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Prevalence and risk factors for Overweight and obesity: a cross sectional countrywide study in Burkina Faso.

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Abstract

Objective: The objective of this study was to determine the prevalence and predictors of overweight and obesity in Burkina Faso using a population-based country-wide sample. We hypothesize that obesity is increasingly becoming a public health issue in low income settings like Burkina Faso.

Design: Secondary analysis of a population-based country wide cross-sectional study

Setting: Burkina Faso, all the 13 regions including both rural and urban residential areas

Participants: 4,800 participants of both sexes, aged between 15 and 64 years.

Main outcomes: overweight and obesity using body mass index cut-off levels of WHO

Results: The prevalence of overweight and obesity in Burkina Faso were 13.82% (CI95%: 12.25 - 15.55) and 4.84% (CI95%:3.99 - 5.86) respectively. Among men, the proportional odds of overweight / obesity increase with urban residency ($p<0.001$), greater age ($p<0.002$), marital status different from single ($p\leq0.007$) and decrease with current smoking ($p=0.009$). Among women, the proportional odds of overweight / obesity increase with urban residency ($p<0.001$), primary educational level ($P=0.01$), high total blood cholesterol level ($p<0.001$), high fasting blood glucose level ($p=0.02$), and decrease with current smoking ($p<0.001$).

Conclusion:

Our study showed that nearly one person out of five in the adult population of Burkina has an abnormal weight status with women more affected than men. Thus, overnutrition needs to be recognized as an important public health issue. The country is witnessing the double burden of malnutrition with the coexistence of overnutrition and undernutrition. Nutrition interventions need to be reshaped to account for this epidemiological picture of malnutrition in Burkina Faso.

Strengths and limitations

Strengths

- To our best knowledge, this is the first nationwide study on obesity and overweight in Burkina Faso with a country level representative sample.
- Outcomes measurements were carried out following international standards through the WHO STEPwise approach to NCDs measurement and prevention.
- We report here a significant burden of overweight and obesity in the adult population of Burkina Faso, confirming that the country is facing the double burden of nutrition: coexistence of malnutrition in children and obesity/overweight in adults. This has an important implication for health policies that must henceforth take into account this double burden.

Limitations

- When interpreting the results of this study, one should bear in mind that this is a cross sectional study. Thus, our ability to derive causal inference from the reported data is weak.
- Overweight or pre-obese is an abnormal status that may evolve towards obesity. However, we don't have data showing that the evolution will be necessary in that direction. It may be also that an overweight person will turn to be normal in the future, particularly in a setting where food security is common.

Introduction

Obesity is defined as an abnormal or excessive accumulation of body fat, due to an energy imbalance between intake and expenditure [1]. It is a major risk factor for many non-communicable diseases (NCD) and a real public health threat in the world[2,3]. In 2012, NCDs accounted for 68% of all deaths worldwide [4].

Obesity, a well-known phenomenon in developed countries, is increasingly common in developing countries, affecting both children and adults [1,2]. Out of all World Health Organization (WHO) regions, the American's Region was the most affected with a prevalence of 27%; the least affected region was South-East Asia (5%). In the Africa region, the proportion of obese people was about 6% among men and 15% among women [4]. Thus, in low- and middle-income countries, the association of overweight / obesity with one or more nutritional deficiencies is often observed, especially among women, known as double burden of malnutrition [5]. However, data from the literature reports that excess weight can largely be avoided; and prevention involves the identification and control of modifiable risk factors[1,2]. These factors are known and described in the literature. These factors are essentially factors related to behavior and / or knowledge (inadequate diet, inactivity, alcohol consumption,), sociodemographic factors (place of residence, socio-economic status), and clinical and metabolic factors (total cholesterol level, HDL, triglycerides) [1,6–8].

However, these factors vary between countries, depending on eating habits and socio-cultural practices [2] . This variability of factors suggests that each country identifies the risk factors that are specific to its context in order to better guide its policies and strategies to address the raising burden of obesity.

Most of the studies conducted so far on factors associated with overweight or obesity in developing countries were often conducted in urban areas[9–13], hospitals[14,15], secondary and high schools [16–18]. There are few nationally representative data on obesity in most sub-Saharan African countries[6,19]. The poor awareness of the burden and risk factors for obesity among the population is an obstacle to engaging countries in the design and implementation of adequate public health interventions.

Our study intends to fill this gap by providing more complete data on the prevalence and the risk factors for overweight and obesity, through a secondary analysis of data from the STEPS survey carried out in Burkina Faso in 2013.

Methods

Study setting

Our study was conducted in Burkina Faso, a landlocked Sahelian country in the heart of West Africa. The country is divided into 13 regions, 45 provinces and 351 municipalities. In 2013, the population was estimated at 17,271,583 inhabitants. The majority of the population lives in rural areas, with agriculture and livestock as main activities[20].

In terms of health, the country is still facing endemic-epidemic diseases, especially malaria, measles**,** cerebro-spinal meningitis, acute respiratory infections, diarrheal diseases and HIV / AIDS infection[21]. The prevalence of acute malnutrition was estimated at 8.2% in 2014[22].

Mortality due to non-communicable diseases is increasing rapidly; it was estimated that 32% of all death cases were due to NCD in 2014[23].

Type of study

We carried out an analytical cross-sectional study consisting of a secondary analysis of the data from the 2013STEPS survey in Burkina Faso.

Study population

The study population of the survey was composed of adults of 25 to 64-year-old who have been living in the national territory for at least six (6) months before the survey. Persons with an inability to answer questions (cognitive impairment) were excluded from the primary study. Pregnant women were excluded from our analysis.

Sampling

The enumeration areas (EAs) from the 2006 General Population and Housing Census , updated in 2010 during the Demographic and Health Survey conducted in Burkina Faso (EDS-BF, 2010) were used as a sampling frame. The STEPS survey was carried out on a nationally representative sample of 4800 households with 20 households per EAs, giving 240 EAs for the whole country. The sample was stratified in each of the 13 administrative regions to provide an adequate representation of the urban and rural areas. This stratification took into account the

distribution of the population depending on the urban (22.7%) and rural environment (77.3%) in Burkina Faso, giving 54 EAs for urban area and 186 EAs for rural areas across the country. Within each stratum, a three-stage cluster sampling was done as recommended by WHO for STEPS NCD risk factors screening surveys.

At the first stage, the choice of clusters or enumeration zones by administrative regions was made by a systematic draw with proportional probability to the size of the EAs.

At the second stage, a household count in each of the selected 240 clusters at the first stage provided a list of households from which a sample of 20 households was selected using a simple systematic random sampling with an Excel Spread Sheet.

At the third level, the choice of individuals within households was made randomly using Kish method [24]. In each household, an individual of 25 to 64 years old living in the household was drawn to participate in the survey.

Sample Size and power of the study

The sample size was calculated by using t following formula:

$$n = \left(\frac{Z_{\alpha}^{2} * P(1-P)}{e^{2}} * 1{,}5 * 8 \right) / 0{,}8$$

where zα = 1.96 for a risk α of 0.05; e = absolute margin of error on the estimate of the proportion (0.05); P: expected hypertension prevalence (0.296). The sample size was adjusted to account for the design effect (1.5), the number of age group per gender (8) and the expected non response rate (20%).

The STEPS survey was conducted on a representative sample of 4,800 individuals. Out of the 4800 participants, 152 were excluded for pregnancy, 153 for missing data (on height and / or weight) and 23 due to a lack of sampling weights. The sample that we analyzed finally included 4472 persons (See figure**1 for study inclusion process**). With this final sample size and assuming a prevalence of obesity of 4.5%, our study has a statistical power of 86.6% to detect an association of a magnitude of 1.5 with the α threshold of 5%.

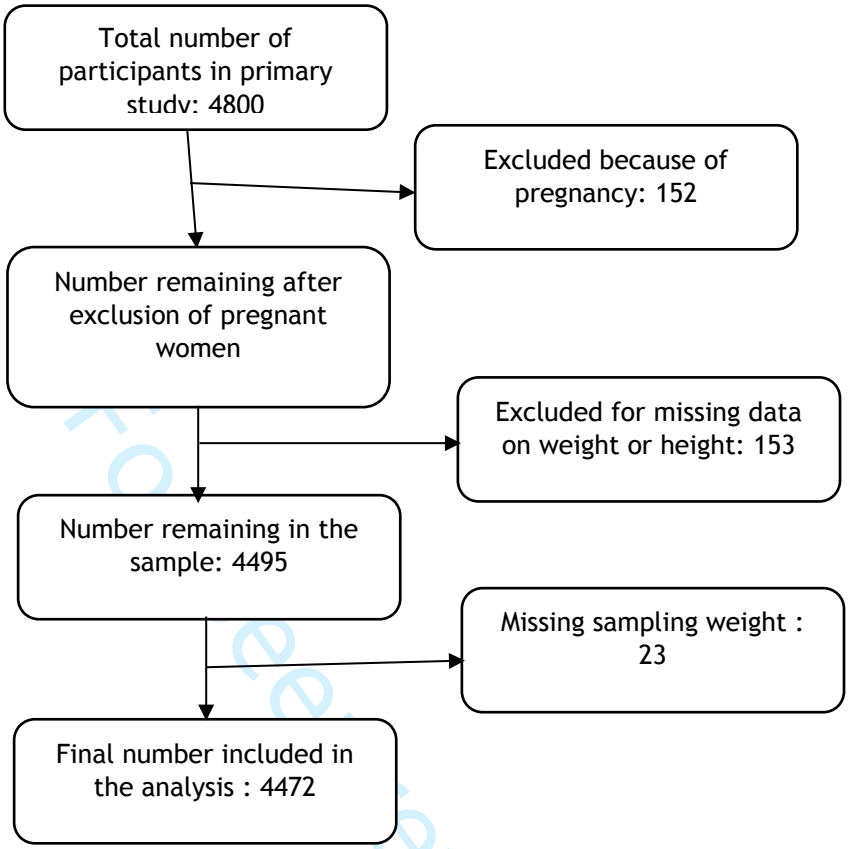

Figure 1 : Diagram flow of the study participants.

Data collection

The collection of data was carried out by nurses, graduate medical and nurse students. The data collection consisted in face-to-face interviews of selected participants using standardized questionnaires and physical and biochemical measurements. The data collection tools were pre-tested before they were used at the national level.

Data collection teams were closely supervised by a team of supervisors composed of statisticians, epidemiologists and clinicians.

Height measurement (in cm) was made in a standing or lying position, using a portable measuring board, on the participant without shoes and hat. The weight in kg was measured using an electronic weighing scales (SECA™) placed on a stable and even surface, the person lightly dressed, shoes-off and in a standing position.

The total cholesterol and blood glucose levels were measured using a Cardiocheck ™ PA SILVER kit that performs all these measurements using a capillary whole blood sample.

Study Variables

The dependent variable, body mass index (BMI) was calculated dividing the weight (kg) by the size (in meters) squared and then used to define undernutrition (BMI <18.5 kg / m^2), normal (18.5 - 24.99 kg / m^2), overweight (25.0-29.99 kg / m^2) and obesity (30 kg / m^2) in accordance with WHO recommendations [2]. A variable with three modalities including normal, overweight and obese was used in univariate and multivariate analyzes.

Independent variables included age, marital status, place of residence, occupational activity, educational level, total cholesterol level, fasting blood glucose, smoking, alcohol consumption, the type of fat most commonly consumed and the intensity of physical activities. Some variables were recoded using specific cut-points of grouping (see Table 1).

Table 1 : Recoding of exposure variables

Variables	Categories
Age groups (years)	«25 to 34» «35 to 44» «45 to 54» «55 to 64»
Education level	«None» «Primary» «Secondary and higher»
Marital status	«Single» «Cohabiting/Married» «Divorced/widowed/ separated»
Occupational status	«Employed» «self-employed» «Unemployed» «House makers »
Total cholesterol level	Normal (<5.2 mmol/l); High cholesterol (≥5.2 mmol/l)
Fasting capillary glucose	Normal (<6.1 mmol/l); High glucose (≥6.1 mmol/l)
Cigarette smoking	« Never » «Current smoker » « Former smoker » « Second hand smoking »
Daily alcohol consumption	• Male : None (0 g) Low (0.01 – 39.99 g) Medium (40 - 59.99) High (60 and over) • Female : None (0 g) Low (0.01 – 19.99 g) Medium (20 - 39.99) High (40 and over)
Fat intake	«None» «Vegetable oil» « butter, lard or fat, margarine»
Physical activity	• High intensity activity: high intensity activities require an energy expenditure greater than 6 Metabolic equivalent of Task (METs). Examples include soccer playing, hole digging, regular swimming, farming etc. • Moderate intensity activity: moderate intensity activities require an energy expenditure of approximately 3–6 METs. Examples include cleaning, vacuuming, polishing, gardening, cycling at a regular pace or horse riding etc. • Low intensity activity: refers to persons who do not meet the above classifications. Here are included people with limited and no physical activity.

Statistical analysis

The predictive variables were selected based on the literature. We carried out stratified gender based analyzes. The Fischer Test was used to evaluate associations between the dependent variable and independent qualitative variables. We calculated crude proportional odds ratio (CPOR) and adjusted proportional adjusted (APORs) using an ordinal logistic regression. We computed robust standard errors to account for the clustered nature of the data. The proportional risk assumption and the overall goodness of fit of the final models were checked before the results were reported. All the analyses were based on complete data analysis (missing data were ignored in all analyses). All analyzes were carried out using the Stata 13.1 software.

Patients and public involvement:

No patient involved.

Results

Background characteristics of the study sample

The socio-demographic characteristics of the individuals of the sample are presented in Table **2**. Participants of the 25-34 age group were majority with 40.92%. There were 2249 women, which represents 52.6% of the participants. Participants with no educational level accounted for 72.93% among men against 77.17% among women. The majority of the individuals were married/living in couple (86.96%).

Table 2 : Demographic and behavioural characteristics of study participants.

Variables	Population		Total
	Male n(%)	Female n(%)	
Residence			
Urban	454 (25.52)	539 (29.70)	993 (27.72)
Rural	1769 (74.48)	1710 (70.30)	3479 (72.28)
Age groups			
25 - 34	933 (38.09)	1044 (43.45)	1977 (40.92)
35 - 44	560 (28.21)	573 (37.65)	1133 (27.91)
45 - 54	424 (20.22)	404 (18.49)	828 (19.31)
55 - 64	306 (13.48)	228 (10.40)	534 (11.86)
Education level			
None	1623 (72.93)	1832 (81.16)	3455 (77.27)
Primary	405 (17.85)	288 (13.07)	693 (15.33)
Secondary (school) and higher	187 (9.22)	129 (5.78)	316 (7.40)
Marital status			
Single	254 (11.04)	68 (3.24)	322 (6.93)
Cohabiting/Married	1879 (85.74)	1963 (88.06)	3842 (86.96)
Divorced/Widowed/separated	87 (3.21)	216 (8.70)	303 (6.10)
Occupational status			
Employed	178 (6.68)	71 (3.44)	249 (2.92)
Self-employed	1945 (86.12)	1188 (50.40)	3133 (67.32)
Unemployed	87 (4.51)	54 (2.44)	141 (3.42)
Housemaker	13 (0.70)	936 (43.72)	949 (23.34)

Prevalence of overweight and obesity

As shown in Table 3, the prevalence of overweight and obesity in the sample were respectively 13.82 ($CI_{95\%}$: 12.25 - 15.55) and 4.84 ($CI_{95\%}$:3.99 - 5.86). The prevalence of obesity was higher among women ($p < 0.0001$) and among urban residents ($p < 0.0001$). However, the proportion of overweight people did not significantly differ between women and men. Among all age groups, obesity was more prevalent in the age group 35 to 44 ($p < 0.0001$). The prevalence of obesity also varies across administrative regions.

Tableau 3 : Prevalence of underweight, overweight and obesity among study participants.

	n	Underweight % (95% CI)	Overweight % (95% CI)	Obesity % (95% CI)
Gender				
Male	2223	8.10 (6.71 - 97.3)	13.91 (11.88 -16.22)	3.29 (2.33 - 4.62)
Female	2249	15.05 (13.19 - 17.12)	13.74 (11.86 -15.86)	6.24 (5.11 - 7.60)
Age groups (years)				
25 - 34	1977	9.32 (7.76 - 11.17)	12.09 (10.22 - 14.24)	3.73 (2.69 - 5.16)
35 - 44	1133	10.77 (8.70 - 13.25)	16.12 (13.35 - 19.34)	5.64 (4.26 - 7.43)
45 - 54	828	14.05 (11.63 - 16.89)	15.75 (12.79 -19.24)	5.26 (3.61 - 7.61)
55 - 64	534	18.75 (15.04 - 23.13)	11.22 (8.36 - 14.90)	6.10 (3.97 - 9.24)
Residence				
Rural	3479	13.32 (11.79 - 15.03)	9.74 (8.33 - 11.35)	1.89 (1.40 - 2.53)
Urban	993	7.67 (5.09 - 11.42)	24.46 (20.06 - 29.47)	12.54 (9.75- 15.99)
Total	**4472**	**11.76 (10.40 - 13.27)**	**13.82 (12.25 - 15.55)**	**4.84 (3.99 - 5.86)**

Risk factors for Obesity and overweight

Among men

In multivariable analysis, significant risk factors for overweight and obesity among men included place of residence, age, marital status, tobacco and fat consumption. Men living in urban areas were around 4 times proportionally more likely to be at least overweight as compared to those living in rural areas (APOR: 3.56, $CI_{95\%}$: 2.38 - 5.33). The odds of being overweight or obese was lower within the 25 to 34 age group compared to other age groups. Men aged 35 to 44 years were two times proportionally more likely to be overweight or obese (APOR: 2.08, $CI_{95\%}$: 1.37 - 3.16). Compared to single men, men living in unions and those living separately, widowed or divorced were having a higher proportional odds of being overweight or obese (APOR: 2.44, $CI_{95\%}$: 1.28 - 4.66 and OR: 4.18, $CI_{95\%}$: 1.76 - 9.94) . The consumption of tobacco reduces by half the proportional odds (APOR: 0.56, $CI_{95\%}$: 0.36 - 0.87) as well as the report of frequent consumption of butter / fat / lard (APOR: 0.49, IC: 0.28 - 0.83).

Among women

Among women, significant risk factors included urban residence, current tobacco consumption, educational level, cholesterol and fasting blood glucose levels. Urban residential status was associated with around three-fold increase in the proportional odds of obesity or overweight (APOR 2.90, $CI_{95\%}$:2.10 - 4.00) as compared to rural residence. Being of primary school

education level increased nearly two times the proportional odds of overweight or obesity (OR: 1.63, $CI_{95\%}$: 1.10 - 2.41) as compared to those that have not been at school (no education). Women with hypercholesterolemia (total cholesterol) and elevated blood glucose also presented higher proportional odds of being overweight or obese (OR: 3.51, $CI_{95\%}$: 1.80 - 6.86 and OR: 1.96, $CI_{95\%}$: 1.08 - 3.55 respectively). The proportional odds of being at least overweight was lower among current tobacco smokers compared to non-smokers (OR: 0.21, $CI_{95\%}$: 0.10 - 0.43). The results of the multivariable analysis are presented in Table 4.

Table 4: Risk factors for overweight and obesity among male and female adult population aged 25–64

	Male (n=2223)				Female (n=2249)			
	CPOR (95% CI)	p-value	APOR (95% CI)	p-value	CPOR (95% CI)	p-value	APOR (95% CI)	p-value
Residence area								
Rural	1.00		1.00		1.00		1.00	
Urban	3.97 (2.93 -5.38)	0.000	3.56 (2.38 -5.33)	0.000	3.83 (3.72 -6.28)	0.000	2.90 (2.10 -4.00)	0.000
Age (years)								
25 – 34	1.00		1.00		1.00		1.00	
35 – 44	1.96 (1.39 - 2.78)	0.000	2.08 (1.37 -3.16)	0.001	1.29 (0.97 -1.73)	0.081	1.34 (0.94 -1.91)	0.103
45 – 54	1.74 (1.18 - 2.56)	0.005	1.72 (1.07 -2.78)	0.026	1.46 (1.04 -2.07)	0.030	1.42 (0.94 -2.15)	0.098
55 – 64	1.42 (0.90 - 2.25)	0.133	1.23 (0.76 -2.12)	0.448	1.40 (0.87 -2.26)	0.168	1.64 (0.90 -3.00)	0.105
Education								
None	1.00		1.00		1.00		1.00	
Primary	1.22 (0.82 -1.80)	0.320	1.11 (0.68 -1.79)	0.681	2.92 (2.09 -4.09)	0.000	1.63 (1.10 -2.41)	0.014
Secondary (school) and over	3.24 (2.12 -4.95)	0.000	1.37 (0.76 -2.47)	0.294	4.07 (2.56 -6.46)	0.000	1.28 (0.66 -2.50)	0.464
Occupation								
Employed	1.00		1.00		1.00		1.00	
Self-employed	0.28 (0.19 -0.43)	0.000	0.78 (0.42 -1.42)	0.412	0.21 (0.12 -0.36)	0.000	0.52 (0.23 -1.14)	0.104

Unemployed	0.51 (0.25 -1.02)	0.057	0.86 (0.38 -1.95)	0.714	0.57 (0.22 -1.45)	0.236	0.90 (0.90 -1.65)	0.200
House maker					0.27 (0.16 -0.47)	0.000	0.50 (0.22 -1.13)	0.097
Marital status								
Single	1.00		1.00		1.00		1.00	
Cohabiting/Married	1.30 (0.81 -2.07)	0.271	2.44 (1.28 -4.66)	0.007	0.66 (0.31 -1.43)	0.297	1.84 (0.73 -4.61)	0.193
Divorced/Widowed/	2.13 (0.96 -4.73)	0.063	4.18 (1.76 -9.94)	0.001	0.72 (0.31 -1.70)	0.459	1.84 (0.66 -5.10)	0.244
Total cholesterol								
Normal	1.00		1.00		1.00		1.00	
High cholesterol	3.41 (1.44 -8.11)	0.05	1.62 (0.54 -4.81)	0.403	5.62 (3.06 -10.32)	0.000	3.51 (1.80 -6.86)	0.000
Fasting glucose								
Normal	1.00		1.00		1.00		1.00	
High glucose	1.71 (0.93 -3.14)	0.083	1.30 (0.61 -2.76)	0.545	2.17 (1.27 -3.71)	0.05	1.96 (1.08 -3.55)	0.026
Tobacco consumption								
Never	1.00		1.00		1.00		1.00	
Current smoker	0.64 (0.43 -0.95)	0.027	0.56 (0.36 -0.86)	0.009	0.20 (0.10 -0.37)	0.000	0.21 (0.10 -0.43)	0.000
Former smoker	1.44 (0.77 -2.71)	0.257	1.02 (0.46 -2.23)	0.960	0.98 (0.18 -5.21)	0.983	0.42 (0.94 -1.92)	0.265
Second hand smoking	1.27 (0.92 -1.75)	0.151	0.98 (0.69 -1.40)	0.920	1.30 (0.99 -1.71)	0.056	1.09 (0.79 -1.49)	0.600

Alcohol								
None	1.00		1.00		1.00		1.00	
Low	1.04 (0.71 -1.51)	0.856	1.02 (0.68 -1.52)	0.919	0.47 (0.26 -0.85)	0.012	0.60 (0.30 -1.21)	0.153
Medium	1.69 (1.00 -2.82)	0.047	1.43 (0.83 -2.47)	0.192	1.44 (1.00 -2.07)	0.047	1.44 (0.96 -2.17)	0.078
High	1.52 (0.74 -3.13)	0.257	1.26 (0.61 -2.64)	0.530	1.21 (0.57 -2.59)	0.620	0.68 (0.30 -1.30)	0.378
Fat used								
None	1.00		1.00		1.00		1.00	
Vegetable oil	1.10 (0.71 -1.71)	0.658	0.71 (0.44 -1.13)	0.144	2.00 (1.27 -3.18)	0.03	1.30 (0.76 -2.21)	0.335
Butter, lard or fat, margarine	0.48 (0.28 -0.81)	0.006	0.49 (0.28 -0.83)	0.008	0.73 (0.44 -1.23)	0.240	0.73 (0.41 -1.32)	0.302
Physical activity								
Low intensity	1.00		1.00		1.00		1.00	
Moderate intensity:	0.58 (0.38 -0.90)	0.016	0.71 (0.43 -1.17)	0.179	0.76 (0.53 -1.10)	0.147	0.89 (0.59 -1.34)	0.581
High intensity	0.44 (0.30 -0.65)	0.000	0.68 (0.43 -1.08)	0.101	0.55 (0.39 -0.76)	0.000	0.87 (0.59 -1.30)	0.506

CPOR : Crude proportional odds ratio ; APOR : Adjusted proportional odds ratio ; CI : Confidence interval

Discussion

Prevalence of overweight and obesity

The overall prevalence of overweight was relatively high in our study, with no significant difference between men and women. Studies in Africa have also found similar prevalence among both sex[19,25]. However, some authors reported higher proportion of overweight among men[26–28]. The prevalence of obesity in our study was around 5% with disparities found across regions.

The prevalence of obesity was higher among women. Several other studies also reported the prevalence of obesity among women[6,7,29–32]. Hormonal effects, especially among older ages, women's maternity and lifestyle, and certain cultural conceptions, would contribute to this higher burden of obesity among women[33].

Factors associated with obesity in Burkina Faso

Living in urban areas and current tobacco consumption are factors associated with obesity or overweight among both genders. Van Der and all in Gambia[16], also noted that risk in urban areas was about 3 times higher than in rural areas (OR: 2.86, 95% CI: 1.89 - 4 , 35). Abubakari et al. in a meta-analysis of studies conducted in sub-Saharan Africa[33] also noted that the risk was higher in urban areas (OR: 2.70, 95% CI, 1.76-4.15). This high risk could be explained by more sedentary lifestyle in urban areas as previously mentioned. In addition, in urban areas, the population consumes more sugar rich foods and fats known as "urban" or "western" foods[5]. Current tobacco consumption was inversely associated with the occurrence of overweight or obesity within both genders. Results from other studies reported that smoking for a long period tends to lead to weight loss. Similarly, cessation of tobacco consumption goes along with weight gain[34,35].

Other factors associated with overweight or obesity among men were age, marital status, consumption of butter /lard / margarine. Several authors also reported a positive association between the risk of obesity and age[9,12,27]. Aging leads to less physical activity and combined with greater socio-economic status, increase the ability to access diverse foods. The use of butter / fat / margarine as the main source of lipid was inversely associated with obesity in our data. This is an unexpected result as one would expect a lower risk of overweight and obesity among those that use predominantly vegetable oil. The lack of quantification of the consumption of the different types of oil makes difficult the comparison. Physical activity was associated with decrease in the odds of obesity in our data but the magnitude of the association

did not reach significance. Other studies carried out by Pasquet et al. in Cameroon[11] and Oladimeji in Nigeria[13] revealed that the practice of intensive physical activity reduces significantly the risk of obesity.

Indeed, the intensive physical activity leads to an increase in the energy expenditure, avoids fat deposition and promotes a development of the muscular mass [36]. Men living in couple were about 75% less likely to be obese compared to single men. Single men have little control over the meals they consume as compared to married ones and may be more exposed to the consumption of restaurants and fast food meals, rich in calories.

Among women, participants who had at least primary and secondary school levels were three and four times more likely to be obese compared to uneducated people. However, in their study among women living in urban areas, Benkeser et al. in Ghana [33] did not find a relation between educational level and obesity. This could be explained by the fact that their study was exclusively carried out in urban areas. The relation between obesity, hypercholesterolemia and hyperglycemia is well-known and was also reported by several authors[6,7,29–32].

Conclusion

Our study showed an important burden of obesity and overweight in the adult population with women more affected than men. Overnutrition needs to be recognized as an important public health issue. The country is witnessing the double burden of malnutrition with the coexistence of overnutrition and undernutrition. Nutrition interventions need to be reshaped to account for this epidemiological picture of malnutrition in Burkina Faso.

Abbreviations

BMI: body mass index; CI: confidence interval; CPOR : Crude proportional odds ratio ; APOR : Adjusted proportional odds ratio ; WHO : World health organization.

Acknowledgements

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Data availability

The STEPS 2013 survey database was used for this study. These data can be obtained at the Ministry of Health by a request. Any request for further analysis can be submitted to Dr Brice Bicaba bicababrico78@gmail.com.

Authors contribution

SK1, MT and SK2 designed the study and SK1 drafted the paper. SK1 and MT performed initial analysis and MT reanalysed the data. SK2, BB and HL made substantial contributions to the interpretation of the data. All authors read and approved the final manuscript.

Conflicts of interest

None

Consent for publication

Not applicable.

Ethical considerations

The STEPS survey got approval from the Ethics Committee for Health Research (Deliberation No. 2012-12-092 of 05 December 2012). Written informed consent was obtained before inclusion in the study. For this study, we obtained an authorization from the General directorate of Health to reanalyze the data and the confidentiality of study participants was preserved.

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

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	2&4
Methods			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	5&6
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7&8
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	*8*
Bias	9	Describe any efforts to address potential sources of bias	7&8
Study size	10	Explain how the study size was arrived at	6
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	8
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	9
		(*c*) Explain how missing data were addressed	9
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	9
		(*e*) Describe any sensitivity analyses	None
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	7& figure 1
		(b) Give reasons for non-participation at each stage	7& figure 1
		(c) Consider use of a flow diagram	Figure 1
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	9&10
		(b) Indicate number of participants with missing data for each variable of interest	10

Outcome data	15*	Report numbers of outcome events or summary measures	10&11
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	11&12&13&14
		(*b*) Report category boundaries when continuous variables were categorized	10
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	None included
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	11-15
Discussion			
Key results	18	Summarise key results with reference to study objectives	16
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	3&16
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	16
Generalisability	21	Discuss the generalisability (external validity) of the study results	16&17
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	18

*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.

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Prevalence and risk factors for Overweight and obesity: a cross sectional countrywide study in Burkina Faso

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Prevalence and risk factors for Overweight and obesity: a cross sectional countrywide study in Burkina Faso.

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Abstract

Objective: The objective of this study was to determine the prevalence and predictors of overweight and obesity in Burkina Faso using a population-based country-wide sample. We hypothesize that there is a significant burden related to overweight/obesity in Burkina Faso.

Design: Secondary analysis of a population-based country wide cross-sectional study

Setting: Burkina Faso, all the 13 regions including both rural and urban residential areas

Participants: 4,800 participants of both sexes, aged between 25 and 64 years.

Main outcomes: overweight and obesity using body mass index cut-off levels of WHO

Results: The prevalence of overweight and obesity in Burkina Faso were 13.82% (CI95%: 12.25 - 15.55) and 4.84% (CI95%:3.99 - 5.86) respectively. Among men, the proportional odds of overweight / obesity increase with urban residency ($p<0.001$), greater age ($p<0.002$), marital status different from single ($p\leq0.007$) and decrease with current smoking ($p=0.009$). Among women, the proportional odds of overweight / obesity increase with urban residency ($p<0.001$), primary educational level ($P=0.01$), high total blood cholesterol level ($p<0.001$), high fasting blood glucose level ($p=0.02$), and decrease with current smoking ($p<0.001$).

Conclusion:

Our study showed that nearly one person out of five in the adult population of Burkina has an abnormal weight status with women being more affected than men. Urban residency is a consistent risk factor in both men and women. Alcohol consumption and education were associated with an increased odds in only women. Overnutrition needs to be recognized as an important public health issue in Burkina Faso and nutrition interventions need to be reshaped to account for it.

Strengths and limitations

Strengths

- To our best knowledge, this is the first nationwide study on obesity and overweight in Burkina Faso with a country level representative sample.
- Outcomes measurements were carried out following international standards through the WHO STEPwise approach to NCDs measurement and prevention.
- Our results showed a significant prevalence of overweight/obesity in the adult population of Burkina Faso, suggesting the need of taking into account overnutrition in health policies in addition to undernutrition.

Limitations

- This is a cross sectional study, which hampers our ability to derive causal inferences from the reported data;
- The Socio-economic status, a known relevant variable was not measured in the primary study;

Introduction

Obesity is defined as an abnormal or excessive accumulation of body fat, due to an energy imbalance between intake and expenditure [1]. It is a major risk factor for many non-communicable diseases (NCD) and a real public health threat in the world[2,3]. In 2012, NCDs accounted for 68% of all deaths worldwide [4].

Obesity, a well-known phenomenon in developed countries, is increasingly common in low-middle income countries, affecting both children and adults [1,2]. Out of all World Health Organization (WHO) regions, the American's Region was the most affected with a prevalence of 27%; the least affected region was South-East Asia (5%). In the Africa region, the proportion of obese people was about 6% among men and 15% among women [4]. Thus, in low- and middle-income countries, the association of overweight / obesity with one or more nutritional deficiencies is often observed, especially among women, known as double burden of malnutrition [5]. However, data from the literature reports that excess weight can largely be avoided; and prevention involves the identification and control of modifiable risk factors[1,2]. These factors have been widely described in the literature. There are mainly related to behavior and / or knowledge (inadequate diet, inactivity, alcohol consumption,), sociodemographic factors (place of residence, socio-economic status), and clinical and metabolic factors (total cholesterol level, HDL, triglycerides) [1,6–8].

However, the factors vary between countries, depending on eating habits and socio-cultural practices [2] . This variability of factors suggests a relevance of country specific studies to identify context specific and relevant risk factors in order to better guide and align the policies and strategies aiming to address the raising burden of obesity.

The studies conducted so far on factors associated with overweight or obesity in low-middle income countries were often conducted in urban areas [[9–13], hospitals[14,15], secondary and high schools [16–18]. There are few nationally representative data on obesity in most sub-Saharan African countries[6,19]. This scarcity of nationally representative data on the burden and risk factors for overweight/obesity is an obstacle to engaging countries in the design and implementation of adequate public health interventions.

Our study intends to fill this gap by providing more complete data on the prevalence and the risk factors for overweight and obesity, through a secondary analysis of data from the STEPS survey carried out in Burkina Faso in 2013.

Methods

Study setting

Our study was conducted in Burkina Faso, a landlocked Sahelian country in the heart of West Africa. The country is divided into 13 regions, 45 provinces and 351 municipalities. In 2013, the population was estimated at 17,271,583 inhabitants. The majority of the population lives in rural areas, with agriculture and livestock as main activities[20].

In terms of health, the country is still facing endemic-epidemic diseases, especially malaria, measles, cerebro-spinal meningitis, acute respiratory infections, diarrheal diseases and HIV / AIDS infection[21]. The prevalence of acute malnutrition in children under five years was estimated at 8.2% in 2014[22].

Mortality due to non-communicable diseases is increasing rapidly in the same time; it was estimated that 32% of all death cases were due to NCD in 2014[23].

Type of study

We carried out an analytical cross-sectional study consisting of a secondary analysis of the data from the 2013STEPS survey in Burkina Faso.

Study population

The study population of the survey was composed of adults of 25 to 64-year-old who have been living in the national territory for at least six (6) months before the survey. Persons with an inability to answer questions (cognitive impairment) were excluded from the primary study. Pregnant women were excluded from our analysis.

Sampling

The enumeration areas (EAs) from the 2006 General Population and Housing Census , updated in 2010 during the Demographic and Health Survey conducted in Burkina Faso (EDS-BF, 2010) were used as sampling frame. The STEPS survey was carried out on a nationally representative sample of 4800 households with 20 households per EAs, giving 240 EAs for the whole country. The sample was stratified in each of the 13 administrative regions to provide an adequate representation of the urban and rural areas. This stratification took into account the distribution

of the population depending on the urban (22.7%) and rural environment (77.3%) in Burkina Faso, giving 54 EAs for urban area and 186 EAs for rural areas across the country. Within each stratum, a three-stage cluster sampling was done as recommended by WHO for STEPS NCD risk factors screening surveys.

At the first stage, the choice of clusters or enumeration zones by administrative regions was made by a systematic draw with proportional probability to the size of the EAs.

At the second stage, a household count in each of the selected 240 clusters at the first stage provided a list of households from which a sample of 20 households was selected using a simple systematic random sampling with an Excel Spread Sheet.

At the third level, the choice of individuals within households was made randomly using Kish method [24]. In each household, an individual of 25 to 64 years old living in the household was drawn to participate in the survey.

Sample Size and power of the study

The sample size was calculated by using the following formula:

$$n = \left(\frac{Z_{\alpha}^{2} * P(1-P)}{e^{2}} * 1{,}5 * 8 \right) / 0{,}8$$

where zα = 1.96 for a risk α of 0.05; e = absolute margin of error on the estimate of the proportion (0.05); P: expected hypertension prevalence (0.296). The sample size was adjusted to account for the design effect (1.5), the number of age group per gender (8) and the expected non response rate (20%).

The STEPS survey was conducted on a representative sample of 4,800 individuals. Out of the 4800 participants, 152 were excluded for pregnancy, 153 for missing data (on height and / or weight) and 23 due to a lack of sampling weights. The sample that we analyzed finally included 4472 persons (See figure**1 for study inclusion process**). With this final sample size and assuming a prevalence of obesity of 4.5%, our study has a statistical power of 86.6% to detect an association of a magnitude of 1.5 with the α threshold of 5%.

Data collection

The collection of data was carried out by nurses, graduate medical and nurse students. The data collection consisted in face-to-face interviews of selected participants using standardized

questionnaires and physical and biochemical measurements. The data collection tools were pre-tested before they were used at the national level.

Data collection teams were closely supervised by a team of supervisors composed of statisticians, epidemiologists and clinicians.

Height measurement (in cm) was made in a standing or lying position, using a portable measuring board, on the participant without shoes and hat. The weight in kg was measured using an electronic weighing scales (SECA™) placed on a stable and even surface, the person lightly dressed, shoes-off and in a standing position.

The total cholesterol and blood glucose levels were measured using a Cardiocheck ™ PA SILVER kit that performs all these measurements using a capillary whole blood sample. Further details on the STEPS survey are available elsewhere[25].

Study Variables

We used body mass index (BMI) to define general obesity. The BMI was calculated dividing the weight (kg) by the size (in meters) squared and then used to define undernutrition (BMI <18.5 kg / m^2), normal (18.5 - 24.99 kg / m^2), overweight (25.0-29.99 kg / m^2) and obesity (30 kg / m^2) in accordance with WHO recommendations [2]. We also used waist circumference to compute central obesity with the cut-off points of 94 cm in men and 80 cm in women[26].

Independent variables included age, marital status, place of residence, occupational activity, educational level, total cholesterol level, fasting blood glucose, smoking, alcohol consumption, the type of fat most commonly consumed and the intensity of physical activities. Some variables were recoded using specific cut-points of grouping (see Table 1).

Table 1 : Recoding of exposure variables

Variables	Categories
Age groups (years)	«25 to 34» «35 to 44» «45 to 54» «55 to 64»
Education level	«None» «Primary» «Secondary and higher»
Marital status	«Single» «Cohabiting/Married» «Divorced/widowed/ separated»
Occupational status	«Employed» «self-employed» «Unemployed» «House makers »
Total cholesterol level	Normal (<5.2 mmol/l); High cholesterol (≥5.2 mmol/l)
Fasting capillary glucose	Normal (<6.1 mmol/l); High glucose (≥6.1 mmol/l)
Cigarette smoking	« Never » «Current smoker » « Former smoker » « Second hand smoking »
Daily alcohol consumption	• Male : None (0 g) Low (0.01 – 39.99 g) Medium (40 - 59.99) High (60 and over) • Female : None (0 g) Low (0.01 – 19.99 g) Medium (20 - 39.99) High (40 and over)
Fat intake	«None» «Vegetable oil» « butter, lard or fat, margarine»

Physical activity	• High intensity activity: high intensity activities require an energy expenditure greater than 6 Metabolic equivalent of Task (METs). Examples include soccer playing, hole digging, regular swimming, farming etc. • Moderate intensity activity: moderate intensity activities require an energy expenditure of approximately 3–6 METs. Examples include cleaning, vacuuming, polishing, gardening, cycling at a regular pace or horse riding etc. • Low intensity activity: refers to persons who do not meet the above classifications. Here are included people with limited and no physical activity.

Statistical analysis

The predictive variables were selected based on the literature. We carried out stratified gender based analyzes. The Fischer Test was used to evaluate associations between the dependent variable and independent qualitative variables. We calculated crude proportional odds ratio (CPOR) and adjusted proportional odds ratios (APORs) using an ordinal logistic regression. The covariates selection in the multivariable analysis was based on epidemiological plausibility and literature review. All the analyses were weighted to account for the study design and we computed robust standard errors to account for the clustered nature of the data. The proportional risk assumption and the overall goodness of fit of the final models were checked before the results were reported. All the analyses were based on complete data analysis (missing data were ignored in all analyses). All analyzes were carried out using the Stata 13.1 software.

Patient and public involvement

There has been no patient and/or public involvement in the study design, data collection, data analysis and writing of this research.

Results

Background characteristics of the study sample

The socio-demographic characteristics of the individuals of the sample are presented in Table **2**. Participants of the 25-34 age group were majority with 40.92%. There were 2249 women, which represents 52.6% of the participants. Participants with no educational level accounted

for 72.93% among men against 77.17% among women. The majority of the individuals were married/living in couple (86.96%).

Table 2 : Demographic and behavioural characteristics of study participants.

Variables	Population		Total
	Male n(%)	Female n(%)	
Residence			
Urban	454 (25.52)	539 (29.70)	993 (27.72)
Rural	1769 (74.48)	1710 (70.30)	3479 (72.28)
Age groups			
25 - 34	933 (38.09)	1044 (43.45)	1977 (40.92)
35 - 44	560 (28.21)	573 (37.65)	1133 (27.91)
45 - 54	424 (20.22)	404 (18.49)	828 (19.31)
55 - 64	306 (13.48)	228 (10.40)	534 (11.86)
Education level			
None	1623 (72.93)	1832 (81.16)	3455 (77.27)
Primary	405 (17.85)	288 (13.07)	693 (15.33)
Secondary (school) and higher	187 (9.22)	129 (5.78)	316 (7.40)
Marital status			
Single	254 (11.04)	68 (3.24)	322 (6.93)
Cohabiting/Married	1879 (85.74)	1963 (88.06)	3842 (86.96)
Divorced/Widowed/separated	87 (3.21)	216 (8.70)	303 (6.10)
Occupational status			
Employed	178 (6.68)	71 (3.44)	249 (2.92)
Self-employed	1945 (86.12)	1188 (50.40)	3133 (67.32)
Unemployed	87 (4.51)	54 (2.44)	141 (3.42)
Housemaker	13 (0.70)	936 (43.72)	949 (23.34)

Prevalence of overweight and obesity

As shown in Table 3, the prevalence of overweight and general obesity in the sample were respectively 13.82 ($CI_{95\%}$: 12.25 - 15.55) and 4.84 ($CI_{95\%}$:3.99 - 5.86). The prevalence of general obesity was higher among women ($p < 0.0001$) and among urban residents ($p < 0.0001$). However, the proportion of overweight people did not significantly differ between women and men. Among all age groups, obesity was more prevalent in the age group 35 to 44 ($p < 0.0001$). The prevalence of obesity also varies across administrative regions (results not shown). The prevalence of central obesity was respectively 6.33% (CI95%: 5.11-7.81) and 34.50%

(CI95%:31.12-38.97) in men and women, with significant rural versus urban difference in both sexes (p<0.001).

Tableau 3 : Prevalence of underweight, overweight and general obesity among study participants.

	n	Underweight % (95% CI)	Overweight % (95% CI)	Obesity % (95% CI)
Gender				
Male	2223	8.10 (6.71 – 97.3)	13.91 (11.88 -16.22)	3.29 (2.33 – 4.62)
Female	2249	15.05 (13.19 – 17.12)	13.74 (11.86 -15.86)	6.24 (5.11 – 7.60)
Age groups (years)				
25 – 34	1977	9.32 (7.76 – 11.17)	12.09 (10.22 – 14.24)	3.73 (2.69 – 5.16)
35 – 44	1133	10.77 (8.70 – 13.25)	16.12 (13.35 – 19.34)	5.64 (4.26 – 7.43)
45 – 54	828	14.05 (11.63 – 16.89)	15.75 (12.79 -19.24)	5.26 (3.61 – 7.61)
55 – 64	534	18.75 (15.04 – 23.13)	11.22 (8.36 – 14.90)	6.10 (3.97 – 9.24)
Residence				
Rural	3479	13.32 (11.79 – 15.03)	9.74 (8.33 – 11.35)	1.89 (1.40 – 2.53)
Urban	993	7.67 (5.09 – 11.42)	24.46 (20.06 – 29.47)	12.54 (9.75- 15.99)
Total	**4472**	**11.76 (10.40 - 13.27)**	**13.82 (12.25 - 15.55)**	**4.84 (3.99 - 5.86)**

Risk factors for Obesity and overweight

Among men.

In multivariable analysis, significant predictors of overweight and obesity among men included place of residence, physical activity, age, marital status, alcohol, tobacco and fat consumption. Men living in urban areas were around 3 times proportionally more likely to be at least overweight as compared to those living in rural areas (APOR: 2.84, CI95%: 1.90 - 4.23). The odds of being overweight or obese was lower within the 25 to 34 age group as compared to35-44 years and 45-54 years. Men aged 35 to 44 years were 1.4 times proportionally more likely to be overweight or obese (APOR: 1.4, $CI_{95\%:}$ 1.00 – 1.90). Compared to single men, men living in unions and those that are widowed or divorced were having higher proportional odds of being overweight or obese (APOR: 1.62, $CI_{95\%:}$ 1.09 - 2.42 and APOR: 1.83, $CI_{95\%:}$ 0.76 - 4.39) . The current consumption of tobacco reduces by nearly half the proportional odds (APOR: 0.53, $CI_{95\%}$: 0.37 - 0.74). No significant difference was found between former and second hand smokers and men who had never smoked. The report of the consumption of butter, lard or margarine as the most often type of fat was associated with more than 30% proportional odds reduction (APOR: 0.62, CI95%: 0.39 - 0.97). The practice of physical activity was also associated with lower odds of overweight/obesity with the odds reduction increasing as the

intensity of the physical activity increases (APOR: 0.68, $CI_{95\%}$:0.44-1.04 and APOR:0.62, $CI_{95\%}$:0.42-0.93).

Among women

Among women, significant risk factors included urban residence, current tobacco consumption, educational level, the type of occupation and fat consumption. Urban residential status was associated with around three-fold increase in the proportional odds of obesity or overweight (APOR 2.67, $CI_{95\%}$:1.89 - 3.78) as compared to rural residence. Being of primary school education level increased nearly two times the proportional odds of overweight or obesity (APOR: 1.80, $CI_{95\%}$:1.26-2.57) as compared to those that have not been at school (no education). The proportional odds of being at least overweight was lower among current tobacco smokers compared to non-smokers (APOR: 0.42, $CI_{95\%}$: 0.29 - 0.60). As compared to wage earners, women that are self-employed and those that house makers were less likely to be overweight/obese (APOR:0.45, $CI_{95\%}$:0.24-0.87 and APOR:0.40, $CI_{95\%}$:0.21-0.77). The report of butter/lard or margarine as type of fat often consumed was associated with lower odds of overweight/obesity (APOR:0.67, $CI_{95\%}$:0.46-0.99).

The results of the multivariable analysis are presented in Table 4.

Table 4: Risk factors for overweight and obesity among male and female adult population aged 25–64

	Male (n=2223)				Female (n=2249)			
	CPOR (95% CI)	p-value	APOR (95% CI)	p-value	CPOR (95% CI)	p-value	APOR (95% CI)	p-value
Residence area								
Rural	1.00		1.00		1.00		1.00	
Urban	3.97 (2.93 -5.38)	0.000	2.84 (1.90 -4.23)	0.000	3.83 (3.72 -6.28)	0.000	2.67 (1.89 -3.78)	0.000
Age (years)								
25 – 34	1.00		1.00		1.00		1.00	
35 – 44	1.96 (1.39 - 2.78)	0.000	1.40 (1.00 -1.90)	0.049	1.29 (0.97 -1.73)	0.081	1.19 (0.89 -1.59)	0.239
45 – 54	1.74 (1.18 - 2.56)	0.005	1.20 (0.81 -1.65)	0.412	1.46 (1.04 -2.07)	0.030	1.18 (0.87 -1.61)	0.287
55 – 64	1.42 (0.90 - 2.25)	0.133	0.67 (0.43 -1.04)	0.074	1.40 (0.87 -2.26)	0.168	1.12 (0.70 -1.80)	0.628
Education								
None	1.00		1.00		1.00		1.00	
Primary	1.22 (0.82 -1.80)	0.320	1.07(0.75 -1.53)	0.708	2.92 (2.09 -4.09)	0.000	1.80 (1.26 -2.57)	0.001
Secondary (school) and over	3.24 (2.12 -4.95)	0.000	1.39 (0.77 -2.48)	0.271	4.07 (2.56 -6.46)	0.000	1.57 (0.87 -2.80)	0.131
Occupation								
Wage earners	1.00		1.00		1.00		1.00	
Self-employed	0.28 (0.19 -0.43)	0.000	0.98 (0.53 -1.81)	0.959	0.21 (0.12 -0.36)	0.000	0.45 (0.24 -0.87)	0.017

Unemployed	0.51 (0.25 -1.02)	0.057	0.75 (0.35 -1.60)	0.458	0.57 (0.22 -1.45)	0.236	0.42 (0.14 -1.27)	0.123
House maker					0.27 (0.16 -0.47)	0.000	0.40 (0.21 -0.77)	0.006
Marital status								
Single	1.00		1.00		1.00		1.00	
Cohabiting/Married	1.30 (0.81 -2.07)	0.271	1.62 (1.09 -2.42)	0.017	0.66 (0.31 -1.43)	0.297	(1.01 -4.16)	0.045
Divorced/Widowed/	2.13 (0.96 -4.73)	0.063	1.83 (0.76 -4.39)	0.176	0.72 (0.31 -1.70)	0.459	1.64 (0.73 -3.68)	0.232
Tobacco consumption								
Never	1.00		1.00		1.00		1.00	
Current smoker	0.64 (0.43 -0.95)	0.027	0.53 (0.37 -0.74)	0.000	0.20 (0.10 -0.37)	0.000	0.42 (0.29 -0.60)	0.000
Former smoker	1.44 (0.77 -2.71)	0.257	1.10 (0.59 -2.05)	0.756	0.98 (0.18 -5.21)	0.983	0.55 (0.13 -2.37)	0.426
Second hand smoking	1.27 (0.92 -1.75)	0.151	1.11 (0.82 -1.50)	0.506	1.30 (0.99 -1.71)	0.056	1.14 (0.87 -1.48)	0.347
Alcohol								
None	1.00		1.00		1.00		1.00	
Low	1.04 (0.71 -1.51)	0.856	0.96 (0.68 -1.35)	0.811	0.47 (0.26 -0.85)	0.012	0.69 (0.45 -1.05)	0.081
Medium	1.69 (1.00 -2.82)	0.047	1.87 (1.20 -2.93)	0.006	1.44 (1.00 -2.07)	0.047	1.17 (0.82 -1.68)	0.386
High	1.52 (0.74 -3.13)	0.257	1.38 (0.77 -2.46)	0.276	1.21 (0.57 -2.59)	0.620	0.71 (0.38 -1.32)	0.280
Fat used								

None	1.00		1.00		1.00		1.00	
Vegetable oil	1.10 (0.71 -1.71)	0.658	0.85 (0.56 -1.30)	0.461	2.00 (1.27 -3.18)	0.03	1.04 (0.72 -1.52)	0.829
Butter, lard or fat, margarine	0.48 (0.28 -0.81)	0.006	0.62 (0.39 -0.97)	0.037	0.73 (0.44 -1.23)	0.240	0.67 (0.46 -0.99)	0.045
Physical activity								
Low intensity	1.00		1.00		1.00		1.00	
Moderate intensity:	0.58 (0.38 -0.90)	0.016	0.68 (0.44 -1.04)	0.076	0.76 (0.53 -1.10)	0.147	0.94 (0.66 -1.33)	0.581
High intensity	0.44 (0.30 -0.65)	0.000	0.62 (0.42 -0.93)	0.021	0.55 (0.39 -0.76)	0.000	0.88 (0.63 -1.23)	0.449

CPOR : Crude proportional odds ratio ; APOR : Adjusted proportional odds ratio ; CI : Confidence interval

Discussion

Prevalence of overweight and obesity

The overall prevalence of overweight was relatively high in our study, with no significant difference between men and women. Studies in Africa have also found similar prevalence among both sex[19,27]. However, some authors reported higher proportion of overweight among men[28–30]. The prevalence of obesity in our study was around 5% with disparities found across regions.

The prevalence of obesity was higher among women. Several other studies also reported higher prevalence of obesity among women[6,7,31,32]. Hormonal effects, especially among older ages, women's maternity and lifestyle, and certain cultural conceptions, may be contributing to this higher burden of obesity among women[33].

Factors associated with obesity

Living in urban areas and current tobacco consumption are factors associated with obesity or overweight among both genders. Van Der and all in Gambia[6], also noted that risk in urban areas was about 3 times higher than in rural areas (OR: 2.86, 95% CI: 1.89 - 4 , 35). Abubakari et al. in a meta-analysis of studies conducted in sub-Saharan Africa[8] also noted that the risk was higher in urban areas (OR: 2.70, 95% CI, 1.76-4.15). This high risk could be explained by more sedentary lifestyle in urban areas as previously mentioned. In addition, in urban areas, eating patterns are different from that of rural areaq with more sugar and fats rich food known as "urban" or "western" foods[5]. Current tobacco consumption was inversely associated with the occurrence of overweight or obesity within both genders. Results from other studies reported that smoking for a long period tends to lead to weight loss. Similarly, cessation of tobacco consumption goes along with weight gain[34,35]. However, because smoking is an exposure with well-known detrimental consequences on health, the observed association between smoking and overweight/obesity shouldn't be interpreted as being in favor of smoking as a strategy to prevent obesity/overweight.

Other factors associated with overweight or obesity among men were age, marital status, consumption of butter /lard / margarine, and physical activity. Several authors also reported a positive association between the risk of obesity and age [9,12,29]. Aging leads to less physical activity and combined with greater socio-economic status, increase the ability to access diverse foods. The use of butter / fat / margarine as the main source of lipid was inversely associated with obesity in our data. This is an unexpected result as one would expect a lower risk of

overweight and obesity among those that use predominantly vegetable oil. The lack of quantification of the consumption of the different types of oil makes difficult the comparison. Physical activity was associated with significant decrease in the odds of obesity only in men and not in women in our data. Other studies carried out by Pasquet et al. in Cameroon[11] and Oladimeji in Nigeria[13] revealed that the practice of intensive physical activity reduces significantly the risk of obesity.

Indeed, the intensive physical activity leads to an increase in the energy expenditure, avoids fat deposition and promotes a development of the muscular mass [36]. Men living in union were about 60% more likely to be obese compared to single men. There was an association in the same direction in women. There is a correlation between marital status and socio-economic position. In our study, we lack data on the socio-economic status and we used education status as a proxy. Our findings of a positive correlation between being married and overweight/obesity may have been confounded by the socio-economic status.

Among women, education was associated with obesity/overweight. However, in their study among women living in urban areas, Benkeser et al. in Ghana [33] did not find a relation between educational level and obesity. This could be explained by the fact that their study was exclusively carried out in urban areas where the heterogeneity between educational statuses may be lesser. We found difference in predictors of overweight/obesity between men and women. Physical activity and age were significant predictors in men and not in women, while the education status and the type of employment were significant predictors in only women. These results are in favor of gender specific predictors for overweight/obesity and are in support of gender-based stratified analyses.

Limitations of the study

The results reported in this study are derived from a cross sectional study limiting our ability to derive causal inferences from the observed associations. Exposures measurements were mainly based on a short window recall as it is usual in this type of studies, hampering the possibility to get further attributes (quantity, duration etc.) on some exposures such as fat and frut consumptions, that would have been invaluable in the interpretation of the results. We did not have information on socio-economic status that is a known key variable when trying to predict overnutrition. Furthermore, the analysis carried out and our interpretation of the results assume that an overweight person is in transition to obese status. While this is conceptually true, we

cannot rule out that an overweight person will turn to be normal in the future, particularly in a setting where food insecurity is common.

Conclusion

Our study showed an important burden of obesity and overweight in the adult population with women more affected than men. Overnutrition needs to be recognized as an important public health issue. The country is witnessing the double burden of malnutrition with the coexistence of overnutrition and undernutrition. Nutrition interventions need to be reshaped to account for this epidemiological picture of malnutrition in Burkina Faso.

Abbreviations

BMI: body mass index; CI: confidence interval; CPOR : Crude proportional odds ratio ; APOR : Adjusted proportional odds ratio ; WHO : World health organization.

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Data availability statement

The STEPS 2013 survey database was used for this study. The dataset can be obtained at the Ministry of Health upon reasonable request. Any request for further analysis can be submitted to Dr Brice Bicaba bicababrico78@gmail.com. No further additional data is available.

Authors contribution

SK1, MT and SK2 designed the study and SK1 drafted the paper. SK1 and MT performed initial analysis and MT reanalysed the data. SK2, BB, JS and HL made substantial contributions to the interpretation of the data. All authors read and approved the final manuscript.

Conflicts of interest

None

Consent for publication

Not applicable.

Ethical considerations

The STEPS survey got approval from the Ethics Committee for Health Research (Deliberation No. 2012-12-092 of 05 December 2012). Written informed consent was obtained before inclusion in the study. For this study, we obtained an authorization from the General directorate of Health to reanalyze the data and the confidentiality of study participants was preserved.

Figure legend

Figure 1: Diagram flow of the study participants. This figure shows the criteria that were used to select the study participants in our study and the numbers that were affected by these criteria and the final sample size of the study.

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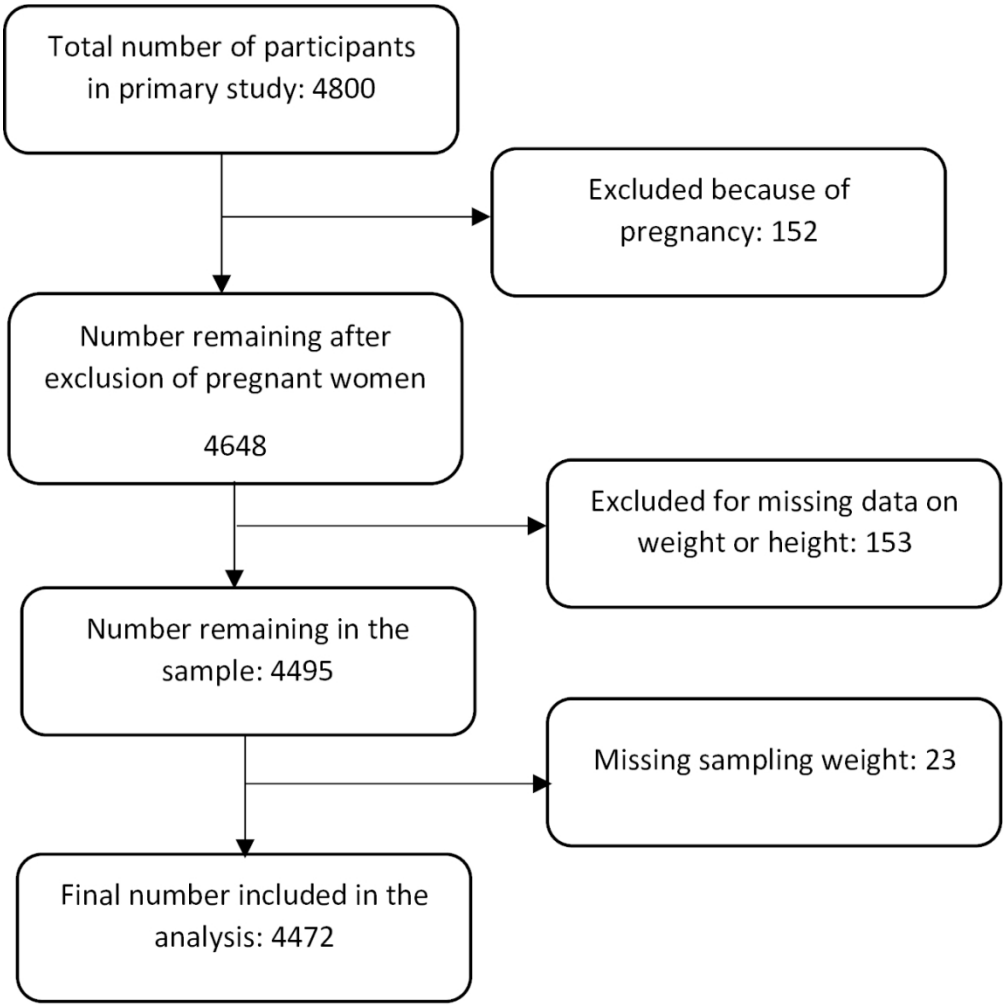

Figure 1 : Diagram flow of the study participants.

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

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	2&4
Methods			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	5&6
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7&8
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	*8*
Bias	9	Describe any efforts to address potential sources of bias	7&8
Study size	10	Explain how the study size was arrived at	6
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	8
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	9
		(*c*) Explain how missing data were addressed	9
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	9
		(*e*) Describe any sensitivity analyses	None
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	7& figure 1
		(b) Give reasons for non-participation at each stage	7& figure 1
		(c) Consider use of a flow diagram	Figure 1
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	9&10
		(b) Indicate number of participants with missing data for each variable of interest	10

Outcome data	15*	Report numbers of outcome events or summary measures	10&11
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	11&12&13&14
		(*b*) Report category boundaries when continuous variables were categorized	10
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	None included
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	11-15
Discussion			
Key results	18	Summarise key results with reference to study objectives	16
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	3&16
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	16
Generalisability	21	Discuss the generalisability (external validity) of the study results	16&17
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	18

*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.

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Prevalence and risk factors for Overweight and obesity: a cross sectional countrywide study in Burkina Faso

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Prevalence and risk factors for overweight and obesity: a cross sectional countrywide study in Burkina Faso.

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Abstract

Objective: The objective of this study was to determine the prevalence and predictors of overweight and obesity in Burkina Faso using a population-based country-wide sample. We hypothesize that there is a significant burden related to overweight/obesity in Burkina Faso.

Design: Secondary analysis of a population-based country wide cross-sectional study

Setting: Burkina Faso, all the 13 regions including both rural and urban residential areas

Participants: 4,800 participants of both sexes, aged between 25 and 64 years.

Main outcomes: overweight and obesity using body mass index cut-off levels of WHO

Results: The prevalence of overweight and obesity in Burkina Faso were 13.82% (CI95%: 12.25 - 15.55) and 4.84% (CI95%:3.99 - 5.86) respectively. Among men, the proportional odds of overweight / obesity increase with urban residency ($p<0.001$), greater age ($p<0.002$), marital status different from single ($p\leq0.007$) and decrease with current smoking ($p=0.009$). Among women, the proportional odds of overweight / obesity increase with urban residency ($p<0.001$), primary educational level ($p=0.01$), high total blood cholesterol level ($p<0.001$), high fasting blood glucose level ($p=0.02$), and decrease with current smoking ($p<0.001$).

Conclusion:

Our study showed that nearly one person out of five in the adult population of Burkina has an abnormal weight status with women being more affected than men. Urban residency is a consistent risk factor in both men and women. Alcohol consumption and education were associated with an increased odds in only women. Overnutrition needs to be recognized as an important public health issue in Burkina Faso and nutrition interventions need to be reshaped to account for it.

Strengths and limitations

Strengths

- To our best knowledge, this is the first nationwide study on obesity and overweight in Burkina Faso with a country level representative sample.
- Outcomes measurements were carried out following international standards through the WHO STEPwise approach to NCDs measurement and prevention.

Limitations

- This is a cross sectional study, which hampers our ability to derive causal inferences from the reported data;
- The Socio-economic status, a known relevant variable was not measured in the primary study;
- Being overweight may not necessarily equate to being an obese person to be, particularly in a setting where food insecurity is common.

Introduction

Obesity is defined as an abnormal or excessive accumulation of body fat, due to an energy imbalance between intake and expenditure [1]. It is a major risk factor for many non-communicable diseases (NCD) and a real public health threat in the world[2,3]. In 2015, high BMI contributed to 4.0 million deaths, which represented 7.1% of the deaths from all causes [4].

Obesity, a well-known phenomenon in developed countries, is increasingly common in low-middle income countries, affecting both children and adults [2,4,5]. In the Eastern Mediterranean Region, the prevalence of obesity increased in adults from 15.1% in 1980 to 20.7% in 2015. It increased from 4.1% to 4.9% in the same period among children [6]. In sub-Saharan Africa (SSA) , Overweight/obesity factors accounted for 266 768 deaths, representing 3.3% of all-cause mortality [7]. Thus, in low- and middle-income countries, the association of overweight / obesity with one or more nutritional deficiencies is often observed, especially among women and known as double burden of malnutrition [8]. However, data from the literature reports that excess weight can largely be avoided; and prevention involves the identification and control of modifiable risk factors[2,5]. These factors have been widely described in the literature. There are mainly related to behavior and / or knowledge (inadequate diet, inactivity, alcohol consumption,), sociodemographic factors (place of residence, socio-economic status), and clinical and metabolic factors (total cholesterol level, HDL, triglycerides) [5,9–11].

However, the factors vary between countries, depending on eating habits and socio-cultural practices [2] . This variability of factors suggests a relevance of country specific studies to identify context specific and relevant risk factors in order to better guide and align the policies and strategies aiming to address the raising burden of obesity.

The studies conducted so far on factors associated with overweight or obesity in low-middle income countries were often conducted in urban areas [[12–16], hospitals[17,18], secondary and high schools [19–21]. There are few nationally representative data on obesity in most sub-Saharan African countries[9,22]. This scarcity of nationally representative data on the burden and risk factors for overweight/obesity is an obstacle to engaging countries in the design and implementation of adequate public health interventions.

Our study intends to fill this gap by providing more complete data on the prevalence and the risk factors for overweight and obesity, through a secondary analysis of data from the STEPS survey carried out in Burkina Faso in 2013.

Methods

Study setting

Our study was conducted in Burkina Faso, a landlocked Sahelian country in the heart of West Africa. The country is divided into 13 regions, 45 provinces and 351 municipalities. In 2013, the population was estimated at 21,478,529 inhabitants. The majority of the population lives in rural areas, with agriculture and livestock as main activities[23,24].

In terms of health, the country is still facing endemic-epidemic diseases, especially malaria, measles, cerebro-spinal meningitis, acute respiratory infections, diarrheal diseases and HIV / AIDS infection[25]. The prevalence of acute malnutrition in children under five years was estimated at 8.1% in 2019[26].

Mortality due to non-communicable diseases is increasing rapidly in the same time; it was estimated that 33% of all death cases were due to NCD in 2016[27].

Type of study

We carried out an analytical cross-sectional study consisting of a secondary analysis of the data from the 2013STEPS survey in Burkina Faso.

Study population

The study population of the survey was composed of adults of 25 to 64-year-old who have been living in the national territory for at least six (6) months before the survey. Persons with an inability to answer questions (cognitive impairment) were excluded from the primary study. Pregnant women were excluded from our analysis.

Sampling

The enumeration areas (EAs) from the 2006 General Population and Housing Census , updated in 2010 during the Demographic and Health Survey conducted in Burkina Faso (EDS-BF, 2010) were used as sampling frame. The STEPS survey was carried out on a nationally representative

sample of 4800 households with 20 households per EAs, giving 240 EAs for the whole country. The sample was stratified in each of the 13 administrative regions to provide an adequate representation of the urban and rural areas. This stratification took into account the distribution of the population depending on the urban (22.7%) and rural environment (77.3%) in Burkina Faso, giving 54 EAs for urban area and 186 EAs for rural areas across the country. Within each stratum, a three-stage cluster sampling was done as recommended by WHO for STEPS NCD risk factors screening surveys.

At the first stage, the choice of clusters or enumeration zones by administrative regions was made by a systematic draw with proportional probability to the size of the EAs.

At the second stage, a household count in each of the selected 240 clusters at the first stage provided a list of households from which a sample of 20 households was selected using a simple systematic random sampling with an Excel Spread Sheet.

At the third level, the choice of individuals within households was made randomly. Once a household is selected, the interviewer creates a listing (sampling frame) of all eligible adults in the household. The listing includes the following variables: name, gender, relationship to the household head and age. Once the listing is created, each eligible member is assigned a unique number. Then using a randomized response table (Kish table), a particular member is chosen for the interview [28]. In each household, an individual of 25 to 64 years old living in the household was drawn to participate in the survey.

Sample Size and power of the study

The sample size was calculated by using the following formula:

$$n = \frac{\left(\frac{Z_{\alpha}^{2} * P(1-P)}{e^{2}} * 1.5 * 8\right)}{0.8} = \frac{\left(\frac{1.96^{2} * 0{,}296(1-0.296)}{0.05^{2}} * 1.5 * 8\right)}{0.8}$$

where zα = 1.96 for a risk α of 0.05; e = absolute margin of error on the estimate of the proportion (0.05); P: expected hypertension prevalence (0.296). The sample size was adjusted to account for the design effect (1.5), the number of age group per gender (8) and the expected non response rate (20%).

The STEPS survey was conducted on a representative sample of 4,800 individuals. Out of the 4800 participants, 152 were excluded for pregnancy, 153 for missing data (on height and / or

weight) and 23 due to a lack of sampling weights. The sample that we analyzed finally included 4472 persons (See figure**1 for study inclusion process**). With this final sample size and assuming a prevalence of obesity of 4.5%, our study has a statistical power of 86.6% to detect an association of a magnitude of 1.5 with the α threshold of 5%.

Data collection

The collection of data was carried out by nurses, graduate medical and nurse students. The data collection consisted in face-to-face interviews of selected participants using standardized questionnaires and physical and biochemical measurements. The data collection tools were pre-tested before they were used at the national level.

Data collection teams were closely supervised by a team of supervisors composed of statisticians, epidemiologists and clinicians.

Height measurement (in cm) was made in a standing or lying position, using a portable measuring board, on the participant without shoes and hat. The weight in kg was measured using an electronic weighing scales (SECA™) placed on a stable and even surface, the person lightly dressed, shoes-off and in a standing position.

The total cholesterol and blood glucose levels were measured using a Cardiocheck ™ PA SILVER kit that performs all these measurements using a capillary whole blood sample. Further details on the STEPS survey are available elsewhere[29].

Patient and public involvement

No patient involved in this research.

Study Variables

We used body mass index (BMI) to define general obesity. The BMI was calculated dividing the weight (kg) by the size (in meters) squared and then used to define undernutrition (BMI <18.5 kg / m^2), normal (18.5 - 24.99 kg / m^2), overweight (25.0-29.99 kg / m^2) and obesity (30 kg / m^2) in accordance with WHO recommendations [2]. We also used waist circumference to compute central obesity with the cut-off points of 94 cm in men and 80 cm in women[30].

Independent variables included age, marital status, place of residence, occupational activity, educational level, total cholesterol level, fasting blood glucose, smoking, alcohol consumption, the type of fat most commonly consumed and the intensity of physical activities. Some variables were recoded using specific cut-points of grouping (see Table 1).

Table 1 : Recoding of exposure variables

Variables	Categories
Age groups (years)	«25 to 34» «35 to 44» «45 to 54» «55 to 64»
Education level	«None» «Primary» «Secondary and higher»
Marital status	«Single» «Cohabiting/Married» «Divorced/widowed/ separated»
Occupational status	«Employed» «self-employed» «Unemployed» «House makers »
Total cholesterol level	Normal (<5.2 mmol/l); High cholesterol (≥5.2 mmol/l)
Fasting capillary glucose	Normal (<6.1 mmol/l); High glucose (≥6.1 mmol/l)
Cigarette smoking	« Never » «Current smoker » « Former smoker » « Second hand smoking »
Daily alcohol consumption	• Male : None (0 g) Low (0.01 – 39.99 g) Medium (40 - 59.99) High (60 and over) • Female : None (0 g) Low (0.01 – 19.99 g) Medium (20 - 39.99) High (40 and over)
Fat intake	«None» «Vegetable oil» « butter, lard or fat, margarine»
Physical activity	• High intensity activity: high intensity activities require an energy expenditure greater than 6 Metabolic equivalent of Task (METs). Examples include soccer playing, hole digging, regular swimming, farming etc. • Moderate intensity activity: moderate intensity activities require an energy expenditure of approximately 3–6 METs. Examples include cleaning, vacuuming, polishing, gardening, cycling at a regular pace or horse riding etc. • Low intensity activity: refers to persons who do not meet the above classifications. Here are included people with limited and no physical activity.

Statistical analysis

The predictive variables were selected based on the literature. We carried out stratified gender based analyzes. The Fisher Test was used to evaluate associations between the dependent variable and independent qualitative variables. We calculated crude proportional odds ratio (CPOR) and adjusted proportional odds ratios (APORs) using an ordinal logistic regression. The covariates selection in the multivariable analysis was based on epidemiological plausibility and literature review. All the analyses were weighted to account for the study design and we computed robust standard errors to account for the clustered nature of the data. The proportional risk assumption and the overall goodness of fit of the final models were checked before the results were reported. All the analyses were based on complete data analysis (missing data were ignored in all analyses). All analyzes were carried out using the Stata 13.1 software.

Results

Background characteristics of the study sample

The socio-demographic characteristics of the individuals of the sample are presented in Table **2**. Participants of the 25-34 age group were majority with 40.92%. There were 2249 women, which represents 52.6% of the participants. Participants with no educational level accounted for 72.93% among men against 77.17% among women. The majority of the individuals were married/living in couple (86.96%).

Table 2 : Demographic and behavioural characteristics of study participants.

Variables	Population		Total
	Male n(%)	Female n(%)	
Residence			
Urban	454 (25.52)	539 (29.70)	993 (27.72)
Rural	1769 (74.48)	1710 (70.30)	3479 (72.28)
Age groups			
25 - 34	933 (38.09)	1044 (43.45)	1977 (40.92)
35 - 44	560 (28.21)	573 (37.65)	1133 (27.91)
45 - 54	424 (20.22)	404 (18.49)	828 (19.31)
55 - 64	306 (13.48)	228 (10.40)	534 (11.86)
Education level			
None	1623 (72.93)	1832 (81.16)	3455 (77.27)
Primary	405 (17.85)	288 (13.07)	693 (15.33)
Secondary (school) and higher	187 (9.22)	129 (5.78)	316 (7.40)
Marital status			
Single	254 (11.04)	68 (3.24)	322 (6.93)
Cohabiting/Married	1879 (85.74)	1963 (88.06)	3842 (86.96)
Divorced/Widowed/separated	87 (3.21)	216 (8.70)	303 (6.10)
Occupational status			
Employed	178 (6.68)	71 (3.44)	249 (2.92)
Self-employed	1945 (86.12)	1188 (50.40)	3133 (67.32)
Unemployed	87 (4.51)	54 (2.44)	141 (3.42)
Housemaker	13 (0.70)	936 (43.72)	949 (23.34)

Prevalence of overweight and obesity

As shown in Table 3, the prevalence of overweight and general obesity in the sample were respectively 13.82 ($CI_{95\%}$: 12.25 - 15.55) and 4.84 ($CI_{95\%}$:3.99 - 5.86). The prevalence of general obesity was higher among women ($p < 0.0001$) and among urban residents ($p < 0.0001$). However, the proportion of overweight people did not significantly differ between women and men. Among all age groups, obesity was more prevalent in the age group 35 to 44 ($p < 0.0001$). The prevalence of obesity also varies across administrative regions (results not shown). The

prevalence of central obesity was respectively 6.33% (CI95%: 5.11-7.81) and 34.50% (CI95%:31.12-38.97) in men and women, with significant rural versus urban difference in both sexes (p<0.001).

Tableau 3 : Prevalence of underweight, overweight and general obesity among study participants.

	n	Underweight % (95% CI)	Overweight % (95% CI)	Obesity % (95% CI)
Gender				
Male	2223	8.10 (6.71 - 97.3)	13.91 (11.88 -16.22)	3.29 (2.33 - 4.62)
Female	2249	15.05 (13.19 - 17.12)	13.74 (11.86 -15.86)	6.24 (5.11 - 7.60)
Age groups (years)				
25 - 34	1977	9.32 (7.76 - 11.17)	12.09 (10.22 - 14.24)	3.73 (2.69 - 5.16)
35 - 44	1133	10.77 (8.70 - 13.25)	16.12 (13.35 - 19.34)	5.64 (4.26 - 7.43)
45 - 54	828	14.05 (11.63 - 16.89)	15.75 (12.79 -19.24)	5.26 (3.61 - 7.61)
55 - 64	534	18.75 (15.04 - 23.13)	11.22 (8.36 - 14.90)	6.10 (3.97 - 9.24)
Residence				
Rural	3479	13.32 (11.79 - 15.03)	9.74 (8.33 - 11.35)	1.89 (1.40 - 2.53)
Urban	993	7.67 (5.09 - 11.42)	24.46 (20.06 - 29.47)	12.54 (9.75- 15.99)
Total	**4472**	**11.76 (10.40 - 13.27)**	**13.82 (12.25 - 15.55)**	**4.84 (3.99 - 5.86)**

Risk factors for Obesity and overweight

Among men.

In multivariable analysis, significant predictors of overweight and obesity among men included place of residence, physical activity, age, marital status, alcohol, tobacco and fat consumption. Men living in urban areas were around 3 times proportionally more likely to be at least overweight as compared to those living in rural areas (APOR: 2.84, CI95%: 1.90 - 4.23). The odds of being overweight or obese was lower within the 25 to 34 age group as compared to35-44 years and 45-54 years. Men aged 35 to 44 years were 1.4 times proportionally more likely to be overweight or obese (APOR: 1.4, $CI_{95\%:}$ 1.00 – 1.90). Compared to single men, men living in unions and those that are widowed or divorced were having higher proportional odds of being overweight or obese (APOR: 1.62, $CI_{95\%:}$ 1.09 - 2.42 and APOR: 1.83, $CI_{95\%:}$ 0.76 - 4.39) . The current consumption of tobacco reduces by nearly half the proportional odds (APOR: 0.53, $CI_{95\%}$: 0.37 - 0.74). No significant difference was found between former and second hand smokers and men who had never smoked. The report of the consumption of butter, lard or margarine as the most often type of fat was associated with more than 30% proportional odds reduction (APOR: 0.62, CI95%: 0.39 - 0.97). The practice of physical activity was also

associated with lower odds of overweight/obesity with the odds reduction increasing as the intensity of the physical activity increases (APOR: 0.68, $CI_{95\%}$:0.44-1.04 and APOR:0.62, $CI_{95\%}$:0.42-0.93).

Among women

Among women, significant risk factors included urban residence, current tobacco consumption, educational level, the type of occupation and fat consumption. Urban residential status was associated with around three-fold increase in the proportional odds of obesity or overweight (APOR 2.67, $CI_{95\%}$:1.89 - 3.78) as compared to rural residence. Being of primary school education level increased nearly two times the proportional odds of overweight or obesity (APOR: 1.80, $CI_{95\%}$:1.26-2.57) as compared to those that have not been at school (no education). The proportional odds of being at least overweight was lower among current tobacco smokers compared to non-smokers (APOR: 0.42, $CI_{95\%}$: 0.29 - 0.60). As compared to wage earners, women that are self-employed and those that house makers were less likely to be overweight/obese (APOR:0.45, $CI_{95\%}$:0.24-0.87 and APOR:0.40, $CI_{95\%}$:0.21-0.77). The report of butter/lard or margarine as type of fat often consumed was associated with lower odds of overweight/obesity (APOR:0.67, $CI_{95\%}$:0.46-0.99).

The results of the multivariable analysis are presented in Table 4.

Table 4: Risk factors for overweight and obesity among male and female adult population aged 25–64

	Male (n=2223)				Female (n=2249)			
	CPOR (95% CI)	p-value	APOR (95% CI)	p-value	CPOR (95% CI)	p-value	APOR (95% CI)	p-value
Residence area								
Rural	1.00		1.00		1.00		1.00	
Urban	3.97 (2.93 -5.38)	0.000	2.84 (1.90 -4.23)	0.000	3.83 (3.72 -6.28)	0.000	2.67 (1.89 -3.78)	0.000
Age (years)								
25 – 34	1.00		1.00		1.00		1.00	
35 – 44	1.96 (1.39 - 2.78)	0.000	1.40 (1.00 -1.90)	0.049	1.29 (0.97 -1.73)	0.081	1.19 (0.89 -1.59)	0.239
45 – 54	1.74 (1.18 - 2.56)	0.005	1.20 (0.81 -1.65)	0.412	1.46 (1.04 -2.07)	0.030	1.18 (0.87 -1.61)	0.287
55 – 64	1.42 (0.90 - 2.25)	0.133	0.67 (0.43 -1.04)	0.074	1.40 (0.87 -2.26)	0.168	1.12 (0.70 -1.80)	0.628
Education								
None	1.00		1.00		1.00		1.00	
Primary	1.22 (0.82 -1.80)	0.320	1.07(0.75 -1.53)	0.708	2.92 (2.09 -4.09)	0.000	1.80 (1.26 -2.57)	0.001
Secondary (school) and over	3.24 (2.12 -4.95)	0.000	1.39 (0.77 -2.48)	0.271	4.07 (2.56 -6.46)	0.000	1.57 (0.87 -2.80)	0.131
Occupation								
Wage earners	1.00		1.00		1.00		1.00	
Self-employed	0.28 (0.19 -0.43)	0.000	0.98 (0.53 -1.81)	0.959	0.21 (0.12 -0.36)	0.000	0.45 (0.24 -0.87)	0.017

Unemployed	0.51 (0.25 -1.02)	0.057	0.75 (0.35 -1.60)	0.458	0.57 (0.22 -1.45)	0.236	0.42 (0.14 -1.27)	0.123
House maker					0.27 (0.16 -0.47)	0.000	0.40 (0.21 -0.77)	0.006
Marital status								
Single	1.00		1.00		1.00		1.00	
Cohabiting/Married	1.30 (0.81 -2.07)	0.271	1.62 (1.09 -2.42)	0.017	0.66 (0.31 -1.43)	0.297	(1.01 -4.16)	0.045
Divorced/Widowed/	2.13 (0.96 -4.73)	0.063	1.83 (0.76 -4.39)	0.176	0.72 (0.31 -1.70)	0.459	1.64 (0.73 -3.68)	0.232
Tobacco consumption								
Never	1.00		1.00		1.00		1.00	
Current smoker	0.64 (0.43 -0.95)	0.027	0.53 (0.37 -0.74)	0.000	0.20 (0.10 -0.37)	0.000	0.42 (0.29 -0.60)	0.000
Former smoker	1.44 (0.77 -2.71)	0.257	1.10 (0.59 -2.05)	0.756	0.98 (0.18 -5.21)	0.983	0.55 (0.13 -2.37)	0.426
Second hand smoking	1.27 (0.92 -1.75)	0.151	1.11 (0.82 -1.50)	0.506	1.30 (0.99 -1.71)	0.056	1.14 (0.87 -1.48)	0.347
Alcohol								
None	1.00		1.00		1.00		1.00	
Low	1.04 (0.71 -1.51)	0.856	0.96 (0.68 -1.35)	0.811	0.47 (0.26 -0.85)	0.012	0.69 (0.45 -1.05)	0.081
Medium	1.69 (1.00 -2.82)	0.047	1.87 (1.20 -2.93)	0.006	1.44 (1.00 -2.07)	0.047	1.17 (0.82 -1.68)	0.386
High	1.52 (0.74 -3.13)	0.257	1.38 (0.77 -2.46)	0.276	1.21 (0.57 -2.59)	0.620	0.71 (0.38 -1.32)	0.280
Fat used								

None	1.00		1.00		1.00		1.00	
Vegetable oil	1.10 (0.71 -1.71)	0.658	0.85 (0.56 -1.30)	0.461	2.00 (1.27 -3.18)	0.03	1.04 (0.72 -1.52)	0.829
Butter, lard or fat, margarine	0.48 (0.28 -0.81)	0.006	0.62 (0.39 -0.97)	0.037	0.73 (0.44 -1.23)	0.240	0.67 (0.46 -0.99)	0.045
Physical activity								
Low intensity	1.00		1.00		1.00		1.00	
Moderate intensity	0.58 (0.38 -0.90)	0.016	0.68 (0.44 -1.04)	0.076	0.76 (0.53 -1.10)	0.147	0.94 (0.66 -1.33)	0.581
High intensity	0.44 (0.30 -0.65)	0.000	0.62 (0.42 -0.93)	0.021	0.55 (0.39 -0.76)	0.000	0.88 (0.63 -1.23)	0.449

CPOR : Crude proportional odds ratio ; APOR : Adjusted proportional odds ratio ; CI : Confidence interval

Discussion

Prevalence of overweight and obesity

The overall prevalence of overweight was relatively high in our study, with no significant difference between men and women. Studies in Africa have also found similar prevalence among both sex[22,31]. However, some authors reported higher proportion of overweight among men[32–34]. The prevalence of obesity in our study was around 5% with disparities found across regions.

The prevalence of obesity was higher among women. Several other studies also reported higher prevalence of obesity among women[9,10,35,36]. Hormonal effects, especially among older ages, women's maternity and lifestyle, and certain cultural conceptions, may be contributing to this higher burden of obesity among women[37].

Factors associated with obesity

Living in urban areas and current tobacco consumption are factors associated with obesity or overweight among both genders. Van Der and all in Gambia[9], also noted that risk in urban areas was about 3 times higher than in rural areas (OR: 2.86, 95% CI: 1.89 - 4 , 35). Abubakari et al. in a meta-analysis of studies conducted in sub-Saharan Africa[11] also noted that the risk was higher in urban areas (OR: 2.70, 95% CI, 1.76-4.15). This high risk could be explained by more sedentary lifestyle in urban areas as previously mentioned. In addition, in urban areas, eating patterns are different from that of rural areaq with more sugar and fats rich food known as "urban" or "western" foods[8]. Current tobacco consumption was inversely associated with the occurrence of overweight or obesity within both genders. Results from other studies reported that smoking for a long period tends to lead to weight loss. Similarly, cessation of tobacco consumption goes along with weight gain[38,39]. However, because smoking is an exposure with well-known detrimental consequences on health, the observed association between smoking and overweight/obesity shouldn't be interpreted as being in favor of smoking as a strategy to prevent obesity/overweight.

Other factors associated with overweight or obesity among men were age, marital status, consumption of butter /lard / margarine, and physical activity. Several authors also reported a positive association between the risk of obesity and age [12,15,33]. Aging leads to less physical activity and combined with greater socio-economic status, increase the ability to access diverse foods. The use of butter / fat / margarine as the main source of lipid was inversely associated with obesity in our data. This is an unexpected result as one would expect a lower risk of

overweight and obesity among those that use predominantly vegetable oil. The lack of quantification of the consumption of the different types of oil makes difficult the comparison. Physical activity was associated with significant decrease in the odds of obesity only in men and not in women in our data. Other studies carried out by Pasquet et al. in Cameroon[14] and Oladimeji in Nigeria[16] revealed that the practice of intensive physical activity reduces significantly the risk of obesity.

Indeed, the intensive physical activity leads to an increase in the energy expenditure, avoids fat deposition and promotes a development of the muscular mass [40]. Men living in union were about 60% more likely to be obese compared to single men. There was an association in the same direction in women. There is a correlation between marital status and socio-economic position. In our study, we lack data on the socio-economic status and we used education status as a proxy. Our findings of a positive correlation between being married and overweight/obesity may have been confounded by the socio-economic status.

Among women, education was associated with obesity/overweight. However, in their study among women living in urban areas, Benkeser et al. in Ghana [37] did not find a relation between educational level and obesity. This could be explained by the fact that their study was exclusively carried out in urban areas where the heterogeneity between educational statuses may be lesser. We found difference in predictors of overweight/obesity between men and women. Physical activity and age were significant predictors in men and not in women, while the education status and the type of employment were significant predictors in only women. These results are in favor of gender specific predictors for overweight/obesity and are in support of gender-based stratified analyses.

Limitations of the study

The results reported in this study are derived from a cross sectional study limiting our ability to derive causal inferences from the observed associations. Exposures measurements were mainly based on a short window recall as it is usual in this type of studies, hampering the possibility to get further attributes (quantity, duration etc.) on some exposures such as fat and frut consumptions, that would have been invaluable in the interpretation of the results. We did not have information on socio-economic status that is a known key variable when trying to predict overnutrition. Furthermore, the analysis carried out and our interpretation of the results assume that an overweight person is in transition to obese status. While this is conceptually true, we

cannot rule out that an overweight person will turn to be normal in the future, particularly in a setting where food insecurity is common.

Conclusion

Our study showed an important burden of obesity and overweight in the adult population with women more affected than men. Overnutrition needs to be recognized as an important public health issue. The country is witnessing the double burden of malnutrition with the coexistence of overnutrition and undernutrition. Nutrition interventions need to be reshaped to account for this epidemiological picture of malnutrition in Burkina Faso.

Abbreviations

BMI: body mass index; CI: confidence interval; CPOR : Crude proportional odds ratio ; APOR : Adjusted proportional odds ratio ; WHO : World health organization.

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Data sharing and availability

The STEPS 2013 survey database was used for this study. The dataset can be obtained at the Ministry of Health upon reasonable request. Any request for further analysis can be submitted to Dr Brice W. Bicaba bicaba_brico@yahoo.fr

No further additional data is available.

Authors contribution

SK1, MT and SK2 designed the study and SK1 drafted the paper. SK1 and MT performed initial analysis and MT reanalysed the data. SK2, BB, JS and HL made substantial contributions to the interpretation of the data. All authors read and approved the final manuscript.

Conflicts of interest

None declared

Consent for publication

Not applicable.

Ethical considerations

The STEPS survey got approval from the Ethics Committee for Health Research (Deliberation No. 2012-12-092 of 05 December 2012). Written informed consent was obtained before inclusion in the study. For this study, we obtained an authorization from the General directorate of Health to reanalyze the data and the confidentiality of study participants was preserved.

Figure legend

Figure 1: Diagram flow of the study participants. This figure shows the criteria that were used to select the study participants in our study and the numbers that were affected by these criteria and the final sample size of the study.

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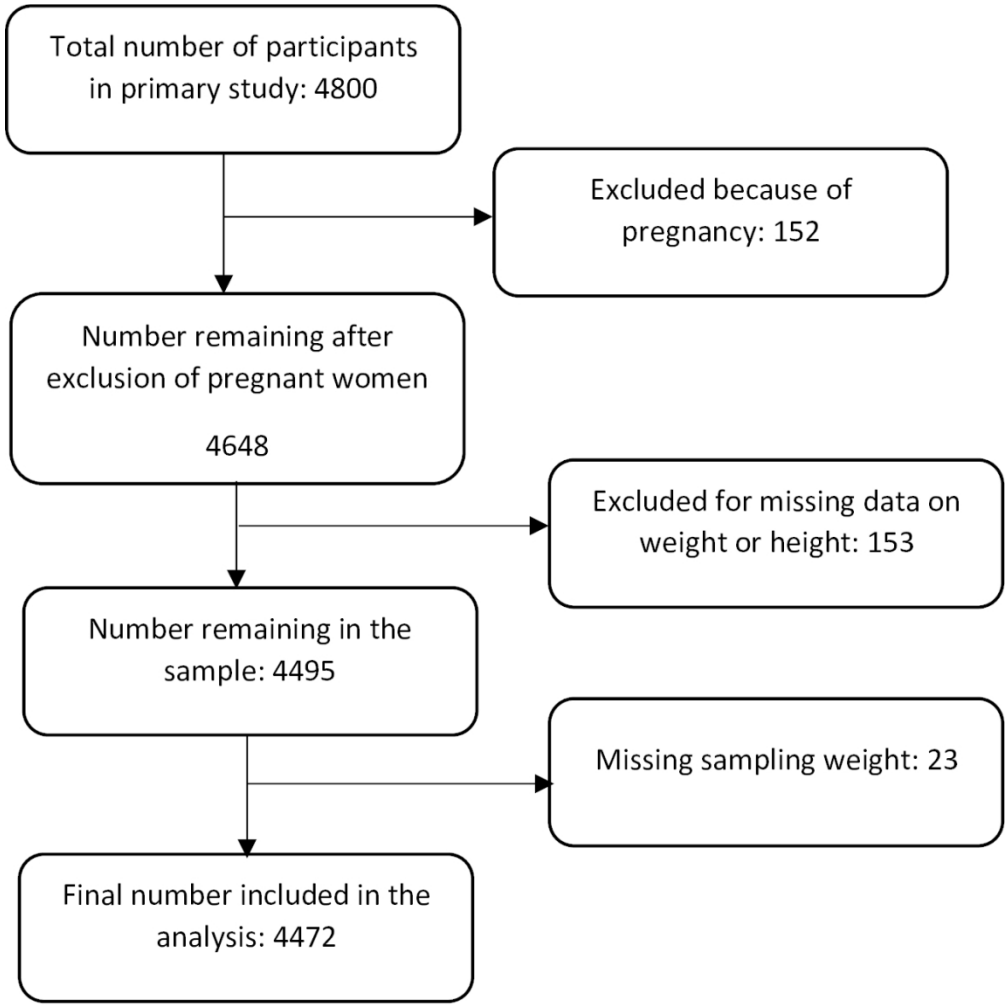

Figure 1 : Diagram flow of the study participants.

111x126mm (300 x 300 DPI)

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

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	2&4
Methods			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	5&6
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7&8
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	*8*
Bias	9	Describe any efforts to address potential sources of bias	7&8
Study size	10	Explain how the study size was arrived at	6
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	8
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	9
		(*c*) Explain how missing data were addressed	9
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	9
		(*e*) Describe any sensitivity analyses	None
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	7& figure 1
		(b) Give reasons for non-participation at each stage	7& figure 1
		(c) Consider use of a flow diagram	Figure 1
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	9&10
		(b) Indicate number of participants with missing data for each variable of interest	10

Outcome data	15*	Report numbers of outcome events or summary measures	10&11
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	11&12&13&14
		(*b*) Report category boundaries when continuous variables were categorized	10
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	None included
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	11-15
Discussion			
Key results	18	Summarise key results with reference to study objectives	16
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	3&16
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	16
Generalisability	21	Discuss the generalisability (external validity) of the study results	16&17
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	18

*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.

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Prevalence and risk factors for Overweight and obesity: a cross sectional countrywide study in Burkina Faso

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Prevalence and risk factors for overweight and obesity: a cross sectional countrywide study in Burkina Faso.

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Abstract

Objective: The objective of this study was to determine the prevalence and predictors of overweight and obesity in Burkina Faso using a population-based country-wide sample. We hypothesize that there is a significant burden related to overweight/obesity in Burkina Faso.

Design: Secondary analysis of a population-based country wide cross-sectional study

Setting: Burkina Faso, all the 13 regions including both rural and urban residential areas

Participants: 4,800 participants of both sexes, aged between 25 and 64 years.

Main outcomes: overweight and obesity using body mass index cut-off levels of WHO

Results: The prevalence of overweight and obesity in Burkina Faso were 13.82% (CI95%: 12.25 - 15.55) and 4.84% (CI95%:3.99 - 5.86) respectively. Among men, the proportional odds of overweight / obesity increase with urban residency ($p<0.001$), greater age ($p<0.002$), marital status different from single ($p\leq0.007$) and decrease with current smoking ($p=0.009$). Among women, the proportional odds of overweight / obesity increase with urban residency ($p<0.001$), primary educational level ($p=0.01$), high total blood cholesterol level ($p<0.001$), high fasting blood glucose level ($p=0.02$), and decrease with current smoking ($p<0.001$).

Conclusion:

Our study showed that nearly one person out of five in the adult population of Burkina has an abnormal weight status with women being more affected than men. Urban residency is a consistent risk factor in both men and women. Alcohol consumption and education were associated with an increased odds in only women. Overnutrition needs to be recognized as an important public health issue in Burkina Faso and nutrition interventions need to be reshaped to account for it.

Strengths and limitations

Strengths

- To our best knowledge, this is the first nationwide study on obesity and overweight in Burkina Faso with a country level representative sample.
- Outcomes measurements were carried out following international standards through the WHO STEPwise approach to NCDs measurement and prevention.

Limitations

- This is a cross sectional study, which hampers our ability to derive causal inferences from the reported data;
- The Socio-economic status, a known relevant variable was not measured in the primary study;
- Being overweight may not necessarily equate to being an obese person to be, particularly in a setting where food insecurity is common.

Introduction

Obesity is defined as an abnormal or excessive accumulation of body fat, due to an energy imbalance between intake and expenditure [1]. It is a major risk factor for many non-communicable diseases (NCD) and a real public health threat in the world[2,3]. In 2015, high BMI contributed to 4.0 million deaths, which represented 7.1% of the deaths from all causes [4].

Obesity, a well-known phenomenon in developed countries, is increasingly common in low-middle income countries, affecting both children and adults [2,4,5]. In the Eastern Mediterranean Region, the prevalence of obesity increased in adults from 15.1% in 1980 to 20.7% in 2015. It increased from 4.1% to 4.9% in the same period among children [6]. In sub-Saharan Africa (SSA) , Overweight/obesity factors accounted for 266 768 deaths, representing 3.3% of all-cause mortality [7]. Thus, in low- and middle-income countries, the association of overweight / obesity with one or more nutritional deficiencies is often observed, especially among women and known as double burden of malnutrition [8]. However, data from the literature reports that excess weight can largely be avoided; and prevention involves the identification and control of modifiable risk factors[2,5]. These factors have been widely described in the literature. There are mainly related to behavior and / or knowledge (inadequate diet, inactivity, alcohol consumption,), sociodemographic factors (place of residence, socio-economic status), and clinical and metabolic factors (total cholesterol level, HDL, triglycerides) [5,9–11].

However, the factors vary between countries, depending on eating habits and socio-cultural practices [2] . This variability of factors suggests a relevance of country specific studies to identify context specific and relevant risk factors in order to better guide and align the policies and strategies aiming to address the raising burden of obesity.

The studies conducted so far on factors associated with overweight or obesity in low-middle income countries were often conducted in urban areas [[12–16], hospitals[17,18], secondary and high schools [19–21]. There are few nationally representative data on obesity in most sub-Saharan African countries[9,22]. This scarcity of nationally representative data on the burden and risk factors for overweight/obesity is an obstacle to engaging countries in the design and implementation of adequate public health interventions.

Our study intends to fill this gap by providing more complete data on the prevalence and the risk factors for overweight and obesity, through a secondary analysis of data from the STEPS survey carried out in Burkina Faso in 2013.

Methods

Study setting

Our study was conducted in Burkina Faso, a landlocked Sahelian country in the heart of West Africa. The country is divided into 13 regions, 45 provinces and 351 municipalities. In 2013, the population was estimated at 21,478,529 inhabitants. The majority of the population lives in rural areas, with agriculture and livestock as main activities[23,24].

In terms of health, the country is still facing endemic-epidemic diseases, especially malaria, measles, cerebro-spinal meningitis, acute respiratory infections, diarrheal diseases and HIV / AIDS infection[25]. The prevalence of acute malnutrition in children under five years was estimated at 8.1% in 2019[26].

Mortality due to non-communicable diseases is increasing rapidly in the same time; it was estimated that 33% of all death cases were due to NCD in 2016[27].

Type of study

We carried out an analytical cross-sectional study consisting of a secondary analysis of the data from the 2013STEPS survey in Burkina Faso.

Study population

The study population of the survey was composed of adults of 25 to 64-year-old who have been living in the national territory for at least six (6) months before the survey. Persons with an inability to answer questions (cognitive impairment) were excluded from the primary study. Pregnant women were excluded from our analysis.

Sampling

The enumeration areas (EAs) from the 2006 General Population and Housing Census , updated in 2010 during the Demographic and Health Survey conducted in Burkina Faso (EDS-BF, 2010) were used as sampling frame. The STEPS survey was carried out on a nationally representative

sample of 4800 households with 20 households per EAs, giving 240 EAs for the whole country. The sample was stratified in each of the 13 administrative regions to provide an adequate representation of the urban and rural areas. This stratification took into account the distribution of the population depending on the urban (22.7%) and rural environment (77.3%) in Burkina Faso, giving 54 EAs for urban area and 186 EAs for rural areas across the country. Within each stratum, a three-stage cluster sampling was done as recommended by WHO for STEPS NCD risk factors screening surveys.

At the first stage, the choice of clusters or enumeration zones by administrative regions was made by a systematic draw with proportional probability to the size of the EAs.

At the second stage, a household count in each of the selected 240 clusters at the first stage provided a list of households from which a sample of 20 households was selected using a simple systematic random sampling with an Excel Spread Sheet.

At the third level, the choice of individuals within households was made randomly. Once a household is selected, the interviewer creates a listing (sampling frame) of all eligible adults in the household. The listing includes the following variables: name, gender, relationship to the household head and age. Once the listing is created, each eligible member is assigned a unique number. Then using a randomized response table (Kish table), a particular member is chosen for the interview [28]. In each household, an individual of 25 to 64 years old living in the household was drawn to participate in the survey.

Sample Size and power of the study

The sample size was calculated by using the following formula:

$$n = \frac{\left(\frac{Z_{\alpha}^2 * P(1-P)}{e^2} * 1.5 * 8\right)}{0.8} = \frac{\left(\frac{1.96^2 * 0{,}296(1-0.296)}{0.05^2} * 1.5 * 8\right)}{0.8} = 4800$$

where zα = 1.96 for a type-I error α of 0.05; e = absolute margin of error on the estimate of the proportion (0.05); P: expected hypertension prevalence (0.296). The sample size was adjusted to account for the design effect (1.5), the number of age group per gender (8) and the expected non response rate (20%).

The STEPS survey was conducted on a representative sample of 4,800 individuals. Out of the 4800 participants, 152 were excluded for pregnancy, 153 for missing data (on height and / or

weight) and 23 due to a lack of sampling weights. The sample that we analyzed finally included 4472 persons (See figure**1 for study inclusion process**). With this final sample size and assuming a prevalence of obesity of 4.5%, our study has a statistical power of 86.6% to detect an association of a magnitude of 1.5 with the type-I error rate α of 5%.

Data collection

The collection of data was carried out by nurses, graduate medical and nurse students. The data collection consisted in face-to-face interviews of selected participants using standardized questionnaires and physical and biochemical measurements. The data collection tools were pre-tested before they were used at the national level.

Data collection teams were closely supervised by a team of supervisors composed of statisticians, epidemiologists and clinicians.

Height measurement (in cm) was made in a standing or lying position, using a portable measuring board, on the participant without shoes and hat. The weight in kg was measured using an electronic weighing scales (SECA™) placed on a stable and even surface, the person lightly dressed, shoes-off and in a standing position.

The total cholesterol and blood glucose levels were measured using a Cardiocheck ™ PA SILVER kit that performs all these measurements using a capillary whole blood sample. Further details on the STEPS survey are available elsewhere[29].

Patient and public involvement

No patient involved in this research.

Study Variables

We used body mass index (BMI) to define general obesity. The BMI was calculated dividing the weight (kg) by the size (in meters) squared and then used to define undernutrition (BMI <18.5 kg / m^2), normal (18.5 - 24.99 kg / m^2), overweight (25.0-29.99 kg / m^2) and obesity (30 kg / m^2) in accordance with WHO recommendations [2]. We also used waist circumference to compute central obesity with the cut-off points of 94 cm in men and 80 cm in women[30].

Independent variables included age, marital status, place of residence, occupational activity, educational level, total cholesterol level, fasting blood glucose, smoking, alcohol consumption, the type of fat most commonly consumed and the intensity of physical activities. Some variables were recoded using specific cut-points of grouping (see Table 1).

Table 1 : Recoding of exposure variables

Variables	Categories
Age groups (years)	«25 to 34» «35 to 44» «45 to 54» «55 to 64»
Education level	«None» «Primary» «Secondary and higher»
Marital status	«Single» «Cohabiting/Married» «Divorced/widowed/ separated»
Occupational status	«Employed» «self-employed» «Unemployed» «House makers »
Total cholesterol level	Normal (<5.2 mmol/l); High cholesterol (≥5.2 mmol/l)
Fasting capillary glucose	Normal (<6.1 mmol/l); High glucose (≥6.1 mmol/l)
Cigarette smoking	« Never » «Current smoker » « Former smoker » « Second hand smoking »
Daily alcohol consumption	• Male : None (0 g) Low (0.01 – 39.99 g) Medium (40 - 59.99) High (60 and over) • Female : None (0 g) Low (0.01 – 19.99 g) Medium (20 - 39.99) High (40 and over)
Fat intake	«None» «Vegetable oil» « butter, lard or fat, margarine»
Physical activity	• High intensity activity: high intensity activities require an energy expenditure greater than 6 Metabolic equivalent of Task (METs). Examples include soccer playing, hole digging, regular swimming, farming etc. • Moderate intensity activity: moderate intensity activities require an energy expenditure of approximately 3–6 METs. Examples include cleaning, vacuuming, polishing, gardening, cycling at a regular pace or horse riding etc. • Low intensity activity: refers to persons who do not meet the above classifications. Here are included people with limited and no physical activity.

Statistical analysis

The predictive variables were selected based on the literature. We carried out stratified gender based analyzes. The Fisher Test was used to evaluate associations between the dependent variable and independent qualitative variables. We calculated crude proportional odds ratio (CPOR) and adjusted proportional odds ratios (APORs) using an ordinal logistic regression model. The dependant ordinal variable has four catgories: underweight, normal, overweight and obese. The covariates selection in the multivariable analysis was based on epidemiological plausibility and literature review. All the analyses were weighted to account for the study design and we computed robust standard errors to account for the clustered nature of the data. The proportional risk assumption and the overall goodness of fit of the final models were checked before the results were reported. All the analyses were based on complete data analysis (missing data were ignored in all analyses). All analyzes were carried out using the Stata 13.1 software.

Results

Background characteristics of the study sample

The socio-demographic characteristics of the individuals of the sample are presented in Table **2**. Participants of the 25-34 age group were majority with 40.92%. There were 2249 women, which represents 52.6% of the participants. Participants with no educational level accounted for 72.93% among men against 77.17% among women. The majority of the individuals were married/living in couple (86.96%).

Table 2 : Demographic and behavioural characteristics of study participants.

Variables	Population		Total
	Male n(%)	Female n(%)	
Residence			
Urban	454 (25.52)	539 (29.70)	993 (27.72)
Rural	1769 (74.48)	1710 (70.30)	3479 (72.28)
Age groups			
25 - 34	933 (38.09)	1044 (43.45)	1977 (40.92)
35 - 44	560 (28.21)	573 (37.65)	1133 (27.91)
45 - 54	424 (20.22)	404 (18.49)	828 (19.31)
55 - 64	306 (13.48)	228 (10.40)	534 (11.86)
Education level			
None	1623 (72.93)	1832 (81.16)	3455 (77.27)
Primary	405 (17.85)	288 (13.07)	693 (15.33)
Secondary (school) and higher	187 (9.22)	129 (5.78)	316 (7.40)
Marital status			
Single	254 (11.04)	68 (3.24)	322 (6.93)
Cohabiting/Married	1879 (85.74)	1963 (88.06)	3842 (86.96)
Divorced/Widowed/separated	87 (3.21)	216 (8.70)	303 (6.10)
Occupational status			
Employed	178 (6.68)	71 (3.44)	249 (2.92)
Self-employed	1945 (86.12)	1188 (50.40)	3133 (67.32)
Unemployed	87 (4.51)	54 (2.44)	141 (3.42)
Housemaker	13 (0.70)	936 (43.72)	949 (23.34)

Prevalence of overweight and obesity

As shown in Table 3, the prevalence of overweight and general obesity in the sample were respectively 13.82 ($CI_{95\%}$: 12.25 - 15.55) and 4.84 ($CI_{95\%}$:3.99 - 5.86). The prevalence of general obesity was higher among women ($p < 0.0001$) and among urban residents ($p < 0.0001$). However, the proportion of overweight people did not significantly differ between women and men. Among all age groups, obesity was more prevalent in the age group 35 to 44 ($p < 0.0001$). The prevalence of obesity also varies across administrative regions (results not shown). The

prevalence of central obesity was respectively 6.33% (CI95%: 5.11-7.81) and 34.50% (CI95%:31.12-38.97) in men and women, with significant rural versus urban difference in both sexes (p<0.001).

Tableau 3 : Prevalence of underweight, overweight and general obesity among study participants.

	n	Underweight % (95% CI)	Overweight % (95% CI)	Obesity % (95% CI)
Gender				
Male	2223	8.10 (6.71 - 97.3)	13.91 (11.88 -16.22)	3.29 (2.33 - 4.62)
Female	2249	15.05 (13.19 - 17.12)	13.74 (11.86 -15.86)	6.24 (5.11 - 7.60)
Age groups (years)				
25 - 34	1977	9.32 (7.76 - 11.17)	12.09 (10.22 - 14.24)	3.73 (2.69 - 5.16)
35 - 44	1133	10.77 (8.70 - 13.25)	16.12 (13.35 - 19.34)	5.64 (4.26 - 7.43)
45 - 54	828	14.05 (11.63 - 16.89)	15.75 (12.79 -19.24)	5.26 (3.61 - 7.61)
55 - 64	534	18.75 (15.04 - 23.13)	11.22 (8.36 - 14.90)	6.10 (3.97 - 9.24)
Residence				
Rural	3479	13.32 (11.79 - 15.03)	9.74 (8.33 - 11.35)	1.89 (1.40 - 2.53)
Urban	993	7.67 (5.09 - 11.42)	24.46 (20.06 - 29.47)	12.54 (9.75- 15.99)
Total	**4472**	**11.76 (10.40 - 13.27)**	**13.82 (12.25 - 15.55)**	**4.84 (3.99 - 5.86)**

Risk factors for Obesity and overweight

Among men.

In multivariable analysis, significant predictors of overweight and obesity among men included place of residence, physical activity, age, marital status, alcohol, tobacco and fat consumption. Men living in urban areas were around 3 times proportionally more likely to be at least overweight as compared to those living in rural areas (APOR: 2.84, CI95%: 1.90 - 4.23). The odds of being overweight or obese was lower within the 25 to 34 age group as compared to35-44 years and 45-54 years. Men aged 35 to 44 years were 1.4 times proportionally more likely to be overweight or obese (APOR: 1.4, $CI_{95\%:}$ 1.00 – 1.90). Compared to single men, men living in unions and those that are widowed or divorced were having higher proportional odds of being overweight or obese (APOR: 1.62, $CI_{95\%:}$ 1.09 - 2.42 and APOR: 1.83, $CI_{95\%:}$ 0.76 - 4.39) . The current consumption of tobacco reduces by nearly half the proportional odds (APOR: 0.53, $CI_{95\%}$: 0.37 - 0.74). No significant difference was found between former and second hand smokers and men who had never smoked. The report of the consumption of butter, lard or margarine as the most often type of fat was associated with more than 30% proportional odds reduction (APOR: 0.62, CI95%: 0.39 - 0.97). The practice of physical activity was also

associated with lower odds of overweight/obesity with the odds reduction increasing as the intensity of the physical activity increases (APOR: 0.68, $CI_{95\%}$:0.44-1.04 and APOR:0.62, $CI_{95\%}$:0.42-0.93).

Among women

Among women, significant risk factors included urban residence, current tobacco consumption, educational level, the type of occupation and fat consumption. Urban residential status was associated with around three-fold increase in the proportional odds of obesity or overweight (APOR 2.67, $CI_{95\%}$:1.89 - 3.78) as compared to rural residence. Being of primary school education level increased nearly two times the proportional odds of overweight or obesity (APOR: 1.80, $CI_{95\%}$:1.26-2.57) as compared to those that have not been at school (no education). The proportional odds of being at least overweight was lower among current tobacco smokers compared to non-smokers (APOR: 0.42, $CI_{95\%}$: 0.29 - 0.60). As compared to wage earners, women that are self-employed and those that house makers were less likely to be overweight/obese (APOR:0.45, $CI_{95\%}$:0.24-0.87 and APOR:0.40, $CI_{95\%}$:0.21-0.77). The report of butter/lard or margarine as type of fat often consumed was associated with lower odds of overweight/obesity (APOR:0.67, $CI_{95\%}$:0.46-0.99).

The results of the multivariable analysis are presented in Table 4.

Table 4: Risk factors for overweight and obesity among male and female adult population aged 25–64

	Male (n=2223)				Female (n=2249)			
	CPOR (95% CI)	p-value	APOR (95% CI)	p-value	CPOR (95% CI)	p-value	APOR (95% CI)	p-value
Residence area								
Rural	1.00		1.00		1.00		1.00	
Urban	3.97 (2.93 -5.38)	0.000	2.84 (1.90 -4.23)	0.000	3.83 (3.72 -6.28)	0.000	2.67 (1.89 -3.78)	0.000
Age (years)								
25 – 34	1.00		1.00		1.00		1.00	
35 – 44	1.96 (1.39 - 2.78)	0.000	1.40 (1.00 -1.90)	0.049	1.29 (0.97 -1.73)	0.081	1.19 (0.89 -1.59)	0.239
45 – 54	1.74 (1.18 - 2.56)	0.005	1.20 (0.81 -1.65)	0.412	1.46 (1.04 -2.07)	0.030	1.18 (0.87 -1.61)	0.287
55 – 64	1.42 (0.90 - 2.25)	0.133	0.67 (0.43 -1.04)	0.074	1.40 (0.87 -2.26)	0.168	1.12 (0.70 -1.80)	0.628
Education								
None	1.00		1.00		1.00		1.00	
Primary	1.22 (0.82 -1.80)	0.320	1.07(0.75 -1.53)	0.708	2.92 (2.09 -4.09)	0.000	1.80 (1.26 -2.57)	0.001
Secondary (school) and over	3.24 (2.12 -4.95)	0.000	1.39 (0.77 -2.48)	0.271	4.07 (2.56 -6.46)	0.000	1.57 (0.87 -2.80)	0.131
Occupation								
Wage earners	1.00		1.00		1.00		1.00	
Self-employed	0.28 (0.19 -0.43)	0.000	0.98 (0.53 -1.81)	0.959	0.21 (0.12 -0.36)	0.000	0.45 (0.24 -0.87)	0.017

Unemployed	0.51 (0.25 -1.02)	0.057	0.75 (0.35 -1.60)	0.458	0.57 (0.22 -1.45)	0.236	0.42 (0.14 -1.27)	0.123
House maker					0.27 (0.16 -0.47)	0.000	0.40 (0.21 -0.77)	0.006
Marital status								
Single	1.00		1.00		1.00		1.00	
Cohabiting/Married	1.30 (0.81 -2.07)	0.271	1.62 (1.09 -2.42)	0.017	0.66 (0.31 -1.43)	0.297	(1.01 -4.16)	0.045
Divorced/Widowed/	2.13 (0.96 -4.73)	0.063	1.83 (0.76 -4.39)	0.176	0.72 (0.31 -1.70)	0.459	1.64 (0.73 -3.68)	0.232
Tobacco consumption								
Never	1.00		1.00		1.00		1.00	
Current smoker	0.64 (0.43 -0.95)	0.027	0.53 (0.37 -0.74)	0.000	0.20 (0.10 -0.37)	0.000	0.42 (0.29 -0.60)	0.000
Former smoker	1.44 (0.77 -2.71)	0.257	1.10 (0.59 -2.05)	0.756	0.98 (0.18 -5.21)	0.983	0.55 (0.13 -2.37)	0.426
Second hand smoking	1.27 (0.92 -1.75)	0.151	1.11 (0.82 -1.50)	0.506	1.30 (0.99 -1.71)	0.056	1.14 (0.87 -1.48)	0.347
Alcohol								
None	1.00		1.00		1.00		1.00	
Low	1.04 (0.71 -1.51)	0.856	0.96 (0.68 -1.35)	0.811	0.47 (0.26 -0.85)	0.012	0.69 (0.45 -1.05)	0.081
Medium	1.69 (1.00 -2.82)	0.047	1.87 (1.20 -2.93)	0.006	1.44 (1.00 -2.07)	0.047	1.17 (0.82 -1.68)	0.386
High	1.52 (0.74 -3.13)	0.257	1.38 (0.77 -2.46)	0.276	1.21 (0.57 -2.59)	0.620	0.71 (0.38 -1.32)	0.280
Fat used								

None	1.00		1.00		1.00		1.00	
Vegetable oil	1.10 (0.71 -1.71)	0.658	0.85 (0.56 -1.30)	0.461	2.00 (1.27 -3.18)	0.03	1.04 (0.72 -1.52)	0.829
Butter, lard or fat, margarine	0.48 (0.28 -0.81)	0.006	0.62 (0.39 -0.97)	0.037	0.73 (0.44 -1.23)	0.240	0.67 (0.46 -0.99)	0.045
Physical activity								
Low intensity	1.00		1.00		1.00		1.00	
Moderate intensity	0.58 (0.38 -0.90)	0.016	0.68 (0.44 -1.04)	0.076	0.76 (0.53 -1.10)	0.147	0.94 (0.66 -1.33)	0.581
High intensity	0.44 (0.30 -0.65)	0.000	0.62 (0.42 -0.93)	0.021	0.55 (0.39 -0.76)	0.000	0.88 (0.63 -1.23)	0.449

CPOR : Crude proportional odds ratio ; APOR : Adjusted proportional odds ratio ; CI : Confidence interval

Discussion

Prevalence of overweight and obesity

The overall prevalence of overweight was relatively high in our study, with no significant difference between men and women. Studies in Africa have also found similar prevalence among both sex[22,31]. However, some authors reported higher proportion of overweight among men[32–34]. The prevalence of obesity in our study was around 5% with disparities found across regions.

The prevalence of obesity was higher among women. Several other studies also reported higher prevalence of obesity among women[9,10,35,36]. Hormonal effects, especially among older ages, women's maternity and lifestyle, and certain cultural conceptions, may be contributing to this higher burden of obesity among women[37].

Factors associated with obesity

Living in urban areas and current tobacco consumption are factors associated with obesity or overweight among both genders. Van Der and all in Gambia[9], also noted that risk in urban areas was about 3 times higher than in rural areas (OR: 2.86, 95% CI: 1.89 - 4 , 35). Abubakari et al. in a meta-analysis of studies conducted in sub-Saharan Africa[11] also noted that the risk was higher in urban areas (OR: 2.70, 95% CI, 1.76-4.15). This high risk could be explained by more sedentary lifestyle in urban areas as previously mentioned. In addition, in urban areas, eating patterns are different from that of rural areaq with more sugar and fats rich food known as "urban" or "western" foods[8]. Current tobacco consumption was inversely associated with the occurrence of overweight or obesity within both genders. Results from other studies reported that smoking for a long period tends to lead to weight loss. Similarly, cessation of tobacco consumption goes along with weight gain[38,39]. However, because smoking is an exposure with well-known detrimental consequences on health, the observed association between smoking and overweight/obesity shouldn't be interpreted as being in favor of smoking as a strategy to prevent obesity/overweight.

Other factors associated with overweight or obesity among men were age, marital status, consumption of butter /lard / margarine, and physical activity. Several authors also reported a positive association between the risk of obesity and age [12,15,33]. Aging leads to less physical activity and combined with greater socio-economic status, increase the ability to access diverse foods. The use of butter / fat / margarine as the main source of lipid was inversely associated with obesity in our data. This is an unexpected result as one would expect a lower risk of

overweight and obesity among those that use predominantly vegetable oil. The lack of quantification of the consumption of the different types of oil makes difficult the comparison. Physical activity was associated with significant decrease in the odds of obesity only in men and not in women in our data. Other studies carried out by Pasquet et al. in Cameroon[14] and Oladimeji in Nigeria[16] revealed that the practice of intensive physical activity reduces significantly the risk of obesity.

Indeed, the intensive physical activity leads to an increase in the energy expenditure, avoids fat deposition and promotes a development of the muscular mass [40]. Men living in union were about 60% more likely to be obese compared to single men. There was an association in the same direction in women. There is a correlation between marital status and socio-economic position. In our study, we lack data on the socio-economic status and we used education status as a proxy. Our findings of a positive correlation between being married and overweight/obesity may have been confounded by the socio-economic status.

Among women, education was associated with obesity/overweight. However, in their study among women living in urban areas, Benkeser et al. in Ghana [37] did not find a relation between educational level and obesity. This could be explained by the fact that their study was exclusively carried out in urban areas where the heterogeneity between educational statuses may be lesser. We found difference in predictors of overweight/obesity between men and women. Physical activity and age were significant predictors in men and not in women, while the education status and the type of employment were significant predictors in only women. These results are in favor of gender specific predictors for overweight/obesity and are in support of gender-based stratified analyses.

Limitations of the study

The results reported in this study are derived from a cross sectional study limiting our ability to derive causal inferences from the observed associations. Exposures measurements were mainly based on a short window recall as it is usual in this type of studies, hampering the possibility to get further attributes (quantity, duration etc.) on some exposures such as fat and frut consumptions, that would have been invaluable in the interpretation of the results. We did not have information on socio-economic status that is a known key variable when trying to predict overnutrition. Furthermore, the analysis carried out and our interpretation of the results assume that an overweight person is in transition to obese status. While this is conceptually true, we

cannot rule out that an overweight person will turn to be normal in the future, particularly in a setting where food insecurity is common.

Conclusion

Our study showed an important burden of obesity and overweight in the adult population with women more affected than men. Overnutrition needs to be recognized as an important public health issue. The country is witnessing the double burden of malnutrition with the coexistence of overnutrition and undernutrition. Nutrition interventions need to be reshaped to account for this epidemiological picture of malnutrition in Burkina Faso.

Abbreviations

BMI: body mass index; CI: confidence interval; CPOR : Crude proportional odds ratio ; APOR : Adjusted proportional odds ratio ; WHO : World health organization.

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Data sharing and availability

The STEPS 2013 survey database was used for this study. The dataset can be obtained at the Ministry of Health upon reasonable request. Any request for further analysis can be submitted to Dr Brice W. Bicaba bicaba_brico@yahoo.fr

No further additional data is available.

Authors contribution

SK1, MT and SK2 designed the study and SK1 drafted the paper. SK1 and MT performed initial analysis and MT reanalysed the data. SK2, BB, JKS and HL made substantial contributions to the interpretation of the data. All authors read and approved the final manuscript.

Conflicts of interest

None declared

Consent for publication

Not applicable.

Ethical considerations

The STEPS survey got approval from the Ethics Committee for Health Research (Deliberation No. 2012-12-092 of 05 December 2012). Written informed consent was obtained before inclusion in the study. For this study, we obtained an authorization from the General directorate of Health to reanalyze the data and the confidentiality of study participants was preserved.

Figure legend

Figure 1: Diagram flow of the study participants. This figure shows the criteria that were used to select the study participants in our study and the numbers that were affected by these criteria and the final sample size of the study.

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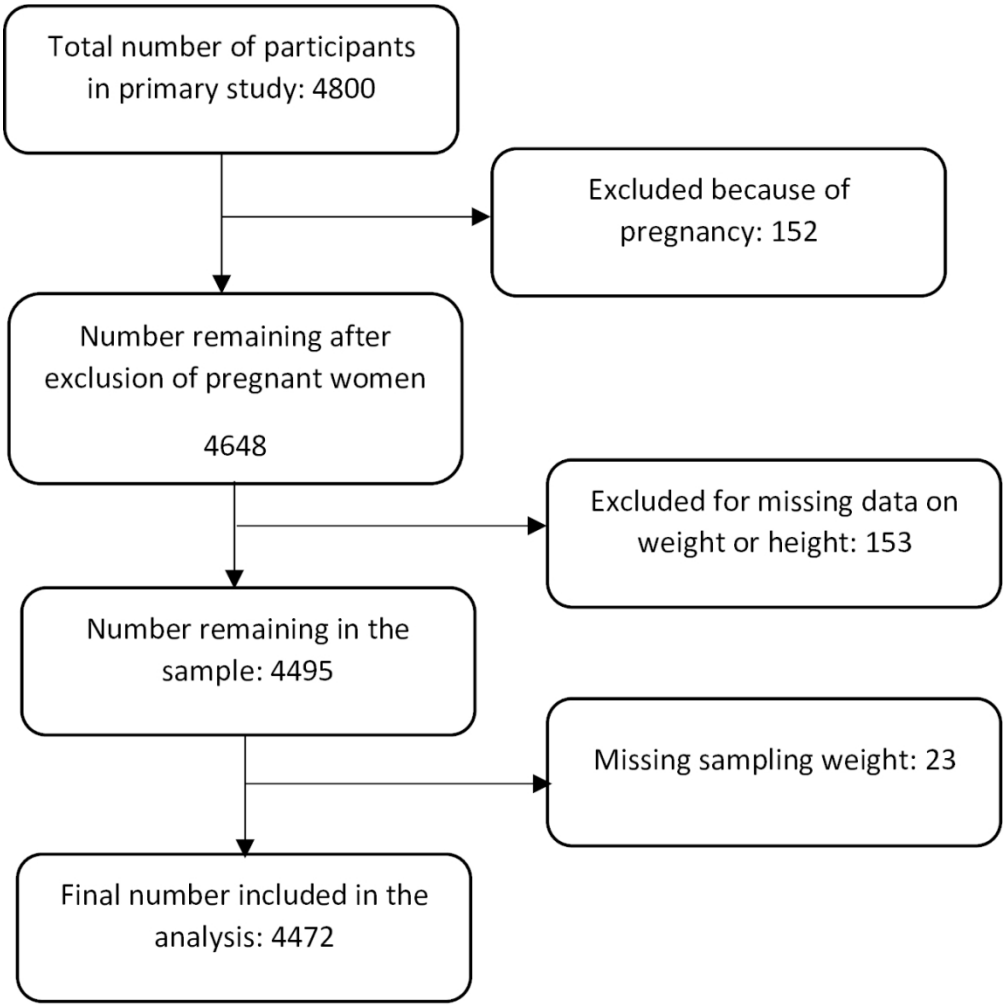

Figure 1 : Diagram flow of the study participants.

Diagram flow of the study participants

111x126mm (300 x 300 DPI)

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

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	2&4
Methods			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	5&6
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7&8
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	*8*
Bias	9	Describe any efforts to address potential sources of bias	7&8
Study size	10	Explain how the study size was arrived at	6
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	8
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	9
		(*c*) Explain how missing data were addressed	9
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	9
		(*e*) Describe any sensitivity analyses	None
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	7& figure 1
		(b) Give reasons for non-participation at each stage	7& figure 1
		(c) Consider use of a flow diagram	Figure 1
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	9&10
		(b) Indicate number of participants with missing data for each variable of interest	10

Outcome data	15*	Report numbers of outcome events or summary measures	10&11
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	11&12&13&14
		(*b*) Report category boundaries when continuous variables were categorized	10
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	None included
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	11-15
Discussion			
Key results	18	Summarise key results with reference to study objectives	16
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	3&16
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	16
Generalisability	21	Discuss the generalisability (external validity) of the study results	16&17
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	18

*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.

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Prevalence and risk factors for overweight and obesity: a cross sectional countrywide study in Burkina Faso.

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Abstract

Objective: The objective of this study was to determine the prevalence and predictors of overweight and obesity in Burkina Faso using a population-based country-wide sample. We hypothesize that there is a significant burden related to overweight/obesity in Burkina Faso.

Design: Secondary analysis of a population-based country wide cross-sectional study

Setting: Burkina Faso, all the 13 regions including both rural and urban residential areas

Participants: 4,800 participants of both sexes, aged between 25 and 64 years.

Main outcomes: overweight and obesity using body mass index cut-off levels of WHO

Results: The prevalence of overweight and obesity in Burkina Faso were 13.82% (CI95%: 12.25 - 15.55) and 4.84% (CI95%:3.99 - 5.86) respectively. Among men, the proportional odds of overweight / obesity increase with urban residency ($p<0.001$), greater age ($p<0.002$), marital status different from single ($p\leq0.007$) and decrease with current smoking ($p=0.009$). Among women, the proportional odds of overweight / obesity increase with urban residency ($p<0.001$), primary educational level ($p=0.01$), high total blood cholesterol level ($p<0.001$), high fasting blood glucose level ($p=0.02$), and decrease with current smoking ($p<0.001$).

Conclusion:

Our study showed that nearly one person out of five in the adult population of Burkina has an abnormal weight status with women being more affected than men. Urban residency is a consistent risk factor in both men and women. Alcohol consumption and education were associated with an increased odds in only women. Overnutrition needs to be recognized as an important public health issue in Burkina Faso and nutrition interventions need to be reshaped to account for it.

Strengths and limitations

Strengths

- To our best knowledge, this is the first nationwide study on obesity and overweight in Burkina Faso with a country level representative sample.
- Outcomes measurements were carried out following international standards through the WHO STEPwise approach to NCDs measurement and prevention.

Limitations

- This is a cross sectional study, which hampers our ability to derive causal inferences from the reported data;
- The Socio-economic status, a known relevant variable was not measured in the primary study;
- Being overweight may not necessarily equate to being an obese person to be, particularly in a setting where food insecurity is common.

Introduction

Obesity is defined as an abnormal or excessive accumulation of body fat, due to an energy imbalance between intake and expenditure [1]. It is a major risk factor for many non-communicable diseases (NCD) and a real public health threat in the world[2,3]. In 2015, high BMI contributed to 4.0 million deaths, which represented 7.1% of the deaths from all causes [4].

Obesity, a well-known phenomenon in developed countries, is increasingly common in low-middle income countries, affecting both children and adults [2,4,5]. In the Eastern Mediterranean Region, the prevalence of obesity increased in adults from 15.1% in 1980 to 20.7% in 2015. It increased from 4.1% to 4.9% in the same period among children [6]. In sub-Saharan Africa (SSA) , Overweight/obesity factors accounted for 266 768 deaths, representing 3.3% of all-cause mortality [7]. Thus, in low- and middle-income countries, the association of overweight / obesity with one or more nutritional deficiencies is often observed, especially among women and known as double burden of malnutrition [8]. However, data from the literature reports that excess weight can largely be avoided; and prevention involves the identification and control of modifiable risk factors[2,5]. These factors have been widely described in the literature. There are mainly related to behavior and / or knowledge (inadequate diet, inactivity, alcohol consumption,), sociodemographic factors (place of residence, socio-economic status), and clinical and metabolic factors (total cholesterol level, HDL, triglycerides) [5,9–11].

However, the factors vary between countries, depending on eating habits and socio-cultural practices [2] . This variability of factors suggests a relevance of country specific studies to identify context specific and relevant risk factors in order to better guide and align the policies and strategies aiming to address the raising burden of obesity.

The studies conducted so far on factors associated with overweight or obesity in low-middle income countries were often conducted in urban areas [[12–16], hospitals[17,18], secondary and high schools [19–21]. There are few nationally representative data on obesity in most sub-Saharan African countries[9,22]. This scarcity of nationally representative data on the burden and risk factors for overweight/obesity is an obstacle to engaging countries in the design and implementation of adequate public health interventions.

Our study intends to fill this gap by providing more complete data on the prevalence and the risk factors for overweight and obesity, through a secondary analysis of data from the STEPS survey carried out in Burkina Faso in 2013.

Methods

Study setting

Our study was conducted in Burkina Faso, a landlocked Sahelian country in the heart of West Africa. The country is divided into 13 regions, 45 provinces and 351 municipalities. In 2013, the population was estimated at 21,478,529 inhabitants. The majority of the population lives in rural areas, with agriculture and livestock as main activities[23,24].

In terms of health, the country is still facing endemic-epidemic diseases, especially malaria, measles, cerebro-spinal meningitis, acute respiratory infections, diarrheal diseases and HIV / AIDS infection[25]. The prevalence of acute malnutrition in children under five years was estimated at 8.1% in 2019[26].

Mortality due to non-communicable diseases is increasing rapidly in the same time; it was estimated that 33% of all death cases were due to NCD in 2016[27].

Type of study

We carried out an analytical cross-sectional study consisting of a secondary analysis of the data from the 2013STEPS survey in Burkina Faso.

Study population

The study population of the survey was composed of adults of 25 to 64-year-old who have been living in the national territory for at least six (6) months before the survey. Persons with an inability to answer questions (cognitive impairment) were excluded from the primary study. Pregnant women were excluded from our analysis.

Sampling and statiscal power

The enumeration areas (EAs) from the 2006 General Population and Housing Census , updated in 2010 during the Demographic and Health Survey conducted in Burkina Faso (EDS-BF, 2010) were used as sampling frame. The STEPS survey was carried out on a nationally representative

sample of 4800 households with 20 households per EAs, giving 240 EAs for the whole country. The sample was stratified in each of the 13 administrative regions to provide an adequate representation of the urban and rural areas. This stratification took into account the distribution of the population depending on the urban (22.7%) and rural environment (77.3%) in Burkina Faso, giving 54 EAs for urban area and 186 EAs for rural areas across the country. Within each stratum, a three-stage cluster sampling was done as recommended by WHO for STEPS NCD risk factors screening surveys.

At the first stage, the choice of clusters or enumeration zones by administrative regions was made by a systematic draw with proportional probability to the size of the EAs.

At the second stage, a household count in each of the selected 240 clusters at the first stage provided a list of households from which a sample of 20 households was selected using a simple systematic random sampling with an Excel Spread Sheet.

At the third level, the choice of individuals within households was made randomly. Once a household is selected, the interviewer creates a listing (sampling frame) of all eligible adults of both sexes aged between 25-64 years in the household. The listing includes the following variables: name, gender, relationship to the household head and age. Once the listing is created, each eligible member is assigned a unique number. Then using a randomized response table (Kish table), a particular member is chosen for the interview [28]. In each household, an individual of 25 to 64 years old living in the household was drawn to participate in the survey.

The STEPS survey took place from September 26 to November 18, 2013 and anrolled a total of 4,800 individuals. Out of the 4800 participants, we excluded 152 pregnant women, 153 with missing data (on height and / or weight) and 23 without sampling weights. The sample size for our secondary analysis comprised 4472 persons (See figure**1 for study inclusion process**). With this final sample size and assuming a prevalence of obesity of 4.5%, our study has a statistical power of 86.6% to detect an association of a magnitude of 1.5 with the type-I error rate α of 5%.

Data collection

The collection of data was carried out by nurses, graduate medical and nurse students. The data collection consisted in face-to-face interviews of selected participants using standardized questionnaires and physical and biochemical measurements. The data collection tools were pre-tested before they were used at the national level.

Data collection teams were closely supervised by a team of supervisors composed of statisticians, epidemiologists and clinicians.

Height measurement (in cm) was made in a standing or lying position, using a portable measuring board, on the participant without shoes and hat. The weight in kg was measured using an electronic weighing scales (SECA™) placed on a stable and even surface, the person lightly dressed, shoes-off and in a standing position.

The total cholesterol and blood glucose levels were measured using a Cardiocheck ™ PA SILVER kit that performs all these measurements using a capillary whole blood sample. Further details on the STEPS survey are available elsewhere[29].

Study Variables

We used body mass index (BMI) to define general obesity. The BMI was calculated dividing the weight (kg) by the size (in meters) squared and then used to define undernutrition (BMI <18.5 kg / m^2), normal (18.5 - 24.99 kg / m^2), overweight (25.0-29.99 kg / m^2) and obesity (30 kg / m^2) in accordance with WHO recommendations [2]. We also used waist circumference to compute central obesity with the cut-off points of 94 cm in men and 80 cm in women[30].

Independent variables included age, marital status, place of residence, occupational activity, educational level, total cholesterol level, fasting blood glucose, smoking, alcohol consumption, the type of fat most commonly consumed and the intensity of physical activities. Some variables were recoded using specific cut-points of grouping (see Table 1).

Table 1 : Recoding of exposure variables

Variables	Categories
Age groups (years)	«25 to 34» «35 to 44» «45 to 54» «55 to 64»
Education level	«None» «Primary» «Secondary and higher»
Marital status	«Single» «Cohabiting/Married» «Divorced/widowed/ separated»
Occupational status	«Employed» «self-employed» «Unemployed» «House makers »
Total cholesterol level	Normal (<5.2 mmol/l); High cholesterol (≥5.2 mmol/l)
Fasting capillary glucose	Normal (<6.1 mmol/l); High glucose (≥6.1 mmol/l)
Cigarette smoking	« Never » «Current smoker » « Former smoker » « Second hand smoking »
Daily alcohol consumption	• Male : None (0 g) Low (0.01 – 39.99 g) Medium (40 - 59.99) High (60 and over) • Female : None (0 g) Low (0.01 – 19.99 g) Medium (20 - 39.99) High (40 and over)
Fat intake	«None» «Vegetable oil» « butter, lard or fat, margarine»
Physical activity	• High intensity activity: high intensity activities require an energy expenditure greater than 6 Metabolic

	equivalent of Task (METs). Examples include soccer playing, hole digging, regular swimming, farming etc. • Moderate intensity activity: moderate intensity activities require an energy expenditure of approximately 3–6 METs. Examples include cleaning, vacuuming, polishing, gardening, cycling at a regular pace or horse riding etc. • Low intensity activity: refers to persons who do not meet the above classifications. Here are included people with limited and no physical activity.

Statistical analysis

The predictive variables were selected based on the literature. We carried out stratified gender based analyzes. The Fisher Test was used to evaluate associations between the dependent variable and independent qualitative variables. We calculated crude proportional odds ratio (CPOR) and adjusted proportional odds ratios (APORs) using an ordinal logistic regression model. The dependant ordinal variable has four catgories: underweight, normal, overweight and obese. The covariates selection in the multivariable analysis was based on epidemiological plausibility and literature review. All the analyses were weighted to account for the study design and we computed robust standard errors to account for the clustered nature of the data. The proportional risk assumption and the overall goodness of fit of the final models were checked before the results were reported. All the analyses were based on complete data analysis (missing data were ignored in all analyses). All analyzes were carried out using the Stata 13.1 software.

Patient and public involvement

Patients or the public WERE NOT involved in the design, or conduct, or reporting, or dissemination plans of our research.

Results

Background characteristics of the study sample

The socio-demographic characteristics of the individuals of the sample are presented in Table **2**. Participants of the 25-34 age group were majority with 40.92%. There were 2249 women, which represents 52.6% of the participants. Participants with no educational level accounted for 72.93% among men against 77.17% among women. The majority of the individuals were married/living in couple (86.96%).

Table 2 : Demographic and behavioural characteristics of study participants.

Variables	Population		Total
	Male n(%)	Female n(%)	
Residence			
Urban	454 (25.52)	539 (29.70)	993 (27.72)
Rural	1769 (74.48)	1710 (70.30)	3479 (72.28)
Age groups			
25 - 34	933 (38.09)	1044 (43.45)	1977 (40.92)
35 - 44	560 (28.21)	573 (37.65)	1133 (27.91)
45 - 54	424 (20.22)	404 (18.49)	828 (19.31)
55 - 64	306 (13.48)	228 (10.40)	534 (11.86)
Education level			
None	1623 (72.93)	1832 (81.16)	3455 (77.27)
Primary	405 (17.85)	288 (13.07)	693 (15.33)
Secondary (school) and higher	187 (9.22)	129 (5.78)	316 (7.40)
Marital status			
Single	254 (11.04)	68 (3.24)	322 (6.93)
Cohabiting/Married	1879 (85.74)	1963 (88.06)	3842 (86.96)
Divorced/Widowed/separated	87 (3.21)	216 (8.70)	303 (6.10)
Occupational status			
Employed	178 (6.68)	71 (3.44)	249 (2.92)
Self-employed	1945 (86.12)	1188 (50.40)	3133 (67.32)
Unemployed	87 (4.51)	54 (2.44)	141 (3.42)
Housemaker	13 (0.70)	936 (43.72)	949 (23.34)

Prevalence of overweight and obesity

As shown in Table 3, the prevalence of overweight and general obesity in the sample were respectively 13.82 ($CI_{95\%}$: 12.25 - 15.55) and 4.84 ($CI_{95\%}$:3.99 - 5.86). The prevalence of general obesity was higher among women ($p < 0.0001$) and among urban residents ($p < 0.0001$). However, the proportion of overweight people did not significantly differ between women and men. Among all age groups, obesity was more prevalent in the age group 35 to 44 ($p < 0.0001$). The prevalence of obesity also varies across administrative regions (results not shown). The prevalence of central obesity was respectively 6.33% (CI95%: 5.11-7.81) and 34.50% (CI95%:31.12-38.97) in men and women, with significant rural versus urban difference in both sexes ($p<0.001$).

Tableau 3 : Prevalence of underweight, overweight and general obesity among study participants.

	n	Underweight % (95% CI)	Overweight % (95% CI)	Obesity % (95% CI)
Gender				
Male	2223	8.10 (6.71 - 97.3)	13.91 (11.88 -16.22)	3.29 (2.33 - 4.62)
Female	2249	15.05 (13.19 - 17.12)	13.74 (11.86 -15.86)	6.24 (5.11 - 7.60)
Age groups (years)				
25 - 34	1977	9.32 (7.76 - 11.17)	12.09 (10.22 - 14.24)	3.73 (2.69 - 5.16)
35 - 44	1133	10.77 (8.70 - 13.25)	16.12 (13.35 - 19.34)	5.64 (4.26 - 7.43)
45 - 54	828	14.05 (11.63 - 16.89)	15.75 (12.79 -19.24)	5.26 (3.61 - 7.61)
55 - 64	534	18.75 (15.04 - 23.13)	11.22 (8.36 - 14.90)	6.10 (3.97 - 9.24)
Residence				
Rural	3479	13.32 (11.79 - 15.03)	9.74 (8.33 - 11.35)	1.89 (1.40 - 2.53)
Urban	993	7.67 (5.09 - 11.42)	24.46 (20.06 - 29.47)	12.54 (9.75- 15.99)
Total	**4472**	**11.76 (10.40 - 13.27)**	**13.82 (12.25 - 15.55)**	**4.84 (3.99 - 5.86)**

Risk factors for Obesity and overweight

Among men.

In multivariable analysis, significant predictors of overweight and obesity among men included place of residence, physical activity, age, marital status, alcohol, tobacco and fat consumption. Men living in urban areas were around 3 times proportionally more likely to be at least overweight as compared to those living in rural areas (APOR: 2.84, CI95%: 1.90 - 4.23). The odds of being overweight or obese was lower within the 25 to 34 age group as compared to35-44 years and 45-54 years. Men aged 35 to 44 years were 1.4 times proportionally more likely to be overweight or obese (APOR: 1.4, $CI_{95\%:}$ 1.00 – 1.90). Compared to single men, men living in unions and those that are widowed or divorced were having higher proportional odds of being overweight or obese (APOR: 1.62, $CI_{95\%:}$ 1.09 - 2.42 and APOR: 1.83, $CI_{95\%:}$ 0.76 - 4.39) . The current consumption of tobacco reduces by nearly half the proportional odds (APOR: 0.53, $CI_{95\%}$: 0.37 - 0.74). No significant difference was found between former and second hand smokers and men who had never smoked. The report of the consumption of butter, lard or margarine as the most often type of fat was associated with more than 30% proportional odds reduction (APOR: 0.62, CI95%: 0.39 - 0.97). The practice of physical activity was also associated with lower odds of overweight/obesity with the odds reduction increasing as the intensity of the physical activity increases (APOR: 0.68, $CI_{95\%}$:0.44-1.04 and APOR:0.62, $CI_{95\%}$:0.42-0.93).

Among women

Among women, significant risk factors included urban residence, current tobacco consumption, educational level, the type of occupation and fat consumption. Urban residential status was associated with around three-fold increase in the proportional odds of obesity or overweight (APOR 2.67, $CI_{95\%}$:1.89 - 3.78) as compared to rural residence. Being of primary school education level increased nearly two times the proportional odds of overweight or obesity (APOR: 1.80, $CI_{95\%}$:1.26-2.57) as compared to those that have not been at school (no education). The proportional odds of being at least overweight was lower among current tobacco smokers compared to non-smokers (APOR: 0.42, $CI_{95\%}$: 0.29 - 0.60). As compared to wage earners, women that are self-employed and those that house makers were less likely to be overweight/obese (APOR:0.45, $CI_{95\%}$:0.24-0.87 and APOR:0.40, $CI_{95\%}$:0.21-0.77). The report of butter/lard or margarine as type of fat often consumed was associated with lower odds of overweight/obesity (APOR:0.67, $CI_{95\%}$:0.46-0.99).

The results of the multivariable analysis are presented in Table 4.

Table 4: Risk factors for overweight and obesity among male and female adult population aged 25–64

	Male (n=2223)				Female (n=2249)			
	CPOR (95% CI)	p-value	APOR (95% CI)	p-value	CPOR (95% CI)	p-value	APOR (95% CI)	p-value
Residence area								
Rural	1.00		1.00		1.00		1.00	
Urban	3.97 (2.93 -5.38)	0.000	2.84 (1.90 -4.23)	0.000	3.83 (3.72 -6.28)	0.000	2.67 (1.89 -3.78)	0.000
Age (years)								
25 – 34	1.00		1.00		1.00		1.00	
35 – 44	1.96 (1.39 - 2.78)	0.000	1.40 (1.00 -1.90)	0.049	1.29 (0.97 -1.73)	0.081	1.19 (0.89 -1.59)	0.239
45 – 54	1.74 (1.18 - 2.56)	0.005	1.20 (0.81 -1.65)	0.412	1.46 (1.04 -2.07)	0.030	1.18 (0.87 -1.61)	0.287
55 – 64	1.42 (0.90 - 2.25)	0.133	0.67 (0.43 -1.04)	0.074	1.40 (0.87 -2.26)	0.168	1.12 (0.70 -1.80)	0.628
Education								
None	1.00		1.00		1.00		1.00	
Primary	1.22 (0.82 -1.80)	0.320	1.07(0.75 -1.53)	0.708	2.92 (2.09 -4.09)	0.000	1.80 (1.26 -2.57)	0.001
Secondary (school) and over	3.24 (2.12 -4.95)	0.000	1.39 (0.77 -2.48)	0.271	4.07 (2.56 -6.46)	0.000	1.57 (0.87 -2.80)	0.131
Occupation								
Wage earners	1.00		1.00		1.00		1.00	
Self-employed	0.28 (0.19 -0.43)	0.000	0.98 (0.53 -1.81)	0.959	0.21 (0.12 -0.36)	0.000	0.45 (0.24 -0.87)	0.017

Unemployed	0.51 (0.25 -1.02)	0.057	0.75 (0.35 -1.60)	0.458	0.57 (0.22 -1.45)	0.236	0.42 (0.14 -1.27)	0.123
House maker					0.27 (0.16 -0.47)	0.000	0.40 (0.21 -0.77)	0.006
Marital status								
Single	1.00		1.00		1.00		1.00	
Cohabiting/Married	1.30 (0.81 -2.07)	0.271	1.62 (1.09 -2.42)	0.017	0.66 (0.31 -1.43)	0.297	(1.01 -4.16)	0.045
Divorced/Widowed/	2.13 (0.96 -4.73)	0.063	1.83 (0.76 -4.39)	0.176	0.72 (0.31 -1.70)	0.459	1.64 (0.73 -3.68)	0.232
Tobacco consumption								
Never	1.00		1.00		1.00		1.00	
Current smoker	0.64 (0.43 -0.95)	0.027	0.53 (0.37 -0.74)	0.000	0.20 (0.10 -0.37)	0.000	0.42 (0.29 -0.60)	0.000
Former smoker	1.44 (0.77 -2.71)	0.257	1.10 (0.59 -2.05)	0.756	0.98 (0.18 -5.21)	0.983	0.55 (0.13 -2.37)	0.426
Second hand smoking	1.27 (0.92 -1.75)	0.151	1.11 (0.82 -1.50)	0.506	1.30 (0.99 -1.71)	0.056	1.14 (0.87 -1.48)	0.347
Alcohol								
None	1.00		1.00		1.00		1.00	
Low	1.04 (0.71 -1.51)	0.856	0.96 (0.68 -1.35)	0.811	0.47 (0.26 -0.85)	0.012	0.69 (0.45 -1.05)	0.081
Medium	1.69 (1.00 -2.82)	0.047	1.87 (1.20 -2.93)	0.006	1.44 (1.00 -2.07)	0.047	1.17 (0.82 -1.68)	0.386
High	1.52 (0.74 -3.13)	0.257	1.38 (0.77 -2.46)	0.276	1.21 (0.57 -2.59)	0.620	0.71 (0.38 -1.32)	0.280
Fat used								

None	1.00		1.00		1.00		1.00	
Vegetable oil	1.10 (0.71 -1.71)	0.658	0.85 (0.56 -1.30)	0.461	2.00 (1.27 -3.18)	0.03	1.04 (0.72 -1.52)	0.829
Butter, lard or fat, margarine	0.48 (0.28 -0.81)	0.006	0.62 (0.39 -0.97)	0.037	0.73 (0.44 -1.23)	0.240	0.67 (0.46 -0.99)	0.045
Physical activity								
Low intensity	1.00		1.00		1.00		1.00	
Moderate intensity	0.58 (0.38 -0.90)	0.016	0.68 (0.44 -1.04)	0.076	0.76 (0.53 -1.10)	0.147	0.94 (0.66 -1.33)	0.581
High intensity	0.44 (0.30 -0.65)	0.000	0.62 (0.42 -0.93)	0.021	0.55 (0.39 -0.76)	0.000	0.88 (0.63 -1.23)	0.449

CPOR : Crude proportional odds ratio ; APOR : Adjusted proportional odds ratio ; CI : Confidence interval

Discussion

Prevalence of overweight and obesity

The overall prevalence of overweight was relatively high in our study, with no significant difference between men and women. Studies in Africa have also found similar prevalence among both sex[22,31]. However, some authors reported higher proportion of overweight among men[32–34]. The prevalence of obesity in our study was around 5% with disparities found across regions.

The prevalence of obesity was higher among women. Several other studies also reported higher prevalence of obesity among women[9,10,35,36]. Hormonal effects, especially among older ages, women's maternity and lifestyle, and certain cultural conceptions, may be contributing to this higher burden of obesity among women[37].

Factors associated with obesity

Living in urban areas and current tobacco consumption are factors associated with obesity or overweight among both genders. Van Der and all in Gambia[9], also noted that risk in urban areas was about 3 times higher than in rural areas (OR: 2.86, 95% CI: 1.89 - 4 , 35). Abubakari et al. in a meta-analysis of studies conducted in sub-Saharan Africa[11] also noted that the risk was higher in urban areas (OR: 2.70, 95% CI, 1.76-4.15). This high risk could be explained by more sedentary lifestyle in urban areas as previously mentioned. In addition, in urban areas, eating patterns are different from that of rural areaq with more sugar and fats rich food known as "urban" or "western" foods[8]. Current tobacco consumption was inversely associated with the occurrence of overweight or obesity within both genders. Results from other studies reported that smoking for a long period tends to lead to weight loss. Similarly, cessation of tobacco consumption goes along with weight gain[38,39]. However, because smoking is an exposure with well-known detrimental consequences on health, the observed association between smoking and overweight/obesity shouldn't be interpreted as being in favor of smoking as a strategy to prevent obesity/overweight.

Other factors associated with overweight or obesity among men were age, marital status, consumption of butter /lard / margarine, and physical activity. Several authors also reported a positive association between the risk of obesity and age [12,15,33]. Aging leads to less physical activity and combined with greater socio-economic status, increase the ability to access diverse foods. The use of butter / fat / margarine as the main source of lipid was inversely associated with obesity in our data. This is an unexpected result as one would expect a lower risk of

overweight and obesity among those that use predominantly vegetable oil. The lack of quantification of the consumption of the different types of oil makes difficult the comparison. Physical activity was associated with significant decrease in the odds of obesity only in men and not in women in our data. Other studies carried out by Pasquet et al. in Cameroon[14] and Oladimeji in Nigeria[16] revealed that the practice of intensive physical activity reduces significantly the risk of obesity.

Indeed, the intensive physical activity leads to an increase in the energy expenditure, avoids fat deposition and promotes a development of the muscular mass [40]. Men living in union were about 60% more likely to be obese compared to single men. There was an association in the same direction in women. There is a correlation between marital status and socio-economic position. In our study, we lack data on the socio-economic status and we used education status as a proxy. Our findings of a positive correlation between being married and overweight/obesity may have been confounded by the socio-economic status.

Among women, education was associated with obesity/overweight. However, in their study among women living in urban areas, Benkeser et al. in Ghana [37] did not find a relation between educational level and obesity. This could be explained by the fact that their study was exclusively carried out in urban areas where the heterogeneity between educational statuses may be lesser. We found difference in predictors of overweight/obesity between men and women. Physical activity and age were significant predictors in men and not in women, while the education status and the type of employment were significant predictors in only women. These results are in favor of gender specific predictors for overweight/obesity and are in support of gender-based stratified analyses.

Limitations of the study

The results reported in this study are derived from a cross sectional study limiting our ability to derive causal inferences from the observed associations. Exposures measurements were mainly based on a short window recall as it is usual in this type of studies, hampering the possibility to get further attributes (quantity, duration etc.) on some exposures such as fat and frut consumptions, that would have been invaluable in the interpretation of the results. We did not have information on socio-economic status that is a known key variable when trying to predict overnutrition. Furthermore, the analysis carried out and our interpretation of the results assume that an overweight person is in transition to obese status. While this is conceptually true, we

cannot rule out that an overweight person will turn to be normal in the future, particularly in a setting where food insecurity is common.

Conclusion

Our study showed an important burden of obesity and overweight in the adult population with women more affected than men. Overnutrition needs to be recognized as an important public health issue. The country is witnessing the double burden of malnutrition with the coexistence of overnutrition and undernutrition. Nutrition interventions need to be reshaped to account for this epidemiological picture of malnutrition in Burkina Faso.

Abbreviations

BMI: body mass index; CI: confidence interval; CPOR : Crude proportional odds ratio ; APOR : Adjusted proportional odds ratio ; WHO : World health organization.

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Data sharing and availability

The STEPS 2013 survey database was used for this study. The dataset can be obtained at the Ministry of Health upon reasonable request. Any request for further analysis can be submitted to Dr Brice W. Bicaba bicaba_brico@yahoo.fr

No further additional data is available.

Authors contribution

SK1, MT and SK2 designed the study and SK1 drafted the paper. SK1 and MT performed initial analysis and MT reanalysed the data. SK2, BB, JKS and HL made substantial contributions to the interpretation of the data. All authors read and approved the final manuscript.

Conflicts of interest

None declared

Consent for publication

Not applicable.

Ethical considerations

The STEPS survey got approval from the Ethics Committee for Health Research (Deliberation No. 2012-12-092 of 05 December 2012). Written informed consent was obtained before inclusion in the study. For this study, we obtained an authorization from the General directorate of Health to reanalyze the data and the confidentiality of study participants was preserved.

Figure legend

Figure 1: Diagram flow of the study participants. This figure shows the criteria that were used to select the study participants in our study and the numbers that were affected by these criteria and the final sample size of the study.

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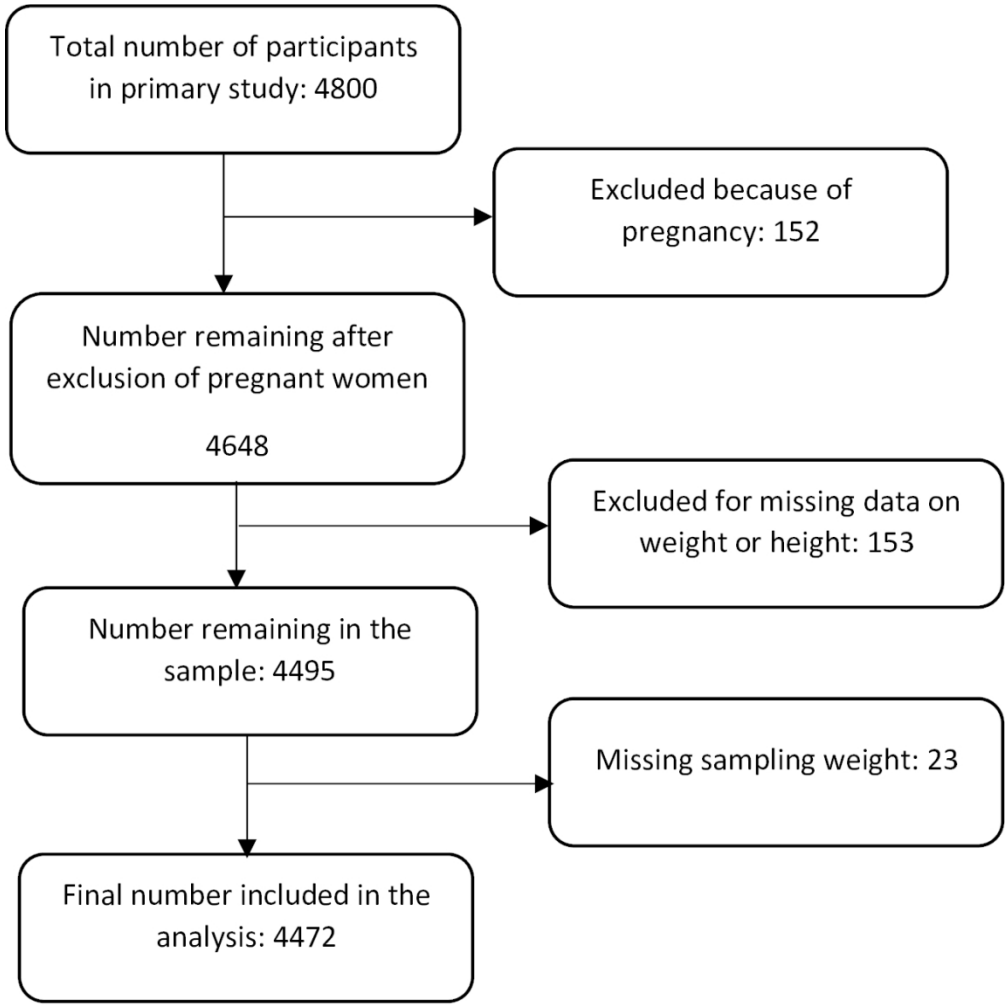

Figure 1 : Diagram flow of the study participants.

Diagram flow of the study participants. This figure shows the criteria that were used to select the study participants in our study and the numbers that were affected by these criteria and the final sample size of the study.

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

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	2&4
Methods			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	5&6
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7&8
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	*8*
Bias	9	Describe any efforts to address potential sources of bias	7&8
Study size	10	Explain how the study size was arrived at	6
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	8
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	9
		(*c*) Explain how missing data were addressed	9
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	9
		(*e*) Describe any sensitivity analyses	None
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	7& figure 1
		(b) Give reasons for non-participation at each stage	7& figure 1
		(c) Consider use of a flow diagram	Figure 1
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	9&10
		(b) Indicate number of participants with missing data for each variable of interest	10

Outcome data	15*	Report numbers of outcome events or summary measures	10&11
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	11&12&13&14
		(*b*) Report category boundaries when continuous variables were categorized	10
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	None included
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	11-15
Discussion			
Key results	18	Summarise key results with reference to study objectives	16
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	3&16
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	16
Generalisability	21	Discuss the generalisability (external validity) of the study results	16&17
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	18

*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.