.00		1.00
Poor physical activity		N.I	
Yes	1.08 (0.83-1.40)		1.46** (1.03-3.24)
No	1.00		1.00
Poor fruit/vegetable consumption		N.I	
Yes	0.82 (0.55-1.22)		0.80 (0.28-2.24)
no	1.00		1.00
Alcohol consumption		N.I	
Yes	0.66* (0.47-0.91)		1.23 (0.53-2.83)
No	1.00		1.00

N.I- not included, Model I: Crude model; Model II: socioeconomic variables included; Model III: socioeconomic + behavioural characteristics included. **statistically significant at p <0.05.

Discussion

The prevalence of overweight/obesity in the study population was 41.3%. Botswana is also joined with other Southern African countries where the national prevalence rates range between 30% and 60% among populations over the age of 15 years in most countries^{10, 26-31}. Botswana is currently undergoing a nutrition transition from high-fibre, low-calorie diets rich in fruits and vegetables to refined, energy-dense foods high in fat, calories, sweeteners and salt¹² and to low physical activity due to transition from agrarian to a sedentary industrial society³² contributing to a greater risk of overweight/obesity.

The observed socioeconomic differences in overweight/obesity prevalence is well-established finding, and consistent with most previous studies³³⁻³⁴. For example, women were found to have higher odds of being overweight/obese than men. Similar findings were observed in most studies in developing countries³⁵⁻³⁷. However, in some developed countries such as US and UK, it was found that adult men tend to be overweight/obese than adult women³⁸⁻⁴². Contrastingly in developing countries such as Botswana adult women are generally noted to be overweight/obese than men at all ages^{26, 35, 39-40}.

In the context of Botswana, observed gender differences in overweight/obesity in this study may be explained by sociocultural dynamics, whereby acculturation, through complex sociocultural pathways encourages weight gain among women^{26, 40}. For example, in Botswana cultural values favour larger body size among women as a sign of fertility, healthfulness, or prosperity²⁶. One indicative finding from this study was that women reported low levels of physical activity which may also contribute to observed high prevalence of overweight/obesity among them.

The study found that age is associated with overweight/obesity even after controlling for socioeconomic and behavioural factors. Overweight/obesity was highest among individuals aged 55-64 years but declined at ages 65+ years. This finding corroborates data from large population studies⁴³⁻⁴⁶ which show that mean body weight and BMI gradually increases during most of adult life and reach peak values at 50–59 years of age in both men and women and after the age of 60 years, mean body weight and BMI tend to decrease⁴⁷⁻⁴⁹. In South Africa similar findings have been observed that overweight/obesity tends to increase with age²¹.

Education differences were also observed for overweight/obesity. It was found that individuals who had high educational attainment had higher odds of overweight/obese than those with low education. This finding corroborates other studies which have shown that education may be associated with overweight/obesity via socioeconomic status, literacy and health behaviors⁵⁰⁻⁵². There was no significant relationship observed between overweight/obesity and work and wealth status. Other studies in neighbouring countries with comparable Human Development Index (HDI) as Botswana including Namibia and South Africa²⁷⁻²⁸ have also shown no wealth or work status differences in overweight/obesity. There are several reasons to such scenario. These reasons include; rapid and disorganized urbanization, increasing sedentary lifestyles, easy access to and consumption of unhealthy food and high energy drinks among both the poor and non-poor in these countries^{21, 27-28}. Further to this a general observation has been made by Ford et al.⁵² that overweight/obesity is no longer an issue of affluence in majority of low and middle income countries.

Further, the study noted that the odds of overweight/obesity were two times greater among smokers than non-smokers. Tuovinen *et al.*⁴¹ based on literature review observed that heavy smokers tend to have greater body weight than do light smokers

or non-smokers, which likely reflect a clustering of other risky behaviours (e.g. low level of physical activity and poor diet) that is conducive to weight gain²³⁻²⁴. In this study, it was observed that smoking, especially among men clustered with poor diet and alcohol consumption. On the other hand some studies have shown that smoking tends to suppress appetite leading to low BMI among smokers^{10, 21, 30}.

Other important finding in this study is that overweight/obesity was significantly associated with poor physical activity. This is consistent with other studies which have shown that a decline in physical activity leads to adiposity⁵². The interpretation of this finding is that Botswana has undergone a transition from an agrarian to industrial society due to urbanization subsequently leading to industrial modernity. Consequently this has led to an increase in poor physical activity in the general population. Poor physical activity leads to overweight/obesity through energy imbalance between calories consumed and calories expended⁵². Generally formal physical activity that is planned, structured, repetitive, and purposeful is not common in Botswana. Consequently in order to increase physical activity and reduce overweight/obesity there is need for a population-based, multi-sectoral, multi-disciplinary, and culturally relevant approach.

Conclusion

Findings from this study indicate higher prevalence of overweight/obesity in Botswana. Key socioeconomic factors associated with overweight/obesity are being a woman, older, and with higher education (secondary and tertiary level education). Behavioral factors such as smoking and poor physical activity were found to be positively associated with overweight/obesity. These results demonstrate that socioeconomic and behavioural factors play an important role in prevalence of overweight/obesity in Botswana. Botswana's multisectoral national strategic plan implementation framework

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for combating NCDs should focus on developing a community based and people centered awareness about the harmful impact of smoking, alcohol, physically inactivity and poor quality of diet facilitated by comprehensive national monitoring and evaluation framework.

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Contributors

MK conceived and undertook the study as part of his PhD research. KN was the lead investigator, while MK, GL, KB, SDR, LG, TM and RM were co-investigators and takes responsibility for the integrity of the data. KN, KB, and MK oversaw the NCD study design and data analysis. MK wrote the first draft of the article. All authors reviewed and approved the final draft of the article.

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Disclaimer

The funding body had no role in the design of the study, analyses, interpretation or decision to submit the manuscript for publication.

Competing Interests

Nil

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Participant consent

Obtained

Ethics Approval

All ethical clearance formalities were completed before the start of the study. The study proposal along with the necessary documents was submitted to and approved by the Institutional Review Board of the University of Botswana (Ref #: UBR/RES/IRB/1583) and the Ministry of Health and Wellness (Ref #: HPDME: 13/18/1 Vol. X (130)). Privacy and confidentiality of highest standard were maintained by treating all respondents as anonymous and no names of respondents are mentioned or implied when presenting findings of the study.

Data sharing statement

The dataset used and/or analysed during the current study is available from the corresponding author (Mpho Keetile) on reasonable request from the Office of Research and Development, University of Botswana.

Protected by copyright, including for uses related to text and data mining, AI training, and similar technologies.
Enseignement Supérieur (ABES)

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STROBE Statement—Checklist of items that should be included in reports of *cross-sectional studies*

	Item No	Recommendation
Title and abstract	1	<p>(a) Socioeconomic and behavioural determinants of overweight/obesity among adults in Botswana: A cross-sectional study</p> <hr/> <p>(b) Objective</p> <p>To undertake a comprehensive assessment of socioeconomic and behavioural determinants of overweight/obesity among adult population in Botswana.</p> <p>Design</p> <p>The study adopted a cross-sectional design by selecting adult respondents in three cities and towns, fifteen urban villages and fifteen rural areas across Botswana using a multistage probability sampling technique.</p> <p>Setting</p> <p>The study was conducted in selected rural and urban areas of Botswana.</p> <p>Participants</p> <p>The study sample consisted of 1178 adult males and females aged 15 years and above.</p> <p>Primary Outcome Measures</p> <p>Objectively measured overweight/obesity.</p> <p>Results</p> <p>Prevalence of overweight/obesity in the study population was estimated at 41%. The adjusted odds ratio (AOR) of overweight/obesity were highest among women (AOR=2.74, 95% C.I. =1.92-3.90), in ages 55-64 years (AOR=5.53, 95% C.I. = 2.62-11.6), among individuals with secondary (AOR=1.70, 95% C.I. = 1.11-2.61) and tertiary education (AOR=1.99, 95% C.I. =1.16-3.38), smokers (AOR=2.16, 95% C.I. = 1.22-3.83) and people with poor physically activity (AOR=1.46, 95% C.I. =1.03-3.24). These were statistically significant at 5% level.</p> <p>Conclusion</p> <p>Being female, elderly, of high education levels, a smoker and having poor physical activity were identified as key factors for prevalence of overweight/obesity. These findings suggest the need for broad based strategies encouraging physical activity among different socioeconomic groups.</p> <p>Key words</p> <p>Overweight, Obesity, socioeconomic, behavioural, Botswana</p> <p>Strengths and Limitations of the study</p> <ul style="list-style-type: none">○ To our knowledge this is the first cross-sectional study in Botswana to comprehensively assess both the socioeconomic and behavioural determinants of overweight/obesity among adults.○ Data were collected from a large and randomly selected representative population. The data contained information on potential confounding factors, with a low proportion of missing information making the study more comparable.○ As the cross sectional design was employed, the causal relationship between an explanatory and an outcome variable was not established.

Introduction

Background/rationale	2	The Botswana WHO STEPS surveys conducted in 2007 and 2014 have shown increasing levels of overweight/obesity in the general adult population of Botswana. Prevalence of overweight/obesity was 18.7% in 2007 and increased to 38.6 % in 2014. Despite evidence of the high prevalence of overweight/obesity in Botswana, there is little evidence of socioeconomic and behavioural determinants of overweight/obesity. To the best of our knowledge this is the first cross sectional study which takes into account both socioeconomic and behavioural factors for understanding the heterogeneity of overweight/obesity in Botswana. The reduction of overweight/obesity prevalence should be a key goal of health-care policy because of its association with many NCDs.
Objectives	3	The main objective of this study was to assess socioeconomic and behavioural determinants associated with overweight/obesity prevalence in Botswana.
Methods		
Study design	4	The study used cross sectional design, and employed stratified multistage probability sampling technique to select respondents in three cities and towns, fifteen urban villages and fifteen rural areas across Botswana.
Setting	5	Data was collected in March 2016, in cities/towns, urban and rural villages of Botswana.
Participants	6	A total sample of 1178 males and females aged 15 years were selected and included as sample for the survey using the Kish Grid Technique.
Variables	7	Overweight/obesity was the outcome variables, other NCDs risk factors such as alcohol consumption, smoking, poor fruit and vegetable consumption, and poor physical activity. Other socioeconomic covariates such as sex, age, work status, residence, education and marital status were used as controls.
Data sources/ measurement	8*	N/A
Bias	9	Validity of data collection tool was done through pretest prior to the survey
Study size	10	The sample size of the study was calculated using the sample size calculator and yielding a sample size of 1280. The sample size is powered to produce estimates for Botswana and for broad socioeconomic categories. The final selection of respondents for inclusion in the study was that 28.5% of the respondents were recruited from cities and towns, 47.3% from urban villages and 24.1% from rural villages. This is proportionate to the size of the population as estimated during the 2011 Botswana Population and Housing Census. Hence the total respondents from towns and cities= $28.5/100 \times 1280 = 365$ respondents; $47.3/100 \times 1280 = 606$ respondents from urban villages, and a total of $24.1/100 \times 1280 = 309$ respondents from rural villages were targeted. Furthermore, the selection of the sample within each enumeration area is calculated in relation to the proportion of population in that district. E.g. for Gaborone = $178654/226649 \times 365 = 288$ (see table1).

Table 1: Summary of sampled districts with their enumeration areas and proportion of study respondents.

Proposed Localities	Population aged 15-65 years (2011 Census)	Proposed Number of EA's	Proposed Number of Population Aged 15-65 years
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Cities and Towns (324291)	226049	18	365
Gaborone	178654	14	288
Selebi-Phikwe	34093	3	55
Jwaneng	13302	1	21
Urban Villages (538585)	271900	30	606
Kanye	31108	3	69
Letlhakeng	5439	1	12
Maitengwe	2969	0	7
Maun	40796	5	91
Mochudi	29331	3	65
Molepolole	43103	5	96
Serowe	35614	4	79
Tsabong	6131	1	14
Tlokeng	28211	3	63
Tutume	10626	1	24
Kopong	6856	1	15
Mmadimare	9192	1	20
Lerala	3943	0	9
Gumare	5180	1	12
Thamaga	13401	1	30
Rural Villages (274363)	21702	15	309
Nthantho	1321	1	19
Ditshetwane	1209	1	17
Senete	1415	1	20
Sehithwa	2928	2	42
Mathubudukwane	1233	1	18
Serinane	358	0	5
Moiyabana	3014	2	43
Werda	1905	1	27
Dikwididi	225	0	3
Makuta	464	0	7
Kgope	521	0	7
Tobane	1455	1	21
Maunatlala	2871	2	41
Etsha 6	2783	2	40
Kubung	188	0	3

For each selected EA, 20 households were selected using systematic sampling method. This followed guidelines used in most Demographic Health Surveys where 20-25 households (hhs) were selected from the primary sampling units (PSUs). For instance, in the case of cities and town; $365/20=18$ EAs. The above procedure was followed for all districts, where each of the sampled EAs, 20 households were selected using systematic sampling method. The Kish grid was used to select the eligible respondents

from the selected households. Thus, once a household is selected, the interviewer created a listing (sampling frame) of all the persons in the household that are eligible for the interview process. This listing includes the name of the person, their gender, their relationship to the head of the household and their age. Once the listing was done, each eligible member was assigned a unique number. Then using a randomized response table a particular member was chosen for the interview.

Quantitative variables	11	Refer to 7 above
Statistical methods	12	<p>(a) Key two methods of data analysis were employed in the study: Bivariate analysis and logistic regression analysis to assess determinants of overweight/obesity</p> <p>(b) An analysis of the interaction effects was done before variables were included for analysis in logistic regression model.</p> <p>(c) None of the variables used in this study had a missing rate of more than 10%. This was within the cut-off from the literature regarding an acceptable percentage of missing data in a data set for valid statistical inferences (see, Schaffer 1999 & Bennett 2001 for example)</p> <p>(d) For sampling strategy, refer to attached file on the NCD study for methodology</p> <p>(e) N/A</p>
Results		
Participants	13*	<p>(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed-N/A</p> <p>(b) Give reasons for non-participation at each stage-N/A</p> <p>(c) Consider use of a flow diagram-N/A</p>
Descriptive data	14*	<p>(a) A total of 1,178 respondents between the ages of 15 years and above were successfully interviewed. The sample constituted a high proportion of females (69.1%) than males (30.9%). The sample age distribution suggests a relatively young population, with over half (59%) of the sample being less than 39 years of age, and almost three quarters (73.5%) being less than fifty years of age. As age increases, the sample skewed in favour of females.</p> <p>More than two fifths (45.4%) of the population resided in urban villages; while the remaining proportion resided in cities and towns (30.2%), and rural areas (24.5%). Almost three quarters (73.8%) of respondents were never married; over a third (35.5%) had primary education or less; over a quarter (27.2%) had junior secondary education while just under a fifth had senior secondary education (17.3%) and tertiary education (19.9%). Close to two fifth (37.5%) in the sample were not employed; over a quarter were employed in either the public or private sector (26.2%) while the remaining proportion were either self-employed (11.2%) , home makers or students (18.2%) and retirees (6.4%).</p> <p>(b) Indicate number of participants with missing data for each variable of interest-N/A</p>
Outcome data	15*	Report numbers of outcome events or summary measures-N/A
Main results	16	(a) It was observed that gender had a significant association with overweight/obesity when controlling for both socioeconomic and behavioural factors. Women were observed to have more than 2 times (AOR=2.74, 95% C.I. =1.92-3.90) greater odds for overweight/obesity than men.

The odds of being overweight/obese increased with age after controlling for socioeconomic and behavioural factors and were highest among individuals aged 55-64 years (AOR=5.53, 95% C.I. = 2.62-11.6), but declined at ages 65+ years (AOR=2.88, 95% C.I. = 1.21-6.86). Education was also found to be a significant factor associated with overweight/obesity in the study population after controlling for socioeconomic covariates. Further, individuals who had secondary (AOR=1.70, 95% C.I. = 1.11-2.61) and tertiary or higher education (AOR=1.99, 95% C.I. =1.16-3.38) were found to have higher probability of being overweight/obese than individuals with primary or less education. Meanwhile, there was no significant relationship observed between work status, wealth status and overweight/obesity in the general study population.

The association between smoking and alcohol consumption with overweight/obesity was found to be negative in the crude model. However, controlling for other socioeconomic and demographic factors, the odds of overweight/obesity increased two times (AOR=2.16, 95% C.I. = 1.22-3.83) among smokers than non-smokers. Overweight/obesity was also significantly associated with poor physical activity (AOR=1.46, 95% C.I. =1.03-3.24) after adjusting for socioeconomic and behavioural factors.

(b) Report category boundaries when continuous variables were categorized-N/A

(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period-N/A

Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses-N/A
Discussion		
Key results	18	Key socioeconomic factors associated with overweight/obesity are being a woman, older, and with higher education (secondary and tertiary level education). Behavioral factors such as smoking and poor physical activity were found to be positively associated with overweight/obesity. These results demonstrate that socioeconomic and behavioural factors play an important role in prevalence of overweight/obesity in Botswana. Botswana's multisectoral national strategic plan implementation framework for combating NCDs should focus on developing a community based and people centered awareness about the harmful impact of smoking, alcohol, physically inactivity and poor quality of diet facilitated by comprehensive national monitoring and evaluation framework.
Limitations	19	The study employed a cross-sectional study design and the main limitation is that because data on each participant was recorded only once it was difficult to infer the temporal association between an explanatory and an outcome variable. Therefore, only an association, and not causation, can be inferred from this study.
Interpretation	20	Limitations of self-reported data such as under and over-reporting were borne in mind when interpreting results of the study
Generalisability	21	The NCDs study sample was not designed to be representative of Botswana, and we are cautious about generalizing these study findings
Other information		
Funding	22	The NCDs study was funded by Office of Research and Development at University of Botswana. However, the funder does not have any influence or say in the present article.

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at www.strobe-statement.org.

For peer review only

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Keywords:	Overweight, Obesity, Socioeconomic, Behavioural, Botswana

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Socioeconomic and behavioural determinants of overweight/obesity among adults in Botswana: A cross-sectional study

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Abstract

Objective

To undertake a comprehensive assessment of socioeconomic and behavioural determinants of overweight/obesity among adult population in Botswana.

Design

The study adopted a cross-sectional design by selecting adult respondents in three cities and towns, fifteen urban villages and fifteen rural areas across Botswana using a multistage probability sampling technique.

Setting

The study was conducted in selected rural and urban areas of Botswana.

Participants

The study sample consisted of 1178 adult males and females aged 15 years and above.

Primary Outcome Measures

Objectively measured overweight/obesity.

Results

Prevalence of overweight/obesity in the study population was estimated at 41%. The adjusted odds ratio (AOR) of overweight/obesity were highest among women (AOR=2.74, 95% C.I. =1.92-3.90), in ages 55-64 years (AOR=5.53, 95% C.I. = 2.62-11.6), among individuals with secondary (AOR=1.70, 95% C.I. = 1.11-2.61) and tertiary education (AOR=1.99, 95% C.I. =1.16-3.38), smokers (AOR=2.16, 95% C.I. = 1.22-3.83) and people with poor physically activity (AOR=1.46, 95% C.I. =1.03-3.24). These were statistically significant at 5% level.

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Conclusion

Women, older adults, people with high education level, smokers and people who reported poor physical activity were found to have higher odds of being overweight/obesity. These findings suggest the need for broad based strategies encouraging physical activity among different socioeconomic groups.

Key words

Overweight, Obesity, socioeconomic, behavioural, Botswana

Strengths and Limitations of the study

- To our knowledge this is the first cross-sectional study in Botswana to comprehensively assess both the socioeconomic and behavioural determinants of overweight/obesity among adults.
- Data were collected from a large and randomly selected representative population. The data contained information on potential confounding factors, with a low proportion of missing information making the study more comparable.
- As the cross sectional design was employed, the causal relationship between an explanatory and an outcome variable was not established.

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Introduction

The disease profile in Botswana is changing, with most deaths and disability in the foreseeable future likely to be accounted for by non-communicable diseases (NCDs). Children, adults and the elderly are all vulnerable to the risk factors that contribute to NCDs especially overweight/obesity, due to unhealthy diets, low physical activity, exposure to tobacco smoke and/or the effects of the harmful use of alcohol¹⁻³. The key drivers of NCDs are ageing, rapid urbanisation and the globalisation of unhealthy lifestyles. Globalization of unhealthy lifestyles like unhealthy diets may show up in individuals as raised blood pressure, increased blood glucose, elevated blood lipids, and overweight/ obesity¹.

Several studies have recently shown that many low income and middle-income countries (LMICs) are experiencing an increase in the prevalence of overweight/obesity⁴⁻⁶. This prevalence is predicted to continue to increase in the future. Much of the increase in prevalence levels for overweight/obesity is expected in countries such as India, some parts of South-East Asia, China, most of South America and some parts of Sub Saharan Africa (SSA)⁷⁻⁸. Until recently, SSA was minimally affected by the overweight/obesity epidemic due to under-nutrition and a major burden of Human Immunodeficiency Virus (HIV) and tuberculosis (TB)⁹. Meanwhile research on overweight/obesity has started to gain significance in SSA¹⁰⁻¹⁴ due to its increasing magnitude.

It has been shown by previous studies that socioeconomic and behavioural factors have a significant association with overweight/obesity¹⁵⁻¹⁶. These studies have shown that socioeconomic and demographic factors such as sex, age, education level, work status, place of residence and wealth status are determinants of

overweight/obesity. Studies have found that women are more likely to be overweight/obese than men, while the odds of being overweight/obesity has been seen to increase with age¹⁷⁻¹⁹. It has also been observed that being employed in a high income job, residing in urban areas, having high education and wealth status are significantly associated with overweight/obesity²⁰.

The review of literature suggests significant association between a number of behavioural factors and overweight/obesity. For example, significant positive association was found between physical inactivity and overweight/obesity²¹. Further, studies have noted that the association between physical inactivity and health outcomes such as overweight/obesity is moderated by other lifestyle factors, especially sedentary lifestyle^{15, 20, 21}. In most developing countries, there has been a substantial shift from jobs with high-energy expenditure such as farming, mining and forestry to more-sedentary sectors of manufacturing, services and office based-work²². This shift has contributed to risky lifestyle behaviours condoning alcohol consumption, poor diets and smoking²³⁻²⁴.

The Botswana World Health Organization (WHO) STEPS surveys conducted in 2007 and 2014 have shown rising levels of overweight/obesity among adult population of Botswana. The estimated prevalence of overweight/obesity was 18.7% in 2007²⁵ and increased to 38.6 % in 2014²⁶. Despite evidence of the high and rising prevalence of overweight/obesity in Botswana, there is little evidence examining the association between socioeconomic and behavioural factors, and overweight/obesity. To the best of our knowledge, this is the first cross sectional study which takes into account both socioeconomic and behavioural factors together for understanding the

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determinants of overweight/obesity. The study would be significant in the context that the reduction of overweight/obesity prevalence should be a key goal of health-care policy because of its associated causes with many NCDs. Keeping this view, the main aim of this study was to examine the association between socioeconomic and behavioural factors, and overweight/obesity in Botswana.

Methods

Sampling, recruitment and ethics

The study used cross sectional design by selecting respondents in three cities and towns, fifteen urban villages and fifteen rural areas across Botswana using a multistage probability sampling technique. A list of districts, localities and enumeration areas (EAs) together with their households was prepared based on the 2011 Botswana Population and Housing census that form a sampling frame. At the first stage, population was stratified into cities and towns, urban villages and rural settlements. A listing of all 26 census districts in each stratum was made and from these districts a total of all 4845 EAs were listed for cities and towns, urban villages and rural settlements. At the second stage, localities in cities and towns, urban villages and rural villages were randomly selected. At the third and fourth stage a random selection of EAs and households, respectively was made. Lastly, individuals aged 15 years and over were selected for interview from the list of households with persons 15 years and over. The NCD study questionnaire was developed using the instruments from the WHO Study on Global Ageing and Adult Health (SAGE), and WHO STEPS Surveys.

All ethical clearance procedures were followed before the start of the study. The study proposal along with the necessary documents were submitted to and approved by the Institutional Review Board of the University of Botswana. Approval for conducting the study was also obtained from the Government of Botswana through the Ministry of Health and Wellness (MoHW).

As part of the study protocol, all respondents were requested to sign a consent form and were told that participation in the study was voluntary. For participants aged 15-17 years written consent was obtained from the parents or guardians. All individuals aged 15 years and above who had successfully completed the NCD study questionnaire were included in the analysis for this study. Privacy and confidentiality of highest standard were maintained by treating all respondents as anonymous and no names of respondents are mentioned or implied when presenting findings of the study.

Definitions and Measurement of variables

The outcome variable for the study is overweight/obesity. Body Mass Index (BMI) was used to classify overweight/obesity. BMI was derived from weight and height: $\text{weight (kg)} / (\text{height (m)} \times \text{height (m)})^1$. The Charder MS7301 250Kg digital scale and the Muac measuring tape were used for anthropometric measurements. Weight was measured, to the nearest 0.1kg, while height was measured in metres. BMI was categorized into: underweight ($\text{BMI} < 18.5 \text{ kg/m}^2$), normal weight ($18.5 \leq \text{BMI} < 25 \text{ kg/m}^2$), overweight ($25 \leq \text{BMI} < 30 \text{ kg/m}^2$) and obese ($\text{BMI} \geq 30 \text{ kg/m}^2$)¹. Overweight and obese were used to create a binary outcome variable which was coded as: being overweight/obese ($\text{BMI} \geq 25 \text{ kg/m}^2$) =1; not overweight/obese =0 ($\text{BMI} < 25 \text{ kg/m}^2$).

Information on NCD risk factors was collected through self-reports. Respondents were asked questions on NCD risk factors such as tobacco use, alcohol consumption, physical activity and fruit and vegetable consumption. For tobacco use, respondents were asked whether they currently smoke tobacco products and their response was coded as yes=1 and no=0. Alcohol consumption was measured based on the intensity of alcohol consumed in the past 30 days. Respondents who had consumed alcohol in the past 30 days were asked about the number of standard alcohol drinks they had each day in the past 7 days and if they reported to have had three or more drinks per day (of approximately 60g alcohol) it was considered to be excessive drinking=1 and 0=otherwise.

Based on WHO recommendations poor physical activity was calculated using an average typical types of activity undertaken¹³. It was calculated based on the time taken while doing physical activity in the past 7 days. Respondents were asked whether they do any moderate to rigorous intensity activities for at least 10 minutes continuously. This was considered for the domains of work and walking (includes at work and at home, walking to travel from place to place, and any other walking for recreation, sport, exercise, or leisure). Based on the time taken on work and walking the respondents were grouped into four categories of: no activity, low, moderate and high activity levels to show the intensity of their physical activity. The resultant variable was coded such that no and low activity (<10 minutes of physical activity) =1 and moderate and high activity (≥10 minutes of physical activity) were coded=0.

Poor fruit and vegetables consumption was created when an individual reported daily consumption of less than the recommended 5 servings of fruits and vegetables. Respondents reported the number of servings for fruits/vegetables they had in a

typical day, and if the servings were less than 5 in a day, they were considered to be having poor fruit/vegetable consumption^{13, 27, 28}.

A wealth index (WI) was constructed to be a measure of wealth status. WI is a composite measure of ownership of consumer durables, housing characteristics, and access to public services¹⁶. Information on a range of durable assets was collected during the survey (e. g. car, refrigerator, television), housing characteristics (e. g. material of dwelling floor and roof, main cooking fuel), access to basic services (e. g. electricity supply, source of drinking water, sanitation facilities) and ownership of livestock (e.g. cattle, goats, sheep, horses, chickens). Further to collection of information on durable assets, information on ownership of land was also collected. Principal component analysis was employed to derive the wealth index variable, which had five categories from the 1st to the 5th quintile (poorest to richest).

Control variables

Age and place of residence were used as control variables. These variables were conceptualized to have an association with the outcome variable. Therefore, as control variables they are included in the net effects model, so that the association between the independent variables of interest becomes isolated and discernible.

Statistical analysis

Descriptive and multivariable logistic analysis were used. Descriptive analysis provided bivariate association of explanatory and outcome variable for further exploration of key determinants of overweight and obesity in Botswana. In the multivariable binary logistic regression, the outcome variable was coded as '1' if respondents were overweight/obese and '0' if they were not overweight/obese. Results of logistic regression analysis were presented together with adjusted odd

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ratios (AOR), 95% confidence intervals (CI) and 5% statistical significance level. Chi-square test was used for bivariate analysis. Data analysis was done using SPSS version 25 program. Since this was a population based study representative of the population, selection bias was minimal and missing cases were few. In order to control for cluster effects, complex sample module in SPSS has been used.

Patient and Public involvement

No patients were involved in developing the research question, outcome measures and overall design of the study.

Results

Sample characteristics

Table 1 presents socioeconomic characteristics of the respondents. The sample constituted a high proportion of females (69.1%) than males (30.9%). The sample age distribution suggests a relatively young population, with over half (59%) of the sample being less than 39 years of age, and almost three quarters (73.5%) being less than fifty years of age.

Table 1: Socio demographic characteristics

Variable	N	%
Sex		
Male	364	30.9
Female	813	69.1
Total	1177	100
Age in years		
<24	270	26.4
25– 34	302	29.5
35 – 44	196	19.2
45– 54	130	12.7
55 – 64	75	7.3
65+ years	50	4.9
Total	1023	100
Locality Type		
Cities/Towns	355	30.2
Urban Villages	534	45.4
Rural Settlements	288	24.5
Total	1177	100
Marital Status		
Never Married	864	73.8
Currently married	199	17.0
Formerly married	108	9.2
Total	1171	100
Highest Level of Education Attained		
Primary or Less	410	35.5
Junior Secondary	314	27.2
Senior Secondary	200	17.3
Tertiary & Over	230	19.9
Total	1154	100
Work Status in past 12 months		
Public Sector	122	10.5
Private Sector	182	15.7
Self Employed	130	11.2
Not Employed	436	37.5
Homemaker-Student	218	18.8
Retired-Other	74	6.4
Total	1162	100
Wealth status		
Lowest	234	19.9
Second	237	20.1
Middle	235	19.9
Fourth	237	20.1
Highest	235	19.9

Total	1178	100
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More than two fifths (45.4%) of the population resided in urban villages; while one – third of them resided in cities and towns (30.2%), and a quarter of them lived in rural areas (24.5%). Almost three-fourth (73.8%) of respondents was never married; over a third (35.5%) had primary education or less; over a quarter (27.2%) had junior secondary education while just under a fifth had senior secondary education (17.3%) and tertiary education (19.9%). Close to two fifth (37.5%) respondents were not employed; over a quarter were employed in either the public or private sector (26.2%).

Table 2 shows behavioural characteristics of the study population. It shows that prevalence of alcohol consumption was estimated at 17.3% while tobacco smoking was estimated at 11.5%. Poor physical activity was also high in the study population with 48.9% of respondents indicating poor physical activity. Poor fruit and vegetable intake was estimated at 82.5%.

Table 2: Behavioural characteristics of the study population

Variable	N	%
Smoking		
Yes	136	11.5
No	1042	88.5
Total	1178	100
Alcohol consumption		
Yes	204	17.3
No	974	82.7
Total	1178	100
Poor physical activity		
Yes	576	48.9
No	602	51.1
Total	1178	100
Poor fruit/vegetable intake		
Yes	1045	82.5
No	133	17.5
Total	1178	100

Prevalence of overweight/obesity

Estimated prevalence of overweight/obesity in the study population was 41.3% (Table 3). There were significant gender differences in prevalence of overweight/obesity. It was found that women than men (48.6% among women, 25.5% among men) were overweight/obese. Individuals residing in rural areas (46.8%), public sector employees (55.2%) and those with low education (45%) showed high prevalence of overweight/obesity. Meanwhile it was found that wealth status was not significantly associated with overweight/obesity. Among the

behavioural factors, the prevalence of overweight/obesity was greater among non-smoker (42.9%). Alcohol consumption, poor physical activity and poor fruits and vegetable consumption did not show any significant association with overweight/obesity.

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Table 3: Prevalence of overweight/obesity by socioeconomic and behavioural characteristics of the study population

Variable	N	%	P-value
Sex			
Male	364	25.5	≤0.001**
Female	813	48.6	
Age			≤0.001**
≤24	270	21.8	
25-34	302	36.8	
35-44	196	53.0	
45-54	130	54.5	
55-64	75	61.8	
65+	50	43.8	
Marital status			≤0.001**
Never-married	864	35.5	
Currently-married	199	62.2	
Formerly-married	108	54.1	
Education			0.019**
Primary or less	410	45.4	
Secondary	514	36.7	
Tertiary or higher	230	44.6	
Residence			0.008**
Cities and towns	355	37.9	
Urban villages	534	41.0	
Rural villages	288	46.8	
Work status			≤0.001**
Public sector	122	52.2	
Private sector	182	36.8	
self-employed	130	55.0	
Not employed	436	45.8	
Home-maker/student	218	29.4	
Retired/other	74	40.3	
Wealth status			0.765
Lowest	234	38.8	
second	237	43.2	

middle	235	41.1	
Fourth	237	39.7	
Highest	235	44.1	
Alcohol consumption			0.445
No	766	33.3	
yes	412	37.7	
Smoking			0.004**
Yes	136	29.7	
No	1042	42.9	
Poor physical activity			0.547
Yes	376	41.5	
No	771	39.6	
Poor fruit/vegetable consumption			0.832
No	133	41.9	
yes	1045	43.0	
Overall	1178	41.3	

Note: **Chi-square test statistically significant at $p < 0.05$.

Determinants of overweight/obesity

Three models were run to assess determinants of overweight/obesity (Table 4). Model I is the crude model and it assessed the association between overweight/obesity and each of the socioeconomic and demographic variables and behavioural factors independently, Model II assessed the association between overweight/obesity adjusting for socioeconomic factors only, while Model III examined the association between overweight/obesity adjusting for both socioeconomic and behavioural factors. It was observed that gender had a significant association with overweight/obesity when controlling for both socioeconomic and behavioural factors. Women were observed to have more than 2 times (AOR=2.74, 95% C.I. =1.92-3.90) greater odds for overweight/obesity than men.

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The odds of being overweight/obese increased with age after controlling for socioeconomic and behavioural factors and were highest among individuals aged 55-64 years (AOR=5.53, 95% C.I. = 2.62-11.6). However, it declined at ages 65+ years (AOR=2.88, 95% C.I. = 1.21-6.86). Education was also found to be a significant factor associated with overweight/obesity when controlling for socioeconomic and behavioural factors. Individuals who had secondary (AOR=1.70, 95% C.I. = 1.11-2.61) and tertiary or higher education (AOR=1.99, 95% C.I. =1.16-3.38) were found to have higher probability of being overweight/obese than individuals with primary or less education. Work status and wealth status were not significantly associated with overweight/obesity.

The association between smoking and alcohol consumption with overweight/obesity was found to be negative in the crude model. However, when controlling for other socioeconomic and demographic factors, the odds of overweight/obesity increased two times (AOR=2.16, 95% C.I. = 1.22-3.83) among smokers than non-smokers. Poor physical activity was also significantly associated with overweight/obesity (AOR=1.46, 95% C.I. =1.03-3.24) adjusting for socioeconomic and behavioural factors.

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Table 4: Odds ratios (OR) from multivariable logistic regression for overweight/obesity among adults in the study population, Botswana.

Variable	Model I		Model II		Model III	
	OR	C.I.	OR	C.I.	OR	C.I.
Sex						
Male	1.00		1.00		1.00	
Female	2.75**	(2.08-3.64)	3.01**	(2.12-4.26)	2.74**	(1.92-3.90)
Age						
≤24	1.00		1.00		1.00	
25-34	2.08**	(1.42-3.03)	1.77**	(1.12-2.77)	1.83**	(1.17-2.88)
35-44	4.02**	(2.67-6.08)	3.70**	(2.23-6.12)	3.87**	(2.34-6.42)
45-54	4.28**	(2.70-6.78)	3.04**	(1.66-5.55)	3.26**	(1.78-5.98)
55-64	5.78**	(3.26-10.2)	4.91**	(2.35-10.2)	5.53**	(2.62-11.6)
65+	2.78**	(1.46-5.28)	2.74**	(1.15-6.50)	2.88**	(1.21-6.86)
Marital status						
Never-married	0.46**	(0.30-0.71)	0.68	(0.34-1.34)	0.66	(0.33-1.32)
Currently-married	1.39	(0.84-2.29)	1.34	(0.66-2.71)	1.28	(0.63-2.61)
Formerly-married	1.00		1.00		1.00	
Education						
Primary or less	1.00		1.00		1.00	
Secondary	0.69**	(0.53-0.91)	0.49**	(0.29-0.83)	1.70**	(1.11-2.61)
Tertiary or higher	0.96	(0.69-1.35)	0.87	(0.58-1.32)	1.99**	(1.16-3.38)
Residence						
Cities and towns	1.00		1.00		1.00	
Urban villages	1.13	(0.86-1.50)	1.06	(0.74-1.50)	1.07	(0.75-1.52)
Rural villages	1.44**	(1.04-1.99)	1.37	(0.88-2.12)	1.37	(0.88-2.12)
Work status						
Public sector	1.61	(0.89-2.93)	1.30	(0.64-2.65)	1.22	(0.59-2.50)
Private sector	0.86	(0.49-1.51)	1.20	(0.61-2.36)	1.19	(0.60-2.35)
self-employed	1.18	(0.65-2.13)	1.24	(0.61-2.51)	1.29	(0.63-2.62)
Not employed	1.25	(0.75-2.08)	1.30	(0.70-2.40)	1.30	(0.70-2.41)
Home-maker/student	0.61	(0.35-1.07)	0.96	(0.48-1.92)	0.96	(0.48-1.92)
Retired/other	1.00		1.00		1.00	
Wealth status						
Lowest	0.80	(0.55-1.17)	0.60	(0.34-1.05)	1.03	(0.64-1.68)
second	0.96	(0.66-1.40)	0.67	(0.40-1.11)	1.12	(0.68-1.85)
middle	0.88	(0.60-1.28)	0.73	(0.45-1.19)	1.20	(0.71-2.01)
Fourth	0.83	(0.57-1.21)	0.79	(0.50-1.23)	1.53	(0.87-2.69)

Highest	1.00	1.00	1.00
Smoking		N.I	
Yes	0.56* (0.37-0.83)		2.16** (1.22-3.83)
No	1.00		1.00
Poor physical activity		N.I	
Yes	1.08 (0.83-1.40)		1.46** (1.03-3.24)
No	1.00		1.00
Poor fruit/vegetable consumption		N.I	
Yes	0.82 (0.55-1.22)		0.80 (0.28-2.24)
no	1.00		1.00
Alcohol consumption		N.I	
Yes	0.66* (0.47-0.91)		1.23 (0.53-2.83)
No	1.00		1.00

N.I- not included, Model I: Crude model; Model II: socioeconomic variables included; Model III: socioeconomic + behavioural characteristics included. **statistically significant at p <0.05.

Discussion

The prevalence of overweight/obesity in the study population was 41.3%. Botswana also seems to have joined with other Southern African countries where the national prevalence rates ranges between 30% and 60% among adults age 15 years and over^{10, 26-31}. Nutrition transition from high-fibre, low-calorie diets rich in fruits and vegetables to refined, energy-dense foods high in fat, calories, sweeteners and salt¹² and low physical activity coupled with transition from agrarian to a sedentary industrial society contributes to a greater risk of overweight/obesity in Botswana³².

Gender differences in overweight/obesity found in this study is a well-established finding and is consistent with most previous studies³³⁻³⁴. Congruent with most studies in developing countries women were found to have higher odds of overweight/obesity than men³⁵⁻³⁷. This is contrary to findings from some developed countries such as United States (US) and United Kingdom (UK) where it was found that adult men tend to be overweight/obese than adult women³⁸⁻⁴². In developing countries such as Botswana, adult women are generally noted to be overweight/obese than adult men at all ages^{26, 35, 39-40}.

In the context of Botswana, gender differences in overweight/obesity can be explained by sociocultural dynamics and complex sociocultural pathways that encourage weight gain among women^{26, 40}. For example, cultural values favour larger body size among women as a sign of fertility, healthfulness, or prosperity in Botswana²⁶. In this study, women reported lower levels of physical activity which may also contribute to higher prevalence of overweight/obesity among them.

Overweight/obesity was highest among individuals aged 55-64 years but declined at ages 65+ years. This finding corroborates data from large scale surveys⁴³⁻⁴⁶ which show that mean body weight and BMI gradually increases during most of adult life and reach peak values at 50–59 years of age in both men and women and after the age of 60 years, mean body weight and BMI tend to decrease⁴⁷⁻⁴⁹. Similarly in South Africa it was found that overweight/obesity tends to increase with age²¹.

Education differences were also observed for overweight/obesity. Individuals who had high educational attainment had higher odds of overweight/obesity than those with low education. This is consistent with other studies that have shown that education is associated with overweight/obesity via socioeconomic status, literacy and health behaviours⁵⁰⁻⁵².

There was no significant association observed between overweight/obesity and work status and for wealth status. Other studies in neighbouring countries with comparable Human Development Index (HDI) as Botswana including Namibia and South Africa²⁷⁻²⁸ have also shown no wealth or work status differences in overweight/obesity. There are several reasons to such scenario. These reasons include; rapid and disorganized urbanization, increasing sedentary lifestyles, easy access to and consumption of unhealthy food and high energy drinks among both the poor and non-poor in these countries^{21, 27-28}. Further to this a general observation has been made by Ford et al.⁵² that overweight/obesity is no longer an issue of affluence in majority of low and middle income countries.

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Further, the study noted that the odds of overweight/obesity were two times greater among smokers than non-smokers. Tuovinen *et al.*⁴¹ based on literature review observed that heavy smokers tend to have greater body weight than do light smokers or non-smokers, which likely reflect a clustering of other risky behaviours (e.g. low level of physical activity and poor diet) that are conducive to weight gain²³⁻²⁴. On the other hand, some studies have shown that smoking tends to suppress appetite leading to low BMI among smokers^{10, 21, 30}.

Other important finding in this study is that overweight/obesity was significantly associated with poor physical activity. This is consistent with other studies which have shown that a decline in physical activity leads to adiposity⁵². The interpretation of this finding is that Botswana has undergone a transition from an agrarian to industrial society due to urbanization subsequently leading to industrial modernity. As a result there is an increase in poor physical activity in the general population²⁴. Poor physical activity leads to overweight/obesity through energy imbalance between calories consumed and calories expended⁵². Generally formal physical activity that is planned, structured, repetitive and purposeful is not common in Botswana. Thus in order to increase physical activity and reduce overweight/obesity there is need for a population-based, multi-sectoral, multi-disciplinary and culturally relevant approach.

This study benefits from data collected from a large and randomly selected sample of respondents. The data contained information on potential confounding factors, with a low proportion of missing information making the study more comparable. Given that the recall period for behavioural risk factors such as smoking, alcohol consumption, poor physical activity and poor fruit and vegetable consumption was

30 days or less there were minimal chances of recall bias. The main limitation is that since the study used a cross sectional design, it was not possible to establish the causal relationship between explanatory variables and overweight/obesity. Furthermore, the NCDs study sample was not designed to be representative of the whole of Botswana. However, the findings of this study give an indication of emerging patterns of overweight/obesity in the country.

Conclusion

In conclusion our findings indicate high prevalence of overweight/obesity in the adult population of Botswana. Overweight/obesity was found to be significantly high among women, older adults and people with higher education levels. Behavioural factors such as smoking and poor physical activity were found to be key correlates of overweight/obesity. These results demonstrate that socioeconomic and behavioural factors play an important role in prevalence of overweight/obesity. Botswana's multisectoral national strategic plan implementation framework for combating NCDs should focus on developing a community based and people centered awareness about the harmful impact of smoking, alcohol, physically inactivity and poor quality of diet facilitated by comprehensive national monitoring and evaluation framework.

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Contributors

This paper is a part of the larger NCD study which was designed, conceived and developed by the study team (MK, KN, GL, KB, SDR, LG, TM and RM). MK did the analysis and wrote the initial draft of this paper. KN, GL and SDR gave feedbacks for revising the first draft. MK, KN and GL worked on the reviewers comments. All authors have reviewed and approved the final version of the manuscript except KB who recently passed away. We dedicate this article to KB whom we miss very much.

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Disclaimer

The funding body had no role in the design of the study, analyses, interpretation or decision to submit the manuscript for publication.

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Competing Interests

Nil

Participant consent

Obtained

Ethics Approval

All ethical clearance formalities were completed before the start of the study. The study proposal along with the necessary documents was submitted to and approved by the Institutional Review Board of the University of Botswana (Ref #: UBR/RES/IRB/1583) and the Ministry of Health and Wellness (Ref #: HPDME: 13/18/1 Vol. X (130)). Privacy and confidentiality of highest standard were maintained by treating all respondents as anonymous and no names of respondents are mentioned or implied when presenting findings of the study.

Data sharing statement

The dataset used and/or analysed during the current study is available from the corresponding author (Mpho Keetile) on reasonable request to the Office of Research and Development, University of Botswana.

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STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of cross-sectional studies

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(a) Indicate the study’s design with a commonly used term in the title or the abstract	2
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	2-3
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4-5
Objectives	3	State specific objectives, including any prespecified hypotheses	6
Methods			
Study design	4	Present key elements of study design early in the paper	6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	7
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants	7
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7-9
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	7-9
Bias	9	Describe any efforts to address potential sources of bias	10
Study size	10	Explain how the study size was arrived at	
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	n/a
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	9
		(b) Describe any methods used to examine subgroups and interactions	n/a
		(c) Explain how missing data were addressed	10
		(d) If applicable, describe analytical methods taking account of sampling strategy	10
		(e) Describe any sensitivity analyses	n/a
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	11
		(b) Give reasons for non-participation at each stage	-
		(c) Consider use of a flow diagram	-
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	11
		(b) Indicate number of participants with missing data for each variable of interest	11
Outcome data	15*	Report numbers of outcome events or summary measures	-
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	16-19
		(b) Report category boundaries when continuous variables were categorized	-
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	-
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	-
Discussion			
Key results	18	Summarise key results with reference to study objectives	20-22
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	22-23
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	23
Generalisability	21	Discuss the generalisability (external validity) of the study results	23
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	24

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at www.strobe-statement.org.