BMJ Open

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

Mpho Keetile,[1] Kannan Navaneetham,[1] Gobopamang Letamo ,[1] Kenabetsho Bainame,[1] Serai Daniel Rakgoasi,[1] Lesego Gabaitiri,[2] Tiny Masupe,[3] Robert Molebatsi[4]

To cite: Keetile M, Navaneetham K, Letamo G, *et al*. Socioeconomic and behavioural determinants of overweight/obesity among adults in Botswana: a cross-sectional study. *BMJ Open* 2019;**9**:e029570. doi:10.1136/bmjopen-2019-029570

► Prepublication history for this paper is available online. To view these files, please visit the journal online (http://dx.doi.org/10.1136/bmjopen-2019-029570).

Received 31 January 2019
Revised 11 September 2019
Accepted 30 September 2019

[1]Department of Population Studies, University of Botswana, Gaborone, Botswana
[2]Statistics, University of Botswana, Gaborone, Botswana
[3]Department of Family Medicine & Public Health, Faculty of Medicine, University of Botswana, Gaborone, Botswana
[4]Sociology, University of Botswana, Gaborone, Botswana

Correspondence to
Dr Mpho Keetile;
mphokeet@yahoo.com

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 3 cities and towns, 15 urban villages and 15 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 OR (AOR) of overweight/obesity were highest among women (AOR=2.74, 95% CI 1.92 to 3.90), in ages 55–64 years (AOR=5.53, 95% CI 2.62 to 11.6), among individuals with secondary (AOR=1.70, 95% CI 1.11 to 2.61) and tertiary education (AOR=1.99, 95% CI 1.16 to 3.38), smokers (AOR=2.16, 95% CI 1.22 to 3.83) and people with poor physically activity (AOR=1.46, 95% CI 1.03 to 3.24). These were statistically significant at 5% level.

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.

Strengths and limitations of this 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.

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 alcohol.[1–3] The key drivers of NCDs are ageing, rapid urbanisation and the globalisation of unhealthy lifestyles. Globalisation of unhealthy lifestyles like unhealthy diets may show up in individuals as raised blood pressure, increased blood glucose, elevated blood lipids and overweight/obesity.[1]

Several studies have recently shown that many low/middle-income countries (LMICs) are experiencing an increase in the prevalence of overweight/obesity.[4–6] 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 HIV and tuberculosis.[9] Meanwhile, research on overweight/obesity has started to gain significance in SSA[10–14] due to its increasing magnitude.

It has been shown by previous studies that socioeconomic and behavioural factors have a significant association with overweight/

obesity.[15 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 age.[17–19] It was 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/obesity.[20]

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/obesity.[21] 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 work.[22] This shift has contributed to risky lifestyle behaviours condoning alcohol consumption, poor diets and smoking.[23 24]

The Botswana 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 2007[25] and increased to 38.6% in 2014.[26] 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 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 healthcare 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 3 cities and towns, 15 urban villages and 15 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.

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: weight (kg) / (height (m) x height (m)).[1] The Charder MS7301 250 kg digital scale and the Muac measuring tape were used for anthropometric measurements. Weight was measured, to the nearest 0.1 kg, while height was measured in metres. BMI was categorised into: underweight (BMI<18.5 kg/m^2), normal weight (18.5≤BMI<25 kg/m^2), overweight (25≤BMI<30 kg/m^2) and obese (BMI≥30 kg/m^2).[1] Overweight and obese were used to create a binary outcome variable which was coded as: being overweight/obese (BMI ≥25 kg/m^2) =1; not overweight/obese=0 (BMI <25 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 last 30 days. Respondents who had consumed alcohol in the last 30 days were asked about the number of standard alcohol drinks they had each day in the last 7 days and if they reported to have had three or more drinks per day (of ~60 g 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 undertaken.[13] It was calculated based on the time taken while doing physical activity in the last 7 days. Respondents were asked whether they do any moderate to rigorous intensity activities for at least 10 min 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 min of physical activity)=1 and moderate and high activity (≥10 min of physical activity) were coded=0.

Poor fruit and vegetables consumption was created when an individual reported daily consumption of less than the recommended five 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 five 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 services.[16] Information on a range of durable assets was collected during the survey (eg, car, refrigerator, television), housing characteristics (eg, material of dwelling floor and roof, main cooking fuel), access to basic services (eg, electricity supply, source of drinking water, sanitation facilities) and ownership of livestock (eg, 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 WI variable, which had five categories from the first to the fifth quintile (poorest to richest).

Control variables

Age and place of residence were used as control variables. These variables were conceptualised 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 explnatory 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 ORs (AORs), 95% CI and 5% statistical significance level. χ^2 test was used for bivariate analysis. Data analysis was done using SPSS V.25 programme. 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 <39 years of age, and almost three-quarters (73.5%) being <50 years of age.

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%.

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.

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

Table 1 Sociodemographic 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+	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 and over	230	19.9
Total	1154	100
Work status in last 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

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

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 two times (AOR=2.74, 95% CI 1.92 to 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% CI 2.62 to 11.6). However, it declined at ages 65+years (AOR=2.88, 95% CI 1.21 to 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% CI 1.11 to 2.61) and tertiary or higher education (AOR=1.99, 95% CI 1.16 to 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% CI 1.22 to 3.83) among smokers than non-smokers. Poor physical activity was also significantly associated with overweight/obesity (AOR=1.46, 95% CI 1.03 to 3.24) adjusting for socioeconomic and behavioural factors.

DISCUSSION

The prevalence of overweight/obesity in the study population was 41.3%. Botswana also seems to have joined

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 (years)			≤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	

*χ^2 test statistically significant at p<0.05

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 salt[12] and low physical activity coupled with transition from agrarian to a sedentary industrial society contributes to a greater risk of overweight/obesity in Botswana.[32]

Gender differences in overweight/obesity found in this study is a well-established finding and is consistent with most previous studies.[10 33] Congruent with most studies in developing countries women were found to have higher odds of overweight/obesity than men.[34–36] 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 women.[37–40] In developing countries such as Botswana, adult women are generally noted to be overweight/obese than adult men at all ages.[26 34 38 39]

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 39] For example, cultural values favour larger body size among women as a sign of fertility, healthfulness or prosperity in Botswana.[26] 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 surveys[41–44] 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 decrease.[33 45 46] Similarly in South Africa it was found that overweight/obesity tends to increase with age.[21]

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 behaviours.[5 47 48]

Table 4 ORs from multivariable logistic regression for overweight/obesity among adults in the study population, Botswana

Variable	Model I OR (CI)	Model II OR (CI)	Model III OR (CI)
Sex			
Male	1.00	1.00	1.00
Female	2.75* (2.08 to 3.64)	3.01* (2.12 to 4.26)	2.74* (1.92 to 3.90)
Age (years)			
≤24	1.00	1.00	1.00
25–34	2.08* (1.42 to 3.03)	1.77* (1.12 to 2.77)	1.83* (1.17 to 2.88)
35–44	4.02* (2.67 to 6.08)	3.70* (2.23 to 6.12)	3.87* (2.34 to 6.42)
45–54	4.28* (2.70 to 6.78)	3.04* (1.66 to 5.55)	3.26* (1.78 to 5.98)
55–64	5.78* (3.26 to 10.2)	4.91* (2.35 to 10.2)	5.53* (2.62 to 11.6
65+	2.78* (1.46 to 5.28)	2.74* (1.15 to 6.50)	2.88* (1.21 to 6.86)
Marital status			
Never married	0.46* (0.30 to 0.71)	0.68 (0.34 to 1.34)	0.66 (0.33 to 1.32)
Currently married	1.39 (0.84 to 2.29)	1.34 (0.66 to 2.71)	1.28 (0.63 to 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 to 0.91)	0.49* (0.29 to 0.83)	1.70* (1.11 to 2.61)
Tertiary or higher	0.96 (0.69 to 1.35)	0.87 (0.58 to 1.32)	1.99* (1.16 to 3.38)
Residence			
Cities and towns	1.00	1.00	1.00
Urban villages	1.13 (0.86 to 1.50)	1.06 (0.74 to 1.50)	1.07 (0.75 to 1.52)
Rural villages	1.44* (1.04 to 1.99)	1.37 (0.88 to 2.12)	1.37 (0.88 to 2.12)
Work status			
Public sector	1.61 (0.89 to 2.93)	1.30 (0.64 to 2.65)	1.22 (0.59 to 2.50)
Private sector	0.86 (0.49 to 1.51)	1.20 (0.61 to 2.36)	1.19 (0.60 to 2.35)
Self-employed	1.18 (0.65 to 2.13)	1.24 (0.61 to 2.51)	1.29 (0.63 to 2.62)
Not employed	1.25 (0.75 to 2.08)	1.30 (0.70 to 2.40)	1.30 (0.70 to 2.41)
Home-maker/student	0.61 (0.35 to 1.07)	0.96 (0.48 to 1.92)	0.96 (0.48 to 1.92)
Retired/other	1.00	1.00	1.00
Wealth status			
Lowest	0.80 (0.55 to 1.17)	0.60 (0.34 to 1.05)	1.03 (0.64 to 1.68)
second	0.96 (0.66 to 1.40)	0.67 (0.40 to 1.11)	1.12 (0.68 to 1.85)
middle	0.88 (0.60 to 1.28)	0.73 (0.45 to 1.19)	1.20 (0.71 to 2.01)
Fourth	0.83 (0.57 to 1.21)	0.79 (0.50 to 1.23)	1.53 (0.87 to 2.69)
Highest	1.00	1.00	1.00
Smoking		N.I	
Yes	0.56* (0.37 to 0.83)		2.16* (1.22 to 3.83)
No	1.00		1.00
Poor physical activity		N.I	
Yes	1.08 (0.83 to 1.40)		1.46* (1.03 to 3.24)
No	1.00		1.00
Poor fruit/vegetable consumption		N.I	
Yes	0.82 (0.55 to 1.22)		0.80 (0.28 to 2.24)
No	1.00		1.00
Alcohol consumption		N.I	

Continued

Table 4 Continued

Variable	Model I OR (CI)	Model II OR (CI)	Model III OR (CI)
Yes	0.66* (0.47 to 0.91)		1.23 (0.53 to 2.83)
No	1.00		1.00

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

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 Africa[27 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 disorganised urbanisation, 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*[5] that overweight/obesity is no longer an issue of affluence in majority of LMICs.

Further, the study noted that the odds of overweight/obesity were two times greater among smokers than non-smokers. Tuovinen *et al*[23] 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 (eg, low level of physical activity and poor diet) that are conducive to weight gain.[23 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 adiposity.[5] The interpretation of this finding is that Botswana has undergone a transition from an agrarian to industrial society due to urbanisation subsequently leading to industrial modernity. As a result there is an increase in poor physical activity in the general population.[24] Poor physical activity leads to overweight/obesity through energy imbalance between calories consumed and calories expended.[5] 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 centred awareness about the harmful impact of smoking, alcohol, physically inactivity and poor quality of diet facilited by comprehensive national monitoring and evaluvation framework.

Acknowledgements We wish to thank University of Botswana for affording us the time and resources to undertake this study. This paper is a part of the larger study on "Chronic Non communicable Diseases in Botswana: Chronic disease prevalence, Health Care Utilization, Health Expenditure and the Life course (NCD study)" funded by the Office of Research of Development (ORD) at the University of Botswana. The authors wish to thank ORD for the financial support. We also wish to thank the study participants.

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.

Funding The 'Chronic Non communicable Diseases in Botswana: Chronic disease prevalence, Health Care Utilization, Health Expenditure and the Life course' survey was supported by Office of Research and Development, through Round 28 Research Funding, University of Botswana.

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.

Patient consent for publication Not required.

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.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data can be availed through the Office of Research and Development, University of Botswana.

ORCID iD

Gobopamang Letamo http://orcid.org/0000-0001-7256-4700

REFERENCES

1 World Health Organization. The global status of overweight and obesity. In: *Fact sheet*. Geneva, 2016.
2 Musaiger AO, Al-Hazzaa HM. Prevalence and risk factors associated with nutrition-related noncommunicable diseases in the eastern Mediterranean region. *Int J Gen Med* 2012;5:199–217.
3 Baldwin W, Kaneda T, Amato L, *et al*. *Noncommunicable diseases and youth: a critical window of opportunity for Latin America and the Caribbean*. Washington, DC: Population Reference Bureau, 2013.
4 Bhurosy T, Jeewon R. Overweight and obesity epidemic in developing countries: a problem with diet, physical activity, or socioeconomic status? *ScientificWorldJournal* 2014;2014
5 Ford ND, Patel SA, Narayan KMV. Obesity in low- and middle-income countries: burden, drivers, and emerging challenges. *Annu Rev Public Health* 2017;38:145–64.
6 Amugsi DA, Dimbuene ZT, Mberu B, *et al*. Prevalence and time trends in overweight and obesity among urban women: an analysis of demographic and health surveys data from 24 African countries, 1991-2014. *BMJ Open* 2017;7:e017344.
7 Hruby A, Hu FB. The epidemiology of obesity: a big picture. *Pharmacoeconomics* 2015;33:673–89.
8 Mamun AA, Finlay JE. Shifting of undernutrition to overnutrition and its determinants among women of reproductive ages in the 36 low to medium income countries. *Obes Res Clin Pract* 2015;9:75–86.
9 Micklesfield LK, Lambert EV, Hume DJ, *et al*. Socio-cultural, environmental and behavioural determinants of obesity in black South African women. *Cardiovasc J Afr* 2013;24:369–75.
10 Biadgilign S, Mgutshini T, Haile D, *et al*. Epidemiology of obesity and overweight in sub-Saharan Africa: a protocol for a systematic review and meta-analysis. *BMJ Open* 2017;7:e017666.
11 Ball GDC, Mushquash AR, Keaschuk RA, *et al*. Using Intervention Mapping to develop the Parents as Agents of Change (PAC©) intervention for managing pediatric obesity. *BMC Res Notes* 2017;10:43.
12 Kelly AS, Barlow SE, Rao G, *et al*. Severe obesity in children and adolescents: identification, associated health risks, and treatment approaches: a scientific statement from the American heart association. *Circulation* 2013;128:1689–712.
13 WHO. *Obesity and overweight*. Geneva: World Health Organization, 2016.
14 Levine JA. Poverty and obesity in the U.S. *Diabetes* 2011;60:2667–8.
15 Kim J, Sharma SV, Park SK. Association between socioeconomic status and obesity in adults: evidence from the 2001 to 2009 Korea National health and nutrition examination survey. *J Prev Med Public Health* 2014;47:94–103.
16 Vyas S, Kumaranayake L. Constructing socio-economic status indices: how to use principal components analysis. *Health Policy Plan* 2006;21:459–68.
17 Maffetone PB, Laursen PB. The prevalence of Overfat adults and children in the US. *Front Public Health* 2017;5.
18 Lumsden MA, Hor K. Impact of obesity on the health of women in midlife. *Obstet Gynecol* 2015;17:201–8.
19 Kim TJ, von dem Knesebeck O. Income and obesity: what is the direction of the relationship? A systematic review and meta-analysis. *BMJ Open* 2018;8:e019862.
20 Hong I, Coker-Bolt P, Anderson KR, *et al*. Relationship between physical activity and overweight and obesity in children: findings from the 2012 National health and nutrition examination survey national youth fitness survey. *Am J Occup Ther* 2016;70:7005180060p1–8. 7005180060.
21 Popkin BM, Slining MM. New dynamics in global obesity facing low- and middle-income countries. *Obes Rev* 2013;14 Suppl 2:11–20.
22 Dare S, Mackay DF, Pell JP. Relationship between smoking and obesity: a cross-sectional study of 499,504 middle-aged adults in the UK general population. *PLoS One* 2015;10:e0123579.
23 Tuovinen E-L, Saarni SE, Männistö S, *et al*. Smoking status and abdominal obesity among normal- and overweight/obese adults: population-based FINRISK study. *Prev Med Rep* 2016;4:324–30.
24 Keetile M, Navaneetham K, Letamo G. Patterns and determinants of hypertension in Botswana. *Z Gesundh Wiss* 2015;23:311–8.
25 Republic of Botswana. *Chronic Disease Risk Surveillance Report 2010- Ministry of Health & WHO*. Government Printers, 2010.
26 Letamo G. The prevalence of, and factors associated with, overweight and obesity in Botswana. *J Biosoc Sci* 2011;43:75–84.
27 Peltzer K, Phaswana-Mafuya N. Fruit and vegetable intake and associated factors in older adults in South Africa. *Glob Health Action* 2012;5:18668–8.
28 Nnyepi MS, Gwisai N, Lekgoa M, *et al*. Evidence of nutrition transition in southern Africa. *Proc Nutr Soc* 2015;74:478–86.
29 WHO. *Obesity and overweight*. Geneva: World Health Organization, 2015.
30 Forouzanfar MH, Afshin A, Alexander LT, *et al*. Global, regional, and national comparative risk assessment of 79 behavioural, environmental and occupational, and metabolic risks or clusters of risks, 1990–2015: a systematic analysis for the global burden of disease study 2015. *The Lancet* 2016;388:1659–724.
31 Agymang C, Boatemaa S, Frempong-Agymang G. Obesity in Sub Saharan Africa. In: Ahima R, ed. *Metabolic syndrome*. Switzeland: Springer International Publishing, 2015: 41–53.
32 Amoah AGB. Sociodemographic variations in obesity among Ghanaian adults. *Public Health Nutr* 2003;6:751–7.
33 Cohen AK, Rai M, Rehkopf DH, *et al*. Educational attainment and obesity: a systematic review. *Obes Rev* 2013;14:989–1005.
34 Kanter R, Caballero B. Global gender disparities in obesity: a review. *Adv Nutr* 2012;3:491–8.
35 Li L, Gower BA, Shelton RC, *et al*. Gender-Specific relationship between obesity and major depression. *Front Endocrinol* 2017;8:292.
36 Pinto KA, Griep RH, Rotenberg L, *et al*. Correction: gender, time use and overweight and obesity in adults: results of the Brazilian longitudinal study of adult health (ELSA-Brasil). *PLoS One* 2018;13:e0198380.
37 Luppino FS, de Wit LM, Bouvy PF, *et al*. Overweight, obesity, and depression: a systematic review and meta-analysis of longitudinal studies. *Arch Gen Psychiatry* 2010;67:220–9.
38 Afshin A, Forouzanfar MH, Reitsma MB, *et al*. Health effects of overweight and obesity in 195 countries over 25 years. *N Engl J Med* 2017;377:13–27.
39 Kamadjeu RM, Edwards R, Atanga JS, *et al*. Anthropometry measures and prevalence of obesity in the urban adult population of Cameroon: an update from the Cameroon burden of diabetes baseline survey. *BMC Public Health* 2006;6:228.
40 Flegal KM, Carroll MD, Kuczmarski RJ, *et al*. Overweight and obesity in the United States: prevalence and trends, 1960–1994. *Int J Obes* 1998;22:39–47.
41 Villareal DT, Apovian CM, Kushner RF, *et al*. Obesity in older adults: technical review and position statement of the American Society for nutrition and NAASO, the obesity Society. *Am J Clin Nutr* 2005;82:923–34.
42 Sperrin M, Marshall AD, Higgins V, *et al*. Body mass index relates weight to height differently in women and older adults: serial cross-sectional surveys in England (1992–2011). *J Public Health* 2016;38:607–13.
43 Vazquez G, Duval S, Jacobs DR, *et al*. Comparison of body mass index, waist circumference, and waist/hip ratio in predicting incident diabetes: a meta-analysis. *Epidemiol Rev* 2007;29:115–28.
44 Wormser D, Kaptoge S, Di Angelantonio E, *et al*. Separate and combined associations of body-mass index and abdominal adiposity with cardiovascular disease: collaborative analysis of 58 prospective studies. *Lancet* 2011;377:1085–95.

45 Morio B, Barra V, Ritz P, *et al*. Benefit of endurance training in elderly people over a short period is reversible. *Eur J Appl Physiol* 2000;81
46 Fletcher JM, Frisvold DE. Higher education and health investments: does more schooling affect preventive health care use? *J Hum Cap* 2009;3:144–76.
47 Devaux M, Sassi F, Church J, *et al*. *Exploring the relationship between education and obesity*. OECD Journal: Economic Studies, 2011: 1. 121–59.
48 Traversy G, Chaput J-P, Jean-Philippe C. Alcohol consumption and obesity: an update. *Curr Obes Rep* 2015;4:122–30.