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The silent epidemic of obesity in The Gambia: Evidence from a nationwide population-based cross sectional health examination survey

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The silent epidemic of obesity in The Gambia: Evidence from a nationwide population-based cross sectional health examination survey

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Abstract

Objectives

Non-communicable diseases account for 70% of global deaths, with 80% occurring in low- and middle-income countries. The rapid increase of obesity in sub-Saharan Africa is a source of concern. We assessed generalised-and abdominal-obesity and associated risk factors for each among adults in The Gambia.

Design: Random nationwide cross sectional health examination survey using WHO STEPwise survey methods.

Setting: The study was conducted in The Gambia.

Participants: This study is based on secondary analysis of a nationally representative sample of adults aged 25-64 years (78% response rate) collected in 2010 using WHO STEPwise survey methods. Analysis was restricted to non-pregnant participants with valid weight and height measurements (n=3533).

Primary and secondary outcome measures

The primary outcome variable was generalised obesity, defined using body mass index. Analyses were weighted for non-response and adjusted for the complex survey design. We conducted multinomial logistic regression analysis to identify factors associated with underweight, overweight and obesity. A secondary outcome variable was abdominal obesity defined using high waist circumference.

Results

Two-fifths of adults were overweight/obese, with a higher obesity prevalence in women (17%, 95%CI: 14.7-19.7; men 8%, 6.0-11.0) and urban residents. 10% of men and 8% of women were underweight. Urban residence [adjusted relative risk ratio (ARRR) 5.8, CI 2.4-14.5], higher education (2.3, 1.2-4.5), older age, ethnicity, and low fruit and vegetable intake (2.8, 1.1-6.8), were strongly associated with obesity among men. Similarly, urban residence (4.7, 2.7-8.2), higher education (2.6, 1.1-6.4), older age and ethnicity were associated with obesity in women.

Conclusion

There is a high burden of overweight/obesity in The Gambia. While obesity rates in rural areas was lower than urban areas, a rising rate of obesity in rural areas is also of concern. Preventive strategies should be directed at raising awareness, discouraging harmful beliefs on weight, and promotion of healthy diets and physical activity.

Key words: Obesity, non-communicable diseases, sub-Saharan Africa, The Gambia, WHO STEP survey, health examination survey

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Strengths and limitations of this study

- Our study uses the most recent nationally-representative data on generalised and abdominal obesity among adults in The Gambia and hence it serves as a baseline study from which future changes in prevalence and risk factors can be assessed.
- The complex sampling strategy and the stringent WHO STEP protocols applied in collecting the data, particularly the use of objective anthropometric measurements taken by trained field staff, minimised biases.
- The study has identified population sub-groups to prioritise with health promotion measures.
- Our main limitation is that the survey did not collect self-reported measures on beliefs about body size and weight management, which are important in The Gambian context to assess and monitor trends on beliefs and practices.

Introduction

Non-communicable diseases (NCDs) are increasing in sub-Saharan Africa (SSA). [1 2] NCDs account for 70% of global deaths; 80% occur in low- and middle-income countries.[2] A pooled analysis of 1698 population-based measurement studies comprising 19 million participants from 200 countries revealed an increasing trend of obesity globally.[3] If these trends continue, meeting the WHO global NCD target of halting the rise of obesity by 2025 is almost impossible. A great concern is the rapid increase of obesity in SSA. Countries in SSA face the challenge of the double burden of communicable and non-communicable diseases, namely that of underweight/malnutrition and obesity.[4 5]

A pooled analysis of population-based studies from 1980-2014 in Africa demonstrated a significant increase in age-standardised mean BMI across the continent.[6] A recent analysis of Demographic and Health Surveys conducted between 1991 and 2014 in 24 African countries revealed a significant increase in obesity among women; rates in some countries tripled.[7] There is evidence suggesting obesity is increasing more quickly in developing countries, especially in SSA, compared with developed countries. [8 9]This is associated with a range of factors including epidemiological and nutritional transition, adoption of western life styles, decreased physical activity, low fruit and vegetable consumption, increased consumption of processed foods, and urbanisation.[10-13]

A study using data from 1942 to 1997 on the causes of death in The Gambian capital Banjul documented the double burden of non-communicable diseases with communicable diseases and malnutrition.[14] In a nationwide assessment among Gambians aged 16 years and above in 1996, 18% were underweight, 8% overweight and 2% obese. [15] A related study in urban and rural communities in The Gambia revealed that 18% of participants were underweight and 4% were obese, with a higher prevalence of obesity (33%) among urban women aged 35 years and above. [16] Both studies confirmed the persistence of the double burden of underweight and overweight in The Gambia, although obesity prevalence was low (but increasing) in those surveys.

The double burden of communicable and non-communicable diseases poses a challenge to governments and families in SSA; The Gambia is no exception. We recently demonstrated a high prevalence of hypertension in The Gambia, with a greater burden in rural areas and among adults classified as obese. [17] Moreover, this demographic double burden has significant implications for wider development concerns. It poses a barrier to poverty alleviation and can hinder the attainment of the UN Sustainable Development Goals (SDGs), particularly Target 3.4, which calls for a reduction in premature mortality due to NCDs by one-third by 2030.[2 18 19] Using the most recent nationally representative data, including objective anthropometric measurements, the aim of this study was to assess the burden of underweight, overweight and obesity among adults (aged 25-64 years) in The Gambia.

Methods

Participants and data collection

Our study is based on secondary analysis of data from the most recent nationally representative population based health examination survey conducted in The Gambia. The study setting and design, sampling, and research instruments have been previously described.[17] Briefly, data were collected from a random sample of adults aged 25-64 years from January to March 2010 using the WHO STEPwise approach.[17 20]The anthropometric measurements were performed by field workers at participants' residences. Weight, height and waist circumference were measured using WHO STEP protocols.[20] The measurements were conducted using standard scales with participants wearing light clothing with foot and head wear removed. Weight was measured to the nearest 0.1kg using digital bathroom scales. Height was measured to the nearest 0.1cm in the standing position, using standard portable stadiometers. Waist circumference was measured (once) to the nearest 0.1cm using a tape measure and was taken midway between the lowest rib and the iliac crest.

Dependent/Outcome variables

The first outcome variable was generalised obesity, defined using body mass index (BMI). We calculated BMI by dividing weight (in kg) by height squared (m^2). We categorised BMI into underweight (BMI <18.5kg/m^2), normal/desirable weight (18.5-24.9kg/m^2), overweight (25.0-29.9kg/m^2) and obese (BMI ≥30kg/m^2), using the WHO thresholds.[21] Secondly, we used abdominal obesity (high waist circumference) as the outcome, defined using the International Diabetes Federation thresholds (≥90 cm in men and ≥80 cm in women).[22]

Independent covariates/predictor variables

The predictor variables included sociodemographic and behavioural risk factors including self-reported age-group, ethnicity, education, residence, fruit and vegetable intake, physical inactivity, and smoking (categories shown in Table S1).

Statistical analysis

The analytical sample was restricted to non-pregnant participants with valid weight and height data (n=3533); complete case analysis was performed as fewer than 1% of adults with valid weight and height had missing information on other variables. We described the participants' sociodemographic characteristics as well as their behavioural risk factors. The prevalence of BMI categories are reported as proportions with their corresponding 95% confidence intervals (CI). We conducted multivariable multinomial logistic regression analysis to identify factors associated with being underweight, overweight and obese separately, comparing each of these categories with the reference group of normal weight. Age-adjusted and fully-adjusted relative risk ratios (ARRR), with their corresponding 95% CIs, are reported. All analyses were stratified by gender, as we expected that the associations between the predictors and outcomes may differ by gender. We did not include smoking (in women) and alcohol consumption (both sexes) in the regression models due to their low prevalence.

Due to the collinearity of the two variables on residence (i.e. local government area and rurality), fully-adjusted models were repeated interchanging these variables. We explored variables that could modify the association between BMI categories and the covariates by fitting interaction terms. There was no evidence of modification (all p>0.05) and hence multinomial regression models without interaction terms are reported. As in other studies, we did not include abdominal obesity in the models for BMI because of the collinearity of waist circumference and BMI.[23]

We explored the factors associated with abdominal obesity (high waist circumference as defined above) by conducting multivariable binary logistic regression analysis. BMI was not included as a predictor in these models because of the aforementioned collinearity of waist circumference and BMI. For abdominal obesity, age-adjusted (OR) and fully-adjusted odds ratios (AOR) with corresponding 95% CI are reported.

All our analyses were weighted for non-response and adjusted for the complex survey design in accordance with WHO STEP wise protocols. Analyses were performed using Stata 15. Ethical approval for the survey was obtained from the National Ethics Committee of The Gambia; participants gave verbal or written consent.

Patient and Public Involvement

Patients and the public are not directly involved in this study. However, the STEP survey on which the data reported in this study is based was population based. All the interviews and anthropometric measurements were conducted at participant's residences. Prior to the survey, people were sensitised about the objectives of the survey and its importance. The sensitisation sessions were done on radio, television, community meeting places etc. Results from the previous analyses have been shared. In addition the results are used by the Ministry of Health of The Gambia in their routine sensitisation campaigns. Like our previous analysis [17], the results of this study will be shared with the public and will also be used to inform policy.

Results

Characteristics of participants

The descriptions of respondents' socio-demographic, behavioural and biological characteristics are presented in Tables S1. The unadjusted mean age was 38.3±10.9 years. More than two-fifths of the participants (44%) were in the youngest age-group (25-34 years), particularly among women (53% vs 33% of men). However, there was no age difference by gender after weighting and adjusting for the complex survey design (P=0.937, Table S1). The adjusted mean BMI was 24.6 kg/m^2 (95% CI 24.1-25.1) and the mean waist circumference was 74.0cm (71.1-76.9). Average levels of BMI and waist circumference were higher among women.

Prevalence of underweight, overweight and obesity

The prevalence of BMI categories by selected socio-demographic and behavioural characteristics are presented for men and women in Tables S2 and S3 respectively. Among men, more than half had a normal/desirable weight (56%, 95% CI 50.8-61.4) and one in ten was underweight (10%, 7.6-12.4). The prevalence of overweight and obesity in men were 26% (21.1-31.6) and 8% (6.0-11.0) respectively (Table S2). Almost a half of women were either overweight (29%, 25.8-31.9) or obese (17%, 14.7-19.7), while 8% (6.1-9.5) were underweight (Table S3). Among both men and women, the prevalence of overweight and of obesity were substantially higher among urban residents, those with a higher level of education, those physically inactive, and those with a high waist circumference. More than 60% of the residents in the capital (Banjul) and the nearby towns (Kanifing Municipality) were either overweight or obese. Obesity was also high among never and ex-smokers in men. The prevalence of abdominal obesity was 10% (CI: 7.8-13.4) in men and 46% (CI: 39.3-52.6) in women (data not shown).

Factors associated with underweight, overweight and obesity

Factors strongly associated with generalised obesity (versus normal/desirable weight) in the multivariable multinomial logistic regressions included older age, ethnicity, higher education and urban residence among both men and women (Tables 1 and 2). Obesity was also associated with low fruit and vegetable consumption (adjusted relative risk ratio (ARRR) 2.8, 95% CI: 1.1-6.8) in men. All these variables with the exception of ethnicity in men were also strongly associated with overweight (versus normal weight), while current smoking was inversely associated with overweight (0.5, 0.4-0.7). Compared with rural residents, the associations of overweight and obesity among urban residents were three- and six-fold higher respectively in men (overweight 2.8, 1.5-5.0; obesity 5.8, 2.4-14.5) and three- and five-fold higher in women (overweight 3.1, 1.9-5.0; obesity 4.7, 2.7-8.2). Physical inactivity was strongly associated with obesity among both men and women in the age-adjusted models but not in the fully-adjusted models, although the direction of the association remained unchanged (Tables 1 and 2).

Table 1: Multinomial logistic regression on factors associated with being underweight, overweight or obese in men [a, b]

	Model I (Age adjusted)			Model II (Fully adjusted)		
	Underweight	**Overweight**	**Obese**	**Underweight**	**Overweight**	**Obese**
Variable	**RRR(95% CI)[c]**	**RRR(95% CI)[c]**	**RRR(95% CI)[c]**	**ARRR (95% CI)[c]**	**ARRR (95% CI)[c]**	**ARRR (95% CI)[c]**
Age Group						
25 -34	Reference	Reference	Reference	Reference	Reference	Reference
35-44	0.69(0.40-1.17)	1.61(1.22-2.12)***	0.95(0.56-1.62)	0.75(0.42-1.36)	[illegible]0(1.38-2.90)***	1.58(0.75-3.33)
45-54	0.97(0.52-1.81)	1.63(1.06-2.52)*	2.06(1.22-3.48)**	1.31(0.66-2.59)	[illegible]1(1.33-3.67)**	3.42(1.83-6.37)***
55-64	0.67(0.37-1.21)	0.96(0.59-1.56)	1.21(0.56-2.57)	0.81(0.43-1.52)	[illegible]3(0.63-2.03)	2.88(1.22-6.80)**
Ethnicity						
Mandinka	Reference	Reference	Reference	Reference	Reference	Reference
Wollof	1.15(0.65-2.03)	1.48(0.93-2.35)	1.85(1.06-3.23)*	1.17(0.66-2.08)	[illegible]4(0.83-2.18)	1.62(1.04-2.53)*
Fula	0.71(0.41-1.24)	0.93(0.64-1.35)	1.09(0.49-2.39)	0.46(0.24-0.88)*	[illegible]5(0.77-1.72)	0.80(0.34-1.87)
Jola	0.67(0.38-1.18)	0.79(0.45-1.39)	1.05(0.45-2.45)	0.66(0.39-1.13)	[illegible]3(0.56-1.89)	1.29(0.56-2.94)
Others	0.44(0.19-1.04)	0.91(0.51-1.65)	2.56(1.26-5.20)**	0.37(0.14-0.96)*	[illegible]2(0.45-1.88)	1.97(0.71-5.43)
Years spent in school						
≤6 Years	Reference	Reference	Reference	Reference	Reference	Reference
7-12 Years	1.19(0.76-1.87)	1.56(1.06-2.31)*	2.54(1.37-4.72)**	1.26(0.75-2.11)	1.[illegible]8(0.81-2.01)	1.24(0.56-2.75)
>12 Years	0.48(0.23-1.00)	1.82(1.12-2.96)**	3.19(1.45-7.02)**	0.50(0.23-1.09)	1.[illegible]6(1.02-2.71)*	2.29 (1.16-4.53)**
Residence (Rurality)						
Rural	Reference	Reference	Reference	Reference	Reference	Reference
Semi urban	0.97(0.37-2.53)	2.05(0.95-4.43)	4.14(1.53-11.19)**	0.70(0.29-2.11)	1.[illegible]2(0.70-3.80)	1.58(0.45-5.56)
Urban	1.18(0.71-1.96)	2.52(1.49-4.27)***	5.03(2.20-11.47)***	1.35(0.81-2.23)	2.[illegible]6(1.52-5.01)***	5.83(2.35-14.50)***
Smoking						
Never smokers	Reference	Reference	Reference	Reference	Reference	Reference
Current smokers	1.71(1.18-2.48)**	0.53(0.38-0.74)***	0.52(0.32-0.84)***	1.48(0.97-2.27)	0.[illegible]2(0.36-0.74)***	0.61(0.34-1.11)
Ex-smokers	1.71(0.97-3.02)	0.81(0.47-1.40)	0.58(0.26-1.32)	1.86(1.07-3.24)*	0.[illegible]5(0.38-1.48)	0.58(0.21-1.63)
Servings of fruit and veg						
≥ 5/day	Reference	Reference	Reference	Reference	Reference	Reference
< 5/day	1.31(0.80-2.14)	1.38(0.86-2.22)	1.50(0.74-3.06)	1.38(0.79-2.38)	1.[illegible]4(1.06-2.87)*	2.75(1.12-6.75)*
Physical Activity [d]						
≥600METS/week	Reference	Reference	Reference	Reference	Reference	Reference
<600METS/week	0.58(0.25-1.36)	1.46(0.86-2.48)	3.02(1.78-5.13)***	0.92(0.31-2.69)	1.[illegible]0(0.53-2.73)	2.23 (0.87-5.70)

Note: Data shown have been weighted for non-response and the analysis took into account the complex survey design.

Fully adjusted models mutually adjusted for the variables shown in the table

[a] BMI is categorised into underweight (BMI<18.5kg/m^2), normal (18.5-24.9 kg/m^2, the reference group), overweight (25.0-29.9kg/m^2) and obese (BMI ≥30kg/m^2).
[b] Those with a desirable weight (normal) used as reference

[c] RRR= Relative Risk Ratio adjusted for age (except for age group as the independent variable), ARRR= Fully Adjusted Relative Risk Ratio
[d] METS =Metabolic equivalents
*$p<0.05$, **$p\leq0.01$, *** $p\leq0.001$

Table 2: Multinomial logistic regression on factors associated with generalised underweight, overweight and obesity in women [a, b]

	Model I (Age adjusted)			Model II (Fully adjusted)		
	Underweight	**Overweight**	**Obese**	**Underweight**	**Overweight**	**Obese**
Variable	**RRR(95% CI)**[c]	**RRR(95% CI)**[c]	**RRR(95% CI)**[c]	**ARRR (95% CI)**[c]	**ARRR (95% CI)**[c]	**ARRR (95% CI)**[c]
Age Group						
25 -34	Reference	Reference	Reference	Reference	Reference	Reference
35-44	0.85(0.55-1.31)	1.16(0.83-1.61)	1.67(1.10-2.54)*	0.79(0.52-1.19)	1.37(0.93-2.01)	2.25(1.31-3.85)**
45-54	0.92(0.50-1.71)	1.42(1.01-1.99)*	1.65(1.00-2.73)	0.88(0.48-1.62)	1.98(1.33-2.96)***	2.66(1.43-4.94)**
55-64	2.09(1.04-4.18)*	1.82(1.03-3.24)*	4.04(2.20-7.39	2.30(1.10-4.80)*	2.81(1.58-4.99)***	4.90(2.44-9.82)***
Ethnicity						
Mandinka	Reference	Reference	Reference	Reference	Reference	Reference
Wollof	0.64(0.32-1.25)	1.31(0.80-2.16)	2.07(1.19-3.61)**	0.69(0.36-1.29)	1.19(0.75-1.87)	1.50(0.90-2.48)
Fula	1.03(0.60-1.78)	1.43(1.01-2.00)*	1.51(0.94-2.41)	0.87(0.47-1.58)	1.69(1.20-2.38)**	1.78(1.09-2.92)*
Jola	1.15(0.64-2.08)	1.14(0.72-1.82)	1.68(0.92-3.07)	1.01(0.57-1.77)	0.98(0.64-1.51)	1.10(0.66-1.84)
Others	0.63(0.31-1.27)	1.54(0.96-2.47)	1.57(0.84-2.92)	0.34(0.14-0.80)**	1.33(0.78-2.28)	1.21(0.62-2.36)
Years spent in school						
≤6 Years	Reference	Reference	Reference	Reference	Reference	Reference
7-12 Years	0.10(0.58-1.69)	1.93(1.31-2.85)***	2.93(1.85-4.64)***	1.12(0.63-1.99)	1.31(0.87-1.95)	1.67(1.00-2.77)*
>12 Years	1.37(0.46-4.14)	3.09(1.53-6.22)**	3.47(1.37-8.89)**	1.93 (0.52-7.18)	2.40(1.10-5.20)*	2.58(1.05-6.36)*
Residence (Rurality)						
Rural	Reference	Reference	Reference	Reference	Reference	Reference
Semi urban	0.47(0.29-0.75)**	2.52(1.75-3.63)***	2.75(1.71-4.43)**	0.54(0.31-0.95)*	2.31(1.46-3.65)***	2.25(1.22-4.14)**
Urban	0.68(0.41-1.13)	3.03(2.06-4.46)***	5.06(3.24-7.90)***	0.84(0.46-1.55)	3.05(1.86-5.01)***	4.71(2.72-8.15)***
Servings of fruits and vegs						
≥ 5/day	Reference	Reference	Reference	Reference	Reference	Reference
< 5/day	0.71(0.41-1.24)	1.03(0.73-1.46)	0.95(0.62-1.46)	0.65(0.37-1.15)	1.10(0.73-1.66)	1.13(0.74-1.75)
Physical Activity [d]						
≥600METS/week	Reference	Reference	Reference	Reference	Reference	Reference
<600METS/week	0.81(0.42-1.54)	1.32(0.83-2.11)	1.67(1.08-2.58)*	1.1.9(0.58-2.44)	1.07(0.63-1.82)	1.02(0.55-1.91)

Note: Data shown have been weighted for non-response and the analysis took into account the complex survey design.
Fully adjusted models mutually adjusted for the variables shown in the table

[a] BMI is categorised into underweight (BMI<18.5kg/m²), normal (18.5-24.9 kg/m², the reference group), overweight (25.0-29.9kg/m²) and obese (BMI ≥30kg/m²).
[b] Those with a desirable weight(normal) used as reference ; [c]RRR= Relative Risk Ratio adjusted for age (except for age group as the independent variable), ARRR= Fully Adjusted Relative Risk Ratio ; [d] METS =Metabolic equivalents . *p<0.05, **p≤0.01, *** p≤0.001

No strong associations were found for underweight (versus normal weight) in men except an increased ARRR among ex-smokers (ARRR 1.9, 1.1-3.2) and an inverse association with being Fula (0.5, 0.2-0.9) or minority ethnicity (0.4, 0.1-1.0) compared with being Mandinka (Table 1). Among women, the risk of being underweight (versus normal weight) was higher among those aged 55-64 years compared with those aged 25-34 years (2.3, CI: 1.1-4.8) and was inversely related with semi-urban residence compared with rural residence (0.5, 0.3-1.0) and to minority ethnicity compared with Mandinka (0.3, 0.1-0.8) (Table 2).

Factors associated with abdominal obesity

In the fully-adjusted multivariable binary logistic regression model, older age, residence, low fruit and vegetable intake (men only) and being an ex-smoker compared with never smoking (men only) were strongly associated with higher odds of abdominal obesity (Table 3). Semi-urban residence (adjusted odds ratio (AOR) 0.4, 95% CI: 0.2-0.9) compared with rural residence, and low fruit and vegetable intake (0.6, 0.4-0.9) compared with the recommended intake of at least five servings a day, were inversely associated with the odds of abdominal obesity among men. Older age (3.2, 2.1-4.9) compared with younger age, and semi-urban residence (2.1, 1.2-3.7) compared with rural residence, were associated with higher odds of abdominal obesity among women (Table 3).

Table 3: Multivariate logistic regression on factors associated with high waist circumference (abdominal obesity)[a]

	Men			Women		
	Model I [b]	**Model II [b]**	**Model III [b]**	**Model I [b]**	**Model II [b]**	**Model III [b]**
Variable	**OR(95% CI) [c]**	**AOR (95% CI) [c]**	**AOR (95% CI) [c]**	**OR(95% CI) [c]**	**AOR (95% CI) [c]**	**AOR (95% CI) [c]**
Age Group						
25 -34	Reference	Reference	Reference	Reference	Reference	Reference
35-44	1.63(1.08-2.47)*	2.04(1.21-3.43)**	1.62(0.96-2.74)	2.06(1.52-2.80)***	2.1[illegible](1.60-2.92)***	2.04(1.49-2.77)***
45-54	1.89(1.19-3.00)**	2.50(1.41-4.43)**	1.97 (1.14-3.38)**	1.91(1.38-2.65)***	1.91(1.34-2.72)***	1.91(1.33-2.74)***
55-64	2.26(1.36-3.75)**	2.24(1.16-4.34)*	1.90(0.96-3.75)	3.57(2.32-5.49)***	3.32(2.07-5.56)***	3.19(2.09-4.87)***
Ethnicity						
Mandinka	Reference	Reference	Reference	Reference	Reference	Reference
Wollof	1.12(0.43-2.90)	1.11(0.51-2.43)	1.06(0.40-2.78)	0.92(0.58-1.46)	1.01(0.64-1.58)	0.81(0.51-1.28)
Fula	0.96(0.49-1.91)	1.05(0.51-2.15)	0.90(0.45-1.76)	0.79(0.55-1.13)	0.8[illegible](0.55-1.21)	0.69(0.48-0.99)*
Jola	1.22(0.60-2.51)	0.86(0.41-1.80)	1.02(0.49-2.12)	0.94(0.62-1.42)	0.82(0.49-1.36)	0.97(0.62-1.53)
Others	0.81(0.38-1.74)	0.71(0.30-1.67)	0.63(0.27-1.44)	0.58(0.33-1.01)	1.00(0.54-1.84)	0.74(0.43-1.28)
Years spent in school						
≤6 Years	Reference	Reference	Reference	Reference	Reference	Reference
7-12 Years	0.96(0.58-1.59)	0.97(0.60-1.59)	0.86(0.50-1.46)	0.84(0.59-1.20)	1.10(0.78-1.55)	0.81(0.61-1.09)
>12 Years	1.21(0.65-2.28)	1.25(0.68-2.31)	1.06(0.58-1.97)	0.75(0.32-1.76)	0.92(0.37-2.24)	0.82(0.32-2.06)
Residence (Local government area) [d]						
LRR	Reference	Reference		Reference	Reference	
CRR	1.75(0.32-9.53)	1.92(0.44-8.32)		0.89(0.33-2.41)	1.20(0.45-3.18)	
NBR	1.94(0.66-5.65)	1.63(0.55-4.85)		1.18(0.64-2.20)	1.08(0.57-2.06)	
URR	0.08(0.01-0.65)**	0.14(0.02-0.98)*		0.24(0.11-0.51)***	0.26(0.11-0..65)**	
WCR	2.66(1.02-6.96)	2.43(0.94-6.32)		1.62(0.83-3.15)	1.59(0.79-3.20)	
Banjul & KM	0.71(0.25-2.03	0.71(0.24-2.07)		0.32(0.15-0.71)	0.37(0.14-1.00)	
Residence (Rurality)						
Rural	Reference		Reference	Reference		Reference
Semi urban	0.32(0.12-0.82)**		0.36(0.15-0.90)*	1.53(0.75-3.10)		2.11(1.21-3.68)**
Urban	0.89(0.45-1.75)		0.82(0.41-1.65)	0.82(0.49-1.37)		0.97(0.58-1.62)
Smoking						
Never smokers	Reference	Reference	Reference			
Current smokers	0.72(0.42-1.26)	0.49(0.28-0.86)**	0.60(0.35-1.03)			

	Men			Women		
	Model I [b]	**Model II [b]**	**Model III [b]**	**Model I [b]**	**Model II [b]**	**Model III [b]**
Variable	**OR(95% CI) [c]**	**AOR (95% CI) [c]**	**AOR (95% CI) [c]**	**OR(95% CI) [c]**	**AOR (95% CI) [c]**	**AOR (95% CI) [c]**
Ex-smokers	1.44(0.92-2.27)	1.24(0.81-1.91)	1.56(1.04-2.36)*			
Servings of fruit and vegetables						
≥ 5/day	Reference	Reference	Reference	Reference	Reference	Reference
< 5/day	0.63(0.40-0.99)*	0.61(0.37-1.01)	0.59(0.37-0.93)*	0.95(0.64-1.42)	0.86(0.50-1.49)	0.81(0.48-1.20)
Physical Activity [e]						
<600METS/week	Reference	Reference	Reference	Reference	Reference	Reference
≥600METS/week	0.78(0.37-1.63)	1.81(0.81-4.06)	1.52(0.65-3.57)	0.64(0.32-1.30)	1.4[illegible](0.81-2.62)	1.22(0.71-2.10)

Note: Data shown have been weighted for non-response and the analysis took into account the complex survey design.

[a]Based on the definition of the International Diabetes Federation (High waist circumference, indicating abdominal obesity defined as ≥90 cm in men or ≥80 cm in women)
[b] Model I adjusted for age only; Model II adjusted for all variables except local government area; Model III adjusted for all variables except rurality
[c] OR= odds ratio adjusted for age (except for age group as the independent variable); AOR= Adjusted odds ratio (fully adjusted).
[d]KM=Kanifing Municipality; WCR =West Coast Region; LRR= Lower River Region; NBR =North Bank Region; CRR = Central River Region; URR =Upper River Region
[e] METS =Metabolic equivalents
*p<0.05, **p≤0.01, *** p≤0.001

Discussion

This study has shown that the burden of overweight and obesity is high in The Gambia, especially among women (29% and 17% respectively) and urban residents. No precise quantification of changes over time in prevalence can be made since the only previous nationwide study was based on a different age cohort. [15] Nevertheless, we can reasonably assume that the prevalence of obesity has increased substantially in The Gambia within a period of less than 15 years. Almost half of women and more than one-third of men aged 25-64 years were either overweight or obese in 2010 while the prevalence of overweight and obesity in 1996 were 8% and 2% respectively among participants aged 16 years and above. The prevalence of underweight, however, halved from 18% in 1996 to 9% in this study. This shows an increasing shift from malnutrition/underweight to overweight and obesity among Gambian adults. These changes reflect shifts in growing economic progress, modernization of household tasks, improved transportation and increasing urbanization.

The prevalence of obesity in The Gambia is more than double the levels reported in similar national WHO STEPwise surveys conducted in Malawi [24], Eritrea [25] and Mozambique [26 27] but is less than that reported in The Republic of Seychelles. [28] The high prevalence of obesity in The Gambia is a cause for concern, given the increasing burden of NCDs, notably hypertension. [17]Although higher in urban areas, generalised obesity is now a problem in both urban and rural areas in The Gambia, in contrast to the evidence from previous studies.[15 16] Despite the health risks associated with overweight/obesity, Gambians are culturally obesity tolerant. [29 30]It has been well documented that perceptions of body weight vary across different parts of the world. [31 32]In some parts of SSA, being overweight is not perceived as a risk factor for NCDs but rather is perceived as a sign of beauty, wealth, success and prestige; such cultural beliefs encourage obesity. [31 32] This is the case in The Gambia.; a study on the perception of body image and attractiveness among adults in urban areas in The Gambia demonstrated high satisfaction with big body image (overweight), especially among women. [29] A cross-cultural comparison using published data on Figure Rating Scales found that Gambians' rating of a 'normal' weight were bigger than those of North Americans, and that Gambians were more tolerant of obesity than white and African-Americans. [29] A related study also conducted in The Gambia showed that weight gain was not associated with weight concern, as 68% of those overweight and 37% of those obese did not perceive themselves to be overweight/obese. [30] Findings from other SSA countries have indicated that women tend to frame fatness as a symbol of wealth, as has been found for example, in Senegal [33 34] and in Zambia. [35] Associating overweight/obesity with beauty and prestige/wealth renders the burden of obesity a silent epidemic, as many people in The Gambia do not consider it a risk or want to address it.

Our models showed that older age, ethnicity, higher education, and urban residence in both genders, and low fruit and vegetable intake and smoking in men, were strongly associated with the risks of overweight and obesity (versus normal weight). Evidence links urbanisation and the increasing burden of obesity and other NCDs, especially in low income countries. [36-39] Higher education was also significantly associated with overweight and obesity in our study. In The Gambia highly educated adults are more likely to be in office jobs, which are mostly sedentary. Physical inactivity was strongly associated with obesity in the age-adjusted regression models among both men and women. However this relationship became statistically insignificant after full-adjustment for social and demographic factors, suggesting that social and demographic factors may be confounding the relationship between physical inactivity and obesity. Leisure-time physical activity was low among the study participants; only 12% of adults in the present study reported engaging in any form of leisure time activity:

most of the physical activity reported was therefore work- and transport-related. Judging from the data, participants with a higher level of education therefore had lower levels of physical activity and hence were more prone to obesity. There is evidence suggesting that increases in the level of physical activity and/or exercise interventions whether supervised or not has a positive impact on BMI and overall health. [40] Our data suggests that leisure time physical activity is low in The Gambia.the Ministry of Health and Social Welfare of The Gambia and its stakeholders should promote physical activity at the individual and population levels. As the promotion of physical activity, especially at the population level, is multidisciplinary, it should be done in collaboration with other government line ministries, municipalities, community based organisations and non-governmental organisations. The goal of the recent WHO Global action plan on physical activity 2018-2030 ('more active people for a healthier world') is to reduce the global prevalence of physical inactivity by 15% by 2030. [41] Our findings support the advisability of the Ministry of Health of The Gambia incorporating this in its national health policy and/or the NCDs policy and strategic plan.

Low fruit and vegetable intake (defined as having fewer than five combined servings a day) was associated with obesity in our study, especially among men. There is a strong linkage between low fruit and vegetable consumption and increased NCD risk. Regular consumption of fruits and vegetables may help prevent unhealthy weight gain, especially when taken as part of a healthy diet. [42 43] A systematic analysis for the Global Burden of Diseases study in 2010 attributed more than 6 million deaths globally to inadequate consumption of fruits and vegetables. [44] An additional finding from our data is that the consumption of fruits and vegetables was low consumption of fruits and vegetables as part of a healthy diet should be widely promoted. Future surveys to monitor overweight/obesity in The Gambia should include a more comprehensive assessment of diet than that collected in the 2010 survey.

Only being an ex-smoker in men and older age in women were positively associated with being underweight (versus normal weight) in the fully-adjusted analyses. Semi-urban residents were less likely to be underweight rather than normal weight compared with rural residents. The association of underweight with being an ex-smoker might be at least partly explained by the associations of both with ill-health. It is possible that ex-smokers were advised to quit smoking because of their illness. Moreover, the association of underweight with older age in women could also be associated with age-related illnesses. Poverty, especially in rural areas, may explain the inverse association of underweight with semi-urban compared with rural residence among women.

A potential positive finding from this study is that higher rates of obesity are found among those with higher incomes, more education and more urban based members of the population, the very people who may be most effectively reached by public health campaigns.

Strengths and limitations of this study

This study presents the most recent nationally-representative data on obesity among adults in The Gambia. It gives a better picture of the true burden of obesity in the country and hence could serve as baseline study from which future changes can be assessed. The complex sampling strategy and the stringent WHO STEP protocols applied in collecting the data, particularly the use of measurements taken by trained field staff instead of a reliance on self-reported anthropometric data, minimised biases.

Our main limitation is the cross-sectional nature of the study, which prevents attribution of causality to the associations. However, it does identify population sub-groups to prioritise with health promotion measures. There is a possibility of misclassifying obesity in people who are physically active and have large muscle mass. For this reason we explored abdominal obesity as an additional outcome variable. 3% of the participants who took part in the physical measurements did not have valid weight and height measurements, which could have led to non-response bias. However, we compared the two groups and there were no systematic differences between those with and without valid anthropometric measurements (data not shown). The survey did not collect self-reported measures on beliefs about body size and weight management, which are important in The Gambian context to assess and monitor trends on beliefs and practices.

Conclusion

This study reveals a high prevalence of obesity among Gambian adults, while the burden of underweight in this population may be decreasing. There are socio-cultural norms that promote overweight, especially among women. Preventive strategies should be directed at raising awareness of the importance of achieving and maintaining a healthy weight; discouraging harmful socio-cultural practices and beliefs about weight; and the promotion of healthy diet and regular physical activity during leisure-time, particularly in urban areas and among women.

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Conflict of interest

The authors have no conflict of interest to declare.

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Author Contributions

BC conceptualised the paper, analysed the data and wrote the first draft of the manuscript. J.S.M, SS, N.E.G and L.N.F revised the work critically for important academic content. OB supervised the survey data collection process and contributed in the revision of the manuscript. All the authors approve the final version of the manuscript

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Supplementary Table 1: Characteristics of study participants by selected demographic, behavioural and biological risk factors

Variable	Men %(95% CI) 1611	Women %(95% CI) 1922	Total %(95% CI) 3533
Gender			
Men			50.2(47.6-52.9)
Women			49.8(47.1-52.4)
Age Group			
25 -34	46.8(42.8-50.8)	45.9(42.8-49.1)	46.3(43.9-48.8)
35-44	26.5(24.0-29.2)	27.0(24.3-29.8)	26.7(24.9-28.7
45-54	16.8(14.7-19.2)	17.6(15.7-19.6)	17.2(15.8-18.7)
55-64	9.9(8.2-11.9)	9.6(7.5-12.1)	9.7(8.2-11.5)
	P<0.937		
Mean age	37.8(37.0-38.6)	37.6(36.8-38.3)	37.7(37.1-38.2)
Marital Status			
Never married	22.6(20.1-25.2)	7.3(5.7-9.4)	15.0(13.4-16.7)
Married	66.4(59.8-72.3)	70.8(63.2-77.4)	68.6(61.9-74.6)
Separated/divorced	2.3(1.7-3.3)	4.8(3.8-6.0)	3.5(2.9-4.4)
Widowed	0.3(0.1-0.9)	5.5(4.2-7.3)	2.9(2.2-3.8)
Cohabiting	8.4(4.3-15.9)	11.6(5.9-21.5)	10.0(5.2-18.5)
	P<0.001		
Ethnicity			
Mandinka	42.1(36.9-47.6)	39.3(33.4-45.6)	40.7(35.6-46.0)
Wollof	16.2(12.1-21.4)	16.1(12.4-20.5)	16.2(12.5-20.7)
Fula	20.7(17.1-25.0)	18.5(15.1-22.4)	19.6(16.4-23.3)
Jola	12.2(8.2-17.8)	15.1(11.1-20.2)	13.6(9.8-18.6)
Other	8.7(6.6-11.5)	11.1(8.5-14.4)	9.9(7.8-12.5)
	P=0.104		
Years spent in school			
≤6 Years	55.0(50.5-59.5)	74.3(69.4-78.6)	64.3(60.1-68.2)
7-12 Years	31.5(28.1-35.2)	22.4(18.7-26.6)	27.1(24.2-30.3)
>12 Years	13.4(11.2-16.0)	3.4(2.3-4.9)	8.6(7.2-10.2)
	P<0.001		
Residence (Local government area) [a]			
Banjul	7.8(2.5-21.9)	7.1(2.2-21.0)	7.5(2.4-20.7)
KMC	23.2(15.1-33.9)	28.2(18.9-39.8)	25.7(17.2-36.6)
WCR	35.7(24.3-48.8)	30.9(20.6-45.5)	33.3(22.6-46.0)
LRR	7.6(3.3-16.8)	7.9(3.4-17.6)	7.8(3.4-16.9)
NBR	8.2(4.4-14.6)	10.3(5.6-18.11)	9.2(5.1-16.3)
CRRN	2.5(0.7-8.9)	2.8(0.7-9.9)	2.7(0.7-9.4)
CRRS	6.1(2.5-14.2)	6.4(2.6-14.7)	6.3(2.6-14.2)
URR	8.9(4.1-18.2)	6.4(2.8-14.1)	7.7(3.5-16.0)
	P=0.131		
Residence (Rurality)			
Urban	57.7(48.2-66.6)	56.8(47.8-65.4)	57.2(48.3-65.7)
Semi urban	8.7(4.3-17.0)	6.8(3.1-14.4)	7.8(3.7-15.5)
Rural	33.6(27.4-40.5)	36.4(29.8-43.6)	35.0(28.9-41.7)
	P=0.187		
Physical Activity [b]			
≥600METS/week	88.9(84.0-92.5)	80.2(72.1-86.4)	84.6(78.2-89.3)
< 600METS/week	11.1(7.5-16.1)	19.8(13.6-27.9)	15.4(10.7-21.8)
	P<0.001		
Smoking			
Never smokers	57.3(52.3-62.1)	98.1(96.9-98.8)	77.6(74.2-80.6)

Variable	Men %(95% CI) 1611	Women %(95% CI) 1922	Total %(95% CI) 3533
Current smokers	33.0(29.0-37.2)	1.2(0.7-1.8)	17.2(14.8-19.8)
Ex-smokers	9.8(7.7-12.4)	0.8(0.3-1.7)	5.3(4.1-6.9)
	P<0.001		
Servings of fruits and vegetables			
≥5 /day	24.0(18.2-30.9)	23.8(18.1-30.6)	23.9(18.4-30.4)
< 5/day	76.0(69.1-81.9)	76.2(69.4-81.9)	76.1(69.6-81.6)
	P= 0.934		
BMI[c]			
Underweight	56.2(50.8-61.4)	46.6(42.8-50.5)	51.4(47.6-55.2)
Normal	9.7(7.6-12.4)	7.6(6.19.5)-	8.7(7.2-10.4)
Overweight	26.0(21.1-31.6)	28.8(25.8-31.9)	27.4(24.0-31.1)
Obese	8.1(6.0-11.0)	17.0(14.7-19.7)	12.6(10.5-14.9)
	P<0. 001		
Mean height (cm)	166.9(165.1-168.7)	160.5(159.5-161.5)	163.7(162.4-165.0)
Mean weight (kg)	65.2(64.1-66.3)	65.5(63.8-67.3)	65.4(64.2-66.5)
Mean BMI(kg/m^2)	23.6(23.1-24.1)	25.6(24.9-26.3)	24.6(24.1-25.1)
Waist circumference [d]			
Normal	89.7(86.7-92.2)	54.2(47.4-60.7)	72.3(67.8-76.3)
High	10.3(7.8-13.4)	45.9(39.3-52.6)	27.7(23.7-32.2)
Mean waist circumference	72.1(65.1-75.0)	76.0(72.9-79.1)	74.0(71.1-76.9)
Waist-to-Hip Ratio [e]			
Normal	83.2(79.4-86.4)	60.6(54.8-66.1)	72.1(68.1-75.8)
High	16.8(13.6-20.6)	39.4(33.9-45.2)	27.9(24.2-31.9)
	P<0.001		
Waist-Height Ratio			
Normal (≤0.5)	81.9(77.9-85.4)	59.9(53.2-66.3)	71.1(66.2-75.6)
High (>0.5)	18.1(14.6-22.1)	40.1(33.7-46.8)	28.9(24.4-33.8)
	P<0.001		
Mean Hip Circumference (cm)	89.3(87.0-91.6)	94.2(92.1-96.3)	91.7(89.7-93.8)

Note: Data shown have been weighted for non-response and the analysis took into account the complex survey design.

[a] KM=Kanifing Municipality; WCR =West Coast Region; LRR= Lower River Region; NBR =North Bank Region; CRRN = Central River Region North, CRRS=Central River Region South; URR =Upper River Region

[b] METS =Metabolic equivalents

[c] BMI is categorised into underweight (BMI<18.5kg/m^2), normal (18.5-24.9 Kg/m^2), overweight (25.0-29.9kg/m^2) and obese (BMI ≥30kg/m^2).

[d] Based on the definition of the International Diabetes Federation (High waist circumference, indicating abdominal obesity defined as ≥90 cm in men or ≥80 cm in women)

[e] Based on the WHO definitions (high WHR defined as >0.90 in men and >85 in women)

NB: The p value indicates the statistical significance of the difference in proportions between men and women obtained using Pearson's chi-squared test

Supplementary Table 2: Prevalence of BMI categories by selected socio-demographic, behavioural and biological factors in men [a, b, c]

Variable	Normal (desirable) %(95% CI)	Underweight %(95% CI)	Overweight %(95% CI)	Obese %(95% CI)	χ^2 P value
Total	56.2(50.8-61.4)	9.7(7.6-12.4)	26.0(21.1-31.6)	8.1(6.0-11.0)	
Age Group					
25 -34	59.0(52.2-65.6)	11.6(8.4-15.9)	22.0(16.3-29.0)	7.3(4.9-10.7)	**0.003**
35-44	54.0(47.3-60.6)	7.3(4.9-10.8)	32.4(25.7-39.8)	6.4(4.1-9.7)	
45-54	48.7(40.5-56.9)	9.3(5.7-14.8)	29.6(23.4-36.7)	12.4(8.8-17.3)	
55-64	61.0(53.4-68.1)	8.0(5.1-12.3)	21.8(16.0-29.0)	9.1(4.6-17.4)	
Marital status					
Never married	55.1(45.1-64.7)	11.9(7.4-18.4)	24.3(16.0-35.2)	8.7(4.8-15.2)	0.222
Married	56.1(50.7-61.4)	7.9(6.0-10.4)	27.7(23.1-32.9)	8.2(5.8-11.6)	
Separated	49.6(34.1-65.2)	14.6(5.7-32.4)	32.1(19.4-48.0)	3.8(0.8-15.6)	
Widowed	63.3(17.6-93.3)	36.8(6.7-82.4)	0.0	0.0	
Cohabiting	60.4(48.7-71.0)	16.3(8.6-29.0)	16.2(9.6-25.8)	7.1(3.5-13.9)	
Ethnicity					
Mandinka	56.8(50.5-62.8)	11.5(8.6-15.1)	25.5(19.1-33.1)	6.3(4.1-9.6)	**0.042**
Wollof	46.8(38.0-55.8)	10.8(6.2-17.9)	32.3(24.4-41.4)	10.2(6.2-16.4)	
Fula	59.1(50.8-66.9)	8.4(5.3-13.1)	25.2(18.3-33.5)	7.3(4.2-12.2)	
Jola	62.6(52.8-71.4)	8.2(4.7-14.1)	22.1(15.3-30.8)	7.1(3.5-13.9)	
Others	55.0(45.2-64.4)	4.8(2.3-9.9)	23.8(16.0-33.7)	16.5(9.8-26.4)	
Residence (LGA) [d]					
Banjul & KM	33.4(25.4-42.8)	3.2(1.7-6.0)	47.2(37.6-57.0)	16.2(11.0- 23.1)	**<0.001**
WCR	68.5(63.5-73.2)	15.3(11.7-19.7)	11.9(9.0-15.4)	4.4(2.9-6.6)	
URR	49.6(38.9-60.3)	4.2(2.0-8.6)	32.4(26.1-39.3)	13.8(8.9-20.9)	
NBR	65.6(54.9-74.9)	13.9(9.1-20.6)	19.1(13.0-27.1)	1.5(1.6-3.4)	
CRR	67.1(54.1-77.9)	15.5(9.6-23.9)	15.6(10.1-23.4)	1.9(0.7-4.4)	
LRR	75.9(62.0-85.9)	5.7(3.0-10.7)	17.9(8.5-34.0)	0.5(0.1-3.1)	
Residence (Rurality)					
Urban	49.1(41.2-57.1)	9.2(6.2-13.5)	30.9(23.2-39.9)	10.7(7.4-15.4)	**0.001**
Semi urban	54.1(40.1-67.5)	8.4(3.3-19.5)	27.7(17.6-40.8)	9.8(4.7-19.1)	
Rural	68.8(62.6-74.3)	10.9(8.1-14.6)	17.1(13.0-22.2)	3.2(1.8-5.6)	
Education level					
No formal education	59.4(54.4-64.1)	9.3(7.1-12.0)	24.9(20.5-29.8)	6.5(4.6-9.3)	**0.007**

Variable	Normal (desirable) %(95% CI)	Underweight %(95% CI)	Overweight %(95% CI)	Obese %(95% CI)	χ^2 P value
Primary/ Middle	61.3(51.9-69.9)	13.4(8.3-21.0)	19.4(13.4-27.4)	5.9(3.0-11.2)	
Secondary/Tertiary	47.7(38.6-56.9)	8.0(4.6-13.7)	32.1(23.6-42.1)	12.1(8.2-17.7)	
Years spent in school					
≤6 Years	60.5(55.7-65.1)	9.4(7.3-12.1)	23.7(19.6-28.3)	6.4(4.6-8.9)	**0.003**
7-12 Years	49.7(41.7-57.8)	13.3(8.6-19.9)	27.9(20.1-37.2)	9.1(5.8-14.1)	
>12 Years	48.5(35.4-61.7)	4.3(2.2-8.5)	34.3(24.8-45.3)	12.9(7.1-22.4)	
Smoking					
Never smokers	53.1(46.8-59.3)	7.0(5.1-9.7)	30.1(24.3-36.7)	9.8(6.8-13.8)	**<0.001**
Current smokers	61.6(54.8-68.1)	13.8(11.0-17.3)	18.8(13.5-25.4)	5.8(3.9-8.7)	
Ex-smokers	55.5(46.8-63.9)	11.8(6.7-20.0)	26.4(18.3-36.6)	6.3(3.2-12.1)	
Servings of fruits and vegs					
≥ 5/day	61.8(54.1-68.8)	9.1(6.5-12.7)	23.3(17.7-29.9)	5.8(3.5-9.6)	0.321
< 5/day	54.1(47.2-60.8)	10.5(7.6-14.3)	27.8(21.5-35.1)	7.8(5.1-10.1)	
Physical Activity [e]					
<600METS/week	46.5(36.3-57.0)	4.7(2.3-9.4)	31.3(22.7-41.4)	17.5(11.5-25.7)	**<0.001**
≥600METS/week	56.8(51.0-62.3)	10.5(8.1-13.5)	25.7(20.2-32.0)	7.1(5.2-9.7)	
Waist circumference [f]					
Normal	57.4(51.3-63.2)	10.9(8.4-14.1)	24.2(18.6-30.7)	7.6(5.3-10.7)	**<0.001**
High	43.2(34.4-52.4)	1.5(0.5-4.7)	41.5(33.2-50.3)	13.8(8.8-21.6)	

Note: Data shown have been weighted for non-response and the analysis took into account the complex survey design.

[a] BMI is categorised into underweight (BMI<18.5kg/m^2), normal (18.5-24.9 kg/m^2), overweight (25.0-29.9kg/m^2) and obese (BMI≥30kg/m^2).
[b] Results adjusted for complex survey design and weighted for non-response
[c] Row percentages are presented, i.e the prevalence of being in that BMI category for people with that socio-demographic and behavioural or biological characteristic
N= unweighted sample/observations
[d] KM= Kanifing Municipality; WCR =West Coast Region; URR =Upper River Region.; NBR =North Bank Region ; CRRS=Central River Region South ; CRRN = Central River Region North ; LRR= Lower River Region. Regions ordered from most to least urban
[e] METS =Metabolic equivalents
[f] Based on the definition of the International Diabetes Federation (High waist circumference, indicating abdominal obesity defined as ≥90 cm in men or ≥80 cm in women)

Supplementary Table 3: Prevalence of BMI categories by selected socio-demographic, behavioural and biological factors in women [a, b, c]

Variable	Normal (desirable) %(95% CI)	Underweight %(95% CI)	Overweight %(95% CI)	Obese %(95% CI)	χ^2 P value
Total	46.6(42.8-50.5)	7.6(6.1-9.5)	28.8(25.8-31.9)	17.0(14.7-19.7)	
Age Group					
25 -34	51.6(46.9-56.2)	8.3(6.3-10.9)	27.4(23.7-31.5)	12.8(10.0-16.2)	**0.001**
35-44	46.1(39.5-52.9)	6.3(4.4-8.9)	28.5(22.9-34.8)	19.1(14.9-24.2)	
45-54	43.3(35.9-51.0)	6.4(3.8-10.5)	32.6(26.5-39.2)	17.7(12.5-24.4)	
55-64	30.3(22.6-39.2)	10.1(5.5-17.9)	29.3(20.3-40.4)	30.3(20.9-41.7)	
Marital status					
Never married	46.8(36.0-57.9)	6.3(3.1-12.7)	36.2(26.4-47.2)	10.7(6.3-17.4)	**0.001**
Married	46.6(42.3-51.0)	6.9(5.2-9.1)	27.9(24.7-31.3)	18.6(15.8-21.8)	
Separated	32.5(22.5-44.4)	9.6(4.5-19.2)	40.8(29.6-53.1)	17.1(9.3-29.5)	
Widowed	37.1(26.6-48.9)	6.0(2.6-13.4)	30.4(21.0-41.8)	26.5(16.1-40.5)	
Cohabiting	57.6(46.8-67.6)	12.5(7.9-19.2)	22.7(16.1-31.1)	7.3(4.8-10.7)	
Ethnicity					
Mandinka	51.1(46.0-56.2)	9.0(6.7-11.9)	26.4(22.6-30.7)	13.5(10.7-16.8)	0.066
Wollof	42.4(33.1-52.4)	4.8(2.7-8.2)	29.3(22.7-36.9)	23.5(17.8-30.4)	
Fula	44.6(37.8-51.6)	7.7(5.2-11.3)	31.7(26.5-37.4)	16.0(12.2-20.6)	
Jola	45.1(37.0-53.4)	8.9(5.1-15.0)	26.4(20.0-33.9)	19.7(13.4-28.0)	
Others	42.5(32.4-53.3)	4.8(2.8-8.1)	34.4(26.8-42.8)	18.3(12.5-26.1)	
Residence (LGA) [d]					
Banjul & KM	32.6(27.2-38.4)	2.3(1.1-4.6)	38.8(33.1-44.8)	26.3(22.1-31.1)	**<0.001**
WCR	49.8(42.8-56.7)	11.4(8.1-15.7)	25.4(20.3-31.2)	13.5(10.0-18.1)	
URR	53.9(45.9-61.6)	9.5(4.7-18.2)	22.7(15.1-32.7)	13.9(8.5-21.8)	
NBR	53.8(46.8-60.6)	13.4(8.2-20.9)	20.9(16.0-26.8)	12.0(9.5-15.2)	
CRR	67.3(51.3-80.1)	7.5(5.0-11.0)	17.7(10.6-27.9)	7.6(3.1-17.1)	
LRR	57.9(44.8-70.0)	7.4(2.9-20.9)	25.6(17.1-36.3)	9.1(4.4-17.9)	
Residence (Rurality)					
Urban	38.0(33.1-43.2)	5.1(3.3-7.7)	34.2(29.7-39.0)	22.7(19.3-26.6)	**<0.001**
Semi urban	43.5(37.5-49.7)	4.2(2.8-6.3)	35.2(30.0-40.8)	17.1(13.8-21.1)	
Rural	60.6(54.9-66.1)	12.1(9.3-15.6)	19.1(15.6-23.2)	8.1(6.1-10.6)	
Education level					
No formal education	49.5(45.3-53.7)	7.6(5.9-9.9)	27.4(24.1-31.0)	15.6(12.9-18.4)	**0.002**
Primary/ Middle	46.7(39.9-53.6)	8.2(5.4-12.4)	27.2(21.6-33.7)	17.9(13.2-23.9)	

Variable	Normal (desirable) %(95% CI)	Underweight %(95% CI)	Overweight %(95% CI)	Obese %(95% CI)	χ^2 P value
Secondary/Tertiary	32.0(25.0-39.8)	6.3(4.0-9.5)	37.9(30.8-45.5)	23.9(17.7-31.6)	
Years spent in school					
≤6 Years	49.2(45.2-53.2)	8.0(6.3-10.1)	26.9(23.8-30.3)	15.9(13.5-18.6)	**0.012**
7-12 Years	38.5(31.0-46.7)	5.6(3.3-9.3)	35.5(28.8-43.0)	20.4(15.1-26.9)	
>12 Years	31.0(18.9-46.5)	7.5(3.0-17.8)	41.5(26.7-57.9)	20.0(9.1-38.3)	
Servings of fruits and vegs					
≥ 5/day	45.1(39.8-50.6)	9.5(6.0-14.7)	27.9(22.7-33.8)	17.5(12.9-23.2)	0.621
< 5/day	46.2(41.3-51.3)	7.0(5.2-9.4)	29.6(26.1-33.4)	17.2(14.5-20.3)	
Physical activity					
<600METS/week	39.0(32.6-45.8)	5.7(3.2-9.9)	31.6(23.8-40.5)	23.7(18.4-30.1)	**0.022**
≥600METS/week	48.3(43.5-53.0)	8.0(6.3-10.4)	28.0(24.9-31.3)	15.7(13.1-18.6)	
Waist circumference [e]					
Normal	51.8(46.1-57.5)	10.3(7.7-13.8)	24.5(20.1-29.3)	13.4(9.6-18.4)	**<0.001**
High	39.7(34.2-45.4)	4.7(3.1-7.1)	34.3(29.9-39.1)	21.3(17.8-25.2)	

Note: Data shown have been weighted for non-response and the analysis took into account the complex survey design.

[a] BMI is categorised into underweight (BMI<18.5Kg/m^2), normal (18.5-24.9 Kg/m^2), overweight (25.0-29.9Kg/m^2) and obese (BMI ≥30Kg/m^2).
[b] Results adjusted for complex survey design and weighted for non-response
[c] Row percentages are presented, i.e the prevalence of being in that BMI category for people with that socio-demographic, behavioral or biological characteristic
N= unweighted sample/observations
[d] KM= [a] KM=Kanifing Municipality; WCR =West Coast Region; URR =Upper River Region.; NBR =North Bank Region ; CRRS=Central River Region South ; CRRN = Central River Region North ; LRR= Lower River Region. Regions ordered from most to least urban
[e] METS =Metabolic equivalents
[f] Based on the definition of the International Diabetes Federation (High waist circumference, indicating abdominal obesity defined as ≥90 cm in men or ≥80 cm in women)

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The silent epidemic of obesity in The Gambia: Evidence from a nationwide population-based cross-sectional health examination survey

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Abstract

Objectives

Non-communicable diseases account for 70% of global deaths; 80% occur in low- and middle-income countries. The rapid increase of obesity in sub-Saharan Africa is a concern. We assessed generalised- and abdominal-obesity and their associated risk factors among adults in The Gambia.

Design: Nationwide cross-sectional health examination survey using WHO STEPwise survey methods.

Setting: The Gambia.

Participants: This study uses secondary analysis of a 2010 nationally-representative random sample of adults aged 25-64y (78% response rate). The target sample size was 5280; 4111 responded. Analysis was restricted to non-pregnant participants with valid weight and height measurements (n=3533).

Primary and secondary outcome measures

The primary outcome variable was generalised obesity, using WHO body mass index (BMI) thresholds. Analyses used non-response weighting and adjusted for the complex survey design. We conducted multinomial logistic regression analysis to identify factors associated with BMI categories. A secondary outcome variable was abdominal obesity defined as high waist circumference (using the International Diabetes Federation thresholds for Europeans).

Results

Two-fifths of adults were overweight/obese, with a higher obesity prevalence in women (17%, 95%CI: 14.7-19.7; men 8%, 6.0-11.0). 10% of men and 8% of women were underweight. Urban residence (adjusted relative risk ratio (ARRR) 5.8, 95%CI 2.4-14.5), higher education (2.3, 1.2-4.5), older age, ethnicity, and low fruit and vegetable intake (2.8, 1.1-6.8) were strongly associated with obesity among men. Urban residence (4.7, 2.7-8.2), higher education (2.6, 1.1-6.4), older age and ethnicity were associated with obesity in women.

Conclusion

There is a high burden of overweight/obesity in The Gambia. While obesity rates in rural areas were lower than in urban areas, obesity prevalence was higher among rural residents in this study compared with previous findings. Preventive strategies should be directed at raising awareness; discouraging harmful beliefs on weight; and promotion of healthy diets and physical activity.

Key words: Obesity, non-communicable diseases, sub-Saharan Africa, The Gambia, WHO STEP survey, health examination survey

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Strengths and limitations of this study

- Our study uses the most recent nationally-representative data on generalised and abdominal obesity among adults in The Gambia and hence it serves as a baseline study from which future changes in prevalence and risk factors can be assessed.
- The complex sampling strategy and the stringent WHO STEP protocols applied in collecting the data, particularly the use of objective anthropometric measurements taken by trained field staff, minimised biases.
- The study has identified population sub-groups to prioritise with health promotion measures.
- Our main limitation is the survey did not collect self-reported measures on beliefs about body size and weight management, which are important in The Gambian context to assess and monitor trends on beliefs and practices. We also had only one complete measure of socio-economic position (education) as missing information on income was high.

INTRODUCTION

Non-communicable diseases (NCDs) are increasing in sub-Saharan Africa (SSA),[1 2] NCDs account for 71% of all deaths globally. They also account for 15 million premature deaths among adults aged 30-69 years; 85% of these premature deaths occur in low- and middle-income countries.[2] A pooled analysis of 1698 population-based measurement studies comprising 19 million participants from 200 countries revealed an increasing trend of obesity globally.[3] If these trends continue, meeting the WHO global NCD target of halting the rise of obesity by 2025 is almost impossible.[4]

A great concern is the rapid increase of obesity in SSA.[1] Countries in SSA face the challenge of the double burden of communicable and non-communicable diseases, and also the double burden of underweight/malnutrition and obesity.[5 6 7] A pooled analysis of population-based studies from 1980-2014 in Africa demonstrated a significant increase in age-standardised mean BMI across the continent.[8] A recent analysis of Demographic and Health Surveys conducted between 1991 and 2014 in 24 African countries revealed a significant increase in obesity among women; rates in some countries tripled.[9] There is evidence suggesting obesity is increasing more quickly in developing countries, especially in SSA, compared with developed countries.[10 11] This is associated with a range of factors, including epidemiological and nutritional transition; adoption of western life styles; decreased physical activity; low fruit and vegetable consumption; increased consumption of processed foods; and urbanisation.[12-15]

Few studies on obesity have been conducted in The Gambia and most of them are either not nationally representative or are out of date. A study using data from 1942 to 1997 on the causes of death in The Gambian capital Banjul documented the double burden of non-communicable diseases with communicable diseases exacerbated by malnutrition.[16] In a nationwide assessment among Gambians aged 16 years and above in 1996, 18% were underweight, 8% overweight and 2% obese.[17] A related study in urban and rural communities in The Gambia revealed that 18% of participants were underweight and 4% were obese, with a higher prevalence of obesity (33%) among urban women aged 35 years and above.[18] Both studies confirmed the persistence of the double burden of underweight and overweight in The Gambia, although obesity prevalence was low (but increasing) in those surveys.

The double burden of communicable and non-communicable diseases poses a challenge to governments and families in SSA; The Gambia is no exception. We recently demonstrated a high prevalence of hypertension in The Gambia, with a greater burden in rural areas and among adults classified as obese.[19] There is also a high prevalence of smoking among Gambian men.[20] Moreover, these health risks have significant implications for wider development concerns. It poses a barrier to poverty alleviation and can hinder the attainment of the UN Sustainable Development Goals (SDGs), particularly Target 3.4, which calls for a reduction in premature mortality due to NCDs by one-third by 2030.[2 21 22] Halting the rise of obesity is also one of the WHO 2025 targets for the reduction of NCD mortality.[4] Using the most recent nationally-representative data, including objective anthropometric measurements, the aim of this study was to assess the burden of underweight, overweight and obesity among adults (aged 25-64 years) in The Gambia.

METHODS

Participants, sampling strategy and data collection

Our study is based on secondary analysis of data from the most recent nationally–representative, population-based health examination survey conducted in The Gambia. The study setting and design, sampling, and research instruments have been previously described.[19 20] Briefly, data were collected from a random sample of adults aged 25-64 years from January to March 2010 using the WHO STEPwise approach.[19 23] Participants were selected using a multi-stage stratified sampling technique based on the 2003 population census of The Gambia. The country's eight local government areas (LGAs) served as strata for the sampling; 264 of the 408 enumeration areas (EAs) were then selected across the country and 20 households selected from each EA, both stages by simple random sampling. One eligible participant aged 25-64 years was sampled from each selected household, using the Kish Method. Sampled participants who were not reached after three or more visits and those who declined were not replaced. The target sample was set at 5280; 4111 responded (response rate 78%). Because of the complex sampling design, sample weights and post-stratification weights were applied to account for differences in the selection probability and to adjust for differences between the national age-sex distribution and that of the achieved sample.

The anthropometric measurements were performed by field workers at the participant's residence. Weight, height and waist circumference were measured using WHO STEP protocols.[23] The measurements were conducted using standard scales with participants wearing light clothing, with foot- and head-wear removed. Weight was measured to the nearest 0.1kg using digital bathroom scales. Height was measured to the nearest 0.1cm in the standing position, using standard portable stadiometers. Waist circumference was measured (once) to the nearest 0.1cm using a tape measure and was taken midway between the lowest rib and the iliac crest.

Dependent/Outcome variables

The first outcome variable was generalised obesity, defined using body mass index (BMI) calculated by dividing weight (in kg) by height squared (m^2). We categorised BMI into underweight (BMI <18.5kg/m^2), normal/desirable weight (18.5-24.9kg/m^2), overweight (25.0-29.9kg/m^2) and obese (BMI ≥30kg/m^2), using the WHO thresholds.[24] We used abdominal obesity (high waist circumference) as the second outcome variable, defined using the International Diabetes Federation thresholds (≥90 cm in men and ≥80 cm in women).[25]

Independent covariates/predictor variables

The predictor variables included sociodemographic and behavioural risk factors including self-reported age-group, ethnicity, education (years of education: ≤6; 7-12; >12), residence, fruit and vegetable intake, physical inactivity, and smoking (categories shown in Table S1). There was a high amount of missing information on income and hence we used level of education as a measure of socioeconomic position.

Statistical analysis

The analytical sample was restricted to non-pregnant participants with valid weight and height data (n=3533). Figure 1 outlines the number of participants sampled, the number excluded due to specific reasons, and the number included in the final analysis.

Complete case analysis was performed as fewer than 1% of adults with valid weight and height had missing information on other variables. In descriptive analyses, we summarised the participants' sociodemographic characteristics as well as their behavioural risk factors.

The prevalence of BMI categories are reported as proportions with their corresponding 95% confidence intervals (CI). We conducted multivariable multinomial logistic regression analysis to identify factors associated with being underweight, overweight and obese separately, comparing each of these categories with the reference category of normal/desirable weight. Sociodemographic and behavioural risk factors in the dataset that are known or thought to be associated with obesity were included. We excluded smoking (in women) and alcohol consumption (both sexes) from the regression models, due to their low prevalence. However, model fit or adequacy was not assessed. Age-adjusted and fully-adjusted relative risk ratios (ARRR), with their corresponding 95% CIs, are reported. All analyses were stratified by gender, as we expected that the associations between the predictors and outcomes may differ by gender.

Due to the collinearity of the two variables on residence (i.e. local government area and rurality), fully-adjusted models were repeated interchanging these variables. We explored variables that could modify the association between BMI categories and the covariates by fitting interaction terms. There was no evidence of modification (all p>0.05) and hence multinomial regression models without interaction terms are reported. As in other studies, we did not include abdominal obesity in the models for BMI because of the collinearity of waist circumference and BMI.[26]

We explored the factors associated with abdominal obesity (high waist circumference as defined above) by conducting multivariable binary logistic regression analysis. BMI was not included as a predictor in these models because of the aforementioned collinearity of waist circumference and BMI. For abdominal obesity, age-adjusted (OR) and fully-adjusted odds ratios (AOR) with corresponding 95% CI are reported.

All analyses were weighted for non-response and adjusted for the complex survey design in accordance with WHO STEP wise protocols. Analyses were performed using Stata V15 (StataCorp, College Station, Texas, USA). Ethical approval for the survey was obtained from the National Ethics Committee of The Gambia; participants gave verbal or written consent.

Patient and Public Involvement

Patients and the public were not directly involved in this study. However, the STEPwise survey on which the data reported in this study is based was population-based. All the interviews and anthropometric measurements were conducted at the participant's residence. Prior to the survey, people were sensitised about the objectives of the survey and its importance through radio, television, community meeting places, etc. Results from the previous analyses have been shared. In addition, the results are used by the Ministry of Health of The Gambia in their routine sensitisation campaigns. Like our previous analysies,[19 20] the results of this study will be shared with the public and will also be used to inform policy.

RESULTS

Characteristics of participants

Descriptions of respondents' socio-demographic, behavioural risk factors and anthropometry data are presented in Table S1. The unadjusted mean age was 38.3±10.9 years. More than two-fifths of the participants (44%) were in the youngest age-group (25-34 years), particularly among women (53% vs 33% of men). However, there was no age difference by gender after weighting and adjusting for the complex survey design (P=0.937, Table S1). The adjusted mean BMI was 24.6 kg/m^2 (95% CI 24.1-25.1) and the mean waist circumference was 74.0cm (71.1-76.9). Mean BMI and waist circumference were both higher among women: BMI in men 23.6 kg/m^2 (23.1-24.1kg/m^2) vs 25.6kg/m^2 (24.9-26.3kg/m^2) in women and waist circumference 72.1cm (65.1-75.0cm) in men compared with 76.0cm (72.9-79.1cm) in women.

Prevalence of underweight, overweight and obesity

The prevalence of BMI categories by selected socio-demographic and behavioural characteristics are presented for men and women in Tables S2 and S3 respectively. Among men, more than half had a normal/desirable weight (56%, 95% CI: 50.8-61.4%) and one in ten was underweight (10%, 7.6-12.4%). The prevalence of overweight and obesity in men were 26% (21.1-31.6%) and 8% (6.0-11.0%) respectively (Table S2). Almost a half of women were either overweight (29%, 25.8-31.9%) or obese (17%, 14.7-19.7%), while 8% (6.1-9.5%) were underweight (Table S3). Among both men and women, the prevalence of overweight and of obesity were substantially higher among urban residents; those with a higher level of education; and those physically inactive. More than 60% of the residents in the capital (Banjul) and the nearby towns (Kanifing Municipality) were either overweight or obese. Obesity was also high among never and ex-smokers in men. The prevalence of abdominal obesity was 10% (95% CI: 7.8-13.4%) in men and 46% (95% CI: 39.3-52.6%) in women (data not shown).

Factors associated with underweight, overweight and obesity

Factors strongly associated with generalised obesity (versus normal/desirable weight) in the multivariable multinomial logistic regressions included older age, ethnicity, higher education and urban residence among both men and women (Tables 1 and 2). Obesity was also associated with low fruit and vegetable consumption (adjusted relative risk ratio (ARRR) 2.8, 95% CI: 1.1-6.8) in men. All these variables with the exception of ethnicity in men were also strongly associated with overweight (versus normal weight), while current smoking was inversely associated with overweight (0.5, 0.4-0.7). Compared with rural residents, the associations of overweight and obesity among urban residents were three- and six-fold higher respectively in men (overweight 2.8, 1.5-5.0; obesity 5.8, 2.4-14.5) and three- and five-fold higher in women (overweight 3.1, 1.9-5.0; obesity 4.7, 2.7-8.2). Physical inactivity was strongly associated with obesity among both men and women in the age-adjusted models but not in the fully-adjusted models, although the direction of the association remained unchanged (Tables 1 and 2).

Table 1: Multinomial logistic regression on factors associated with being underweight, overweight or obese in men[a]

	Model I (Age adjusted)			Model II (Fully adjusted)		
	Underweight[b]	Overweight[b]	Obese[b]	Underweight[b]	Overweight[b]	Obese[b]
Variable	**RRR (95% CI)[c]**	**RRR (95% CI)[c]**	**RRR (95% CI)[c]**	**ARRR (95% CI)[c]**	**ARRR (95% CI)[c]**	**ARRR (95% CI)[c]**
Age-group						
25-34	Reference	Reference	Reference	Reference	Reference	Reference
35-44	0.69(0.40-1.17)	1.61(1.22-2.12)***	0.95(0.56-1.62)	0.75(0.42-1.36)	2.00(1.38-2.90)***	1.58(0.75-3.33)
45-54	0.97(0.52-1.81)	1.63(1.06-2.52)*	2.06(1.22-3.48)**	1.31(0.66-2.59)	2.21(1.33-3.67)**	3.42(1.83-6.37)***
55-64	0.67(0.37-1.21)	0.96(0.59-1.56)	1.21(0.56-2.57)	0.81(0.43-1.52)	1.13(0.63-2.03)	2.88(1.22-6.80)**
Ethnicity						
Mandinka	Reference	Reference	Reference	Reference	Reference	Reference
Wollof	1.15(0.65-2.03)	1.48(0.93-2.35)	1.85(1.06-3.23)*	1.17(0.66-2.08)	1.34(0.83-2.18)	1.62(1.04-2.53)*
Fula	0.71(0.41-1.24)	0.93(0.64-1.35)	1.09(0.49-2.39)	0.46(0.24-0.88)*	1.15(0.77-1.72)	0.80(0.34-1.87)
Jola	0.67(0.38-1.18)	0.79(0.45-1.39)	1.05(0.45-2.45)	0.66(0.39-1.13)	1.03(0.56-1.89)	1.29(0.56-2.94)
Others	0.44(0.19-1.04)	0.91(0.51-1.65)	2.56(1.26-5.20)**	0.37(0.14-0.96)*	0.92(0.45-1.88)	1.97(0.71-5.43)
Years spent in school						
≤6 Years	Reference	Reference	Reference	Reference	Reference	Reference
7-12 Years	1.19(0.76-1.87)	1.56(1.06-2.31)*	2.54(1.37-4.72)**	1.26(0.75-2.11)	1.28(0.81-2.01)	1.24(0.56-2.75)
>12 Years	0.48(0.23-1.00)	1.82(1.12-2.96)**	3.19(1.45-7.02)**	0.50(0.23-1.09)	1.66(1.02-2.71)*	2.29 (1.16-4.53)**
Residence (Rurality)						
Rural	Reference	Reference	Reference	Reference	Reference	Reference
Semi urban	0.97(0.37-2.53)	2.05(0.95-4.43)	4.14(1.53-11.19)**	0.70(0.29-2.11)	1.62(0.70-3.80)	1.58(0.45-5.56)
Urban	1.18(0.71-1.96)	2.52(1.49-4.27)***	5.03(2.20-11.47)***	1.35(0.81-2.23)	2.76(1.52-5.01)***	5.83(2.35-14.50)***
Smoking						
Never smokers	Reference	Reference	Reference	Reference	Reference	Reference
Current smokers	1.71(1.18-2.48)**	0.53(0.38-0.74)***	0.52(0.32-0.84)***	1.48(0.97-2.27)	0.52(0.36-0.74)***	0.61(0.34-1.11)
Ex-smokers	1.71(0.97-3.02)	0.81(0.47-1.40)	0.58(0.26-1.32)	1.86(1.07-3.24)*	0.75(0.38-1.48)	0.58(0.21-1.63)
Servings of fruit and vegetables						
≥ 5/day	Reference	Reference	Reference	Reference	Reference	Reference
< 5/day	1.31(0.80-2.14)	1.38(0.86-2.22)	1.50(0.74-3.06)	1.38(0.79-2.38)	1.74(1.06-2.87)*	2.75(1.12-6.75)*
Physical Activity[d]						
≥600METS/week	Reference	Reference	Reference	Reference	Reference	Reference
<600METS/week	0.58(0.25-1.36)	1.46(0.86-2.48)	3.02(1.78-5.13)***	0.92(0.31-2.69)	1.20(0.53-2.73)	2.23 (0.87-5.70)

[a]Data shown have been weighted for non-response and the analysis took into account the complex survey design.

[b]BMI is categorised into underweight (BMI<18.5kg/m^2), normal/desirable weight (18.5-24.9 kg/m^2, the reference group), overweight (25.0-29.9kg/m^2) and obese (BMI ≥30kg/m^2). Those with a desirable weight (normal) used as reference.

cRRR= Relative Risk Ratio adjusted for age (except for age group as the independent variable), ARRR= Fully Adjusted Relative Risk Ratio; Estimates in the fully adjusted models were mutually adjusted for the variables shown in the table

dMETS =Metabolic equivalents.

*p<0.05, **p≤0.01, *** p≤0.001

Table 2: Multinomial logistic regression on factors associated with generalised underweight, overweight and obesity in women[a]

	Model I (Age adjusted)			Model II (Fully adjusted)		
	Underweight[b]	Overweight[b]	Obese[b]	Underweight[b]	Overweight[b]	Obese[b]
Variable	**RRR(95% CI)[c]**	**RRR(95% CI)[c]**	**RRR(95% CI)[c]**	**ARRR (95% CI)[c]**	**ARRR (95% CI)[c]**	**ARRR (95% CI)[c]**
Age-group						
25-34	Reference	Reference	Reference	Reference	Reference	Reference
35-44	0.85(0.55-1.31)	1.16(0.83-1.61)	1.67(1.10-2.54)*	0.79(0.52-1.19)	1.37(0.93-2.01)	2.25(1.31-3.85)**
45-54	0.92(0.50-1.71)	1.42(1.01-1.99)*	1.65(1.00-2.73)	0.88(0.48-1.62)	1.98(1.33-2.96)***	2.66(1.43-4.94)**
55-64	2.09(1.04-4.18)*	1.82(1.03-3.24)*	4.04(2.20-7.39	2.30(1.10-4.80)*	2.81(1.58-4.99)***	4.90(2.44-9.82)***
Ethnicity						
Mandinka	Reference	Reference	Reference	Reference	Reference	Reference
Wollof	0.64(0.32-1.25)	1.31(0.80-2.16)	2.07(1.19-3.61)**	0.69(0.36-1.29)	1.19(0.75-1.87)	1.50(0.90-2.48)
Fula	1.03(0.60-1.78)	1.43(1.01-2.00)*	1.51(0.94-2.41)	0.87(0.47-1.58)	1.69(1.20-2.38)**	1.78(1.09-2.92)*
Jola	1.15(0.64-2.08)	1.14(0.72-1.82)	1.68(0.92-3.07)	1.01(0.57-1.77)	0.98(0.64-1.51)	1.10(0.66-1.84)
Others	0.63(0.31-1.27)	1.54(0.96-2.47)	1.57(0.84-2.92)	0.34(0.14-0.80)**	1.33(0.78-2.28)	1.21(0.62-2.36)
Years spent in school						
≤6 Years	Reference	Reference	Reference	Reference	Reference	Reference
7-12 Years	0.10(0.58-1.69)	1.93(1.31-2.85)***	2.93(1.85-4.64)***	1.12(0.63-1.99)	1.31(0.87-1.95)	1.67(1.00-2.77)*
>12 Years	1.37(0.46-4.14)	3.09(1.53-6.22)**	3.47(1.37-8.89)**	1.93 (0.52-7.18)	2.40(1.10-5.20)*	2.58(1.05-6.36)*
Residence (Rurality)						
Rural	Reference	Reference	Reference	Reference	Reference	Reference
Semi urban	0.47(0.29-0.75)**	2.52(1.75-3.63)***	2.75(1.71-4.43)**	0.54(0.31-0.95)*	2.31(1.46-3.65)***	2.25(1.22-4.14)**
Urban	0.68(0.41-1.13)	3.03(2.06-4.46)***	5.06(3.24-7.90)***	0.84(0.46-1.55)	3.05(1.86-5.01)***	4.71(2.72-8.15)***
Servings of fruits and vegetables						
≥ 5/day	Reference	Reference	Reference	Reference	Reference	Reference
< 5/day	0.71(0.41-1.24)	1.03(0.73-1.46)	0.95(0.62-1.46)	0.65(0.37-1.15)	1.10(0.73-1.66)	1.13(0.74-1.75)
Physical Activity[d]						
≥600METS/week	Reference	Reference	Reference	Reference	Reference	Reference
<600METS/week	0.81(0.42-1.54)	1.32(0.83-2.11)	1.67(1.08-2.58)*	1.19(0.58-2.44)	1.07(0.63-1.82)	1.02(0.55-1.91)

[a] Data have been weighted for non-response and the analysis took into account the complex survey design.
[b]BMI is categorised into underweight (BMI<18.5kg/m^2), normal/desirable weight (18.5-24.9 kg/m^2, the reference group), overweight (25.0-29.9kg/m^2) and obese (BMI ≥30kg/m^2). Those with a desirable weight (normal) used as reference ;
[c]RRR= Relative Risk Ratio adjusted for age (except for age group as the independent variable), ARRR= Fully Adjusted Relative Risk Ratio; Estimates in the fully adjusted models were mutually adjusted for all the variables shown in the table.
[d] METS =Metabolic equivalents. *p<0.05, **p≤0.01, *** p≤0.001

No strong associations were found for underweight (versus normal/desirable weight) in men except for an increased ARRR among ex-smokers (ARRR 1.9, 1.1-3.2) and an inverse association with being Fula (0.5, 0.2-0.9) or minority ethnicity (0.4, 0.1-1.0) compared with being Mandinka (Table 1). Among women, the risk of being underweight (versus normal weight) was higher among those aged 55-64 years compared with those aged 25-34 years (2.3, 95% CI: 1.1-4.8) and was inversely related with semi-urban residence compared with rural residence (0.5, 0.3-1.0) and to minority ethnicity compared with Mandinka (0.3, 0.1-0.8) (Table 2).

Factors associated with abdominal obesity

In the fully-adjusted multivariable binary logistic regression model, older age, residence, low fruit and vegetable intake (men only) and being an ex-smoker compared with never smoking (men only) were strongly associated with higher odds of abdominal obesity (Table 3). Semi-urban residence (adjusted odds ratio (AOR) 0.4, 95% CI: 0.2-0.9) compared with rural residence, and low fruit and vegetable intake (0.6, 0.4-0.9) compared with the recommended intake of at least five servings a day, were inversely associated with the odds of abdominal obesity among men. Older age (3.2, 2.1-4.9) compared with younger age, and semi-urban residence (2.1, 1.2-3.7) compared with rural residence, were associated with higher odds of abdominal obesity among women (Table 3).

Table 3: Multivariate binary logistic regression on factors associated with high waist circumference (abdominal obesity)[a]

	Men			Women		
	Model I [b]	**Model II [b]**	**Model III [b]**	**Model I [b]**	**Model II [b]**	**Model III [b]**
Variable	**OR (95% CI) [c]**	**AOR (95% CI) [c]**	**AOR (95% CI) [c]**	**OR (95% CI) [c]**	**AOR (95% CI) [c]**	**AOR (95% CI) [c]**
Age-group						
25-34	Reference	Reference	Reference	Reference	Reference	Reference
35-44	1.63(1.08-2.47)*	2.04(1.21-3.43)**	1.62(0.96-2.74)	2.06(1.52-2.80)***	2.17 (1.60-2.92)***	2.04(1.49-2.77)***
45-54	1.89(1.19-3.00)**	2.50(1.41-4.43)**	1.97 (1.14-3.38)**	1.91(1.38-2.65)***	1.91(1.34-2.72)***	1.91(1.33-2.74)***
55-64	2.26(1.36-3.75)**	2.24(1.16-4.34)*	1.90(0.96-3.75)	3.57(2.32-5.49)***	3.39(2.07-5.56)***	3.19(2.09-4.87)***
Ethnicity						
Mandinka	Reference	Reference	Reference	Reference	Reference	Reference
Wollof	1.12(0.43-2.90)	1.11(0.51-2.43)	1.06(0.40-2.78)	0.92(0.58-1.46)	1.01(0.64-1.58)	0.81(0.51-1.28)
Fula	0.96(0.49-1.91)	1.05(0.51-2.15)	0.90(0.45-1.76)	0.79(0.55-1.13)	0.82(0.55-1.21)	0.69(0.48-0.99)*
Jola	1.22(0.60-2.51)	0.86(0.41-1.80)	1.02(0.49-2.12)	0.94(0.62-1.42)	0.82(0.49-1.36)	0.97(0.62-1.53)
Others	0.81(0.38-1.74)	0.71(0.30-1.67)	0.63(0.27-1.44)	0.58(0.33-1.01)	1.00(0.54-1.84)	0.74(0.43-1.28)
Years spent in school						
≤6 Years	Reference	Reference	Reference	Reference	Reference	Reference
7-12 Years	0.96(0.58-1.59)	0.97(0.60-1.59)	0.86(0.50-1.46)	0.84(0.59-1.20)	1.10(0.78-1.55)	0.81(0.61-1.09)
>12 Years	1.21(0.65-2.28)	1.25(0.68-2.31)	1.06(0.58-1.97)	0.75(0.32-1.76)	0.92(0.37-2.24)	0.82(0.32-2.06)
Residence (Local government area) [d]						
LRR	Reference	Reference	-	Reference	Reference	-
CRR	1.75(0.32-9.53)	1.92(0.44-8.32)	-	0.89(0.33-2.41)	1.20(0.45-3.18)	-
NBR	1.94(0.66-5.65)	1.63(0.55-4.85)	-	1.18(0.64-2.20)	1.08(0.57-2.06)	-
URR	0.08(0.01-0.65)**	0.14(0.02-0.98)*	-	0.24(0.11-0.51)***	0.26(0.11-0..65)**	-
WCR	2.66(1.02-6.96)	2.43(0.94-6.32)	-	1.62(0.83-3.15)	1.59(0.79-3.20)	-
Banjul & KM	0.71(0.25-2.03	0.71(0.24-2.07)	-	0.32(0.15-0.71)	0.37(0.14-1.00)	-
Residence (Rurality)						
Rural	Reference	-	Reference	Reference	-	Reference
Semi urban	0.32(0.12-0.82)**	-	0.36(0.15-0.90)*	1.53(0.75-3.10)	-	2.11(1.21-3.68)**
Urban	0.89(0.45-1.75)	-	0.82(0.41-1.65)	0.82(0.49-1.37)	-	0.97(0.58-1.62)
Smoking[e]						
Never smokers	Reference	Reference	Reference	-	-	-
Current smokers	0.72(0.42-1.26)	0.49(0.28-0.86)**	0.60(0.35-1.03)	-	-	-

	Men			Women		
	Model I [b]	Model II [b]	Model III [b]	Model I [b]	Model II [b]	Model III [b]
Variable	**OR (95% CI) [c]**	**AOR (95% CI) [c]**	**AOR (95% CI) [c]**	**OR (95% CI) [c]**	**AOR (95% CI) [c]**	**AOR (95% CI) [c]**
Ex-smokers	1.44(0.92-2.27)	1.24(0.81-1.91)	1.56(1.04-2.36)*	-	-	-
Servings of fruit and vegetables						
≥ 5/day	Reference	Reference	Reference	Reference	Reference	Reference
< 5/day	0.63(0.40-0.99)*	0.61(0.37-1.01)	0.59(0.37-0.93)*	0.95(0.64-1.42)	0.86(0.50-1.49)	0.81(0.48-1.20)
Physical Activity[f]						
<600METS/week	Reference	Reference	Reference	Reference	Reference	Reference
≥600METS/week	0.78(0.37-1.63)	1.81(0.81-4.06)	1.52(0.65-3.57)	0.64(0.32-1.30)	1.46(0.81-2.62)	1.22(0.71-2.10)

287 Note: Data shown have been weighted for non-response and the analysis took into account the complex survey design.

288 [a]Based on the definition of the International Diabetes Federation (High waist circumference, indicating abdominal obesity, defined as ≥90cm in men and ≥80cm in women).
289 [b]Model I adjusted for age only; Model II adjusted for all variables except local government area; Model III adjusted for all variables except rurality.
290 [c]OR=odds ratio adjusted for age (except for age group as the independent variable); AOR= Adjusted odds ratio (fully adjusted)
291 [d]KM=Kanifing Municipality; WCR =West Coast Region; LRR= Lower River Region; NBR =North Bank Region; CRR = Central River Region; URR =Upper River Region
292 [e]Smoking status not included in the analyses for women due to the low prevalence.
293 [f]METS =Metabolic equivalents
294 *p<0.05, **p≤0.01, *** p≤0.001
295

DISCUSSION

Using the most recent nationally-representative data, including objective anthropometric measurements, the aim of this study was to assess the burden of underweight, overweight and obesity among adults (aged 25-64 years) in The Gambia. This study has shown that the burden of overweight and obesity is high in The Gambia, especially among women (29% and 17% respectively) and urban residents. No precise quantification of changes over time in prevalence can be made since the only previous nationwide study was based on a different age cohort.[17] Nevertheless, we can reasonably assume that the prevalence of obesity has increased substantially in The Gambia within a period of less than 15 years. Almost half of women and more than one-third of men aged 25-64 years were either overweight or obese in 2010 while the prevalence of overweight and obesity in 1996 were 8% and 2% respectively among participants aged 16 years and above. The prevalence of underweight, however, halved from 18% in 1996 to 9% in this study. This shows an increasing shift from malnutrition/underweight to overweight and obesity among Gambian adults. These changes reflect shifts in growing economic progress, modernization of household tasks, improved transportation and increasing urbanization.

The prevalence of obesity in The Gambia is more than double the levels reported in similar national WHO STEPwise surveys conducted in Malawi[27], Eritrea[28] and Mozambique[29,30] but is less than that reported in The Republic of Seychelles.[31] The high prevalence of obesity in The Gambia is a cause for concern, given the increasing burden of NCDs, notably hypertension.[19] Although higher in urban areas, generalised obesity is now a problem in both urban and rural areas in The Gambia, in contrast to the evidence from previous studies.[17,18] Despite the health risks associated with overweight/obesity, Gambians are culturally obesity tolerant.[32,33] It has been well documented that perceptions of body weight vary across different parts of the world.[34 35] In some parts of SSA, being overweight is not perceived as a risk factor for NCDs but rather is perceived as a sign of beauty, wealth, success and prestige; such cultural beliefs encourage obesity.[34 35] This is the case in The Gambia; a study on the perception of body image and attractiveness among adults in urban areas in The Gambia demonstrated high satisfaction with big body image (overweight), especially among women.[32] A cross-cultural comparison using published data on Figure Rating Scales found that Gambians' rating of a 'normal' weight were bigger than those of North Americans, and that Gambians were more tolerant of obesity than white and African-Americans.[32] A related study also conducted in The Gambia showed that weight gain was not associated with weight concern, as 68% of those overweight and 37% of those obese did not perceive themselves to be overweight/obese.[33] Findings from other SSA countries have indicated that women tend to frame fatness as a symbol of wealth, as has been found for example, in Senegal[36 37] and in Zambia.[38] Associating overweight/obesity with beauty and prestige/wealth renders the burden of obesity a silent epidemic, as many people in The Gambia do not consider it a risk or want to address it.

Our models showed that older age, ethnicity, higher education, and urban residence in both genders, and low fruit and vegetable intake and smoking in men, were strongly associated with the risks of overweight and obesity (versus normal/desirable weight). Evidence links urbanisation and the increasing burden of obesity and other NCDs, especially in low-income countries.[39-42] Higher education was also significantly associated with overweight and obesity in our study. Highly educated adults in The Gambia are more likely to be in office jobs, which are mostly sedentary. Physical inactivity was strongly associated with obesity in the age-adjusted regression models among both men and women. However, this relationship failed to attain statistical significance after full-adjustment for social and demographic factors, suggesting that social and demographic factors may be confounding the age-adjusted relationship between physical inactivity and obesity. Leisure-time physical activity was low among the study participants; only 12% of adults in the present study reported engaging in any form of leisure time activity: most of the physical activity reported was therefore work- and transport-related. Judging from the data, participants with a higher level of education therefore had lower levels of physical activity and hence were more prone to obesity. There is evidence suggesting that increases in the level of physical activity and/or involvement in exercise interventions - whether supervised or not - has a positive impact on BMI and overall health.[43] Given our evidence that leisure time physical activity is low in The Gambia, the Ministry of Health and Social Welfare of The Gambia and its stakeholders should promote physical activity at the individual and population levels. As the promotion of physical activity, especially at the population level, is multidisciplinary, it should be done in collaboration with other government line ministries, municipalities, community-based organisations and non-governmental organisations. The goal of the recent WHO Global Action Plan on Physical Activity 2018-2030 (‘more active people for a healthier world’) is to reduce the global prevalence of physical inactivity by 15% by 2030.[44] Our findings support the advisability of the Ministry of Health of The Gambia incorporating this in its national health policy and/or the NCDs policy and strategic plan.

Low fruit and vegetable intake (defined as having fewer than five combined servings a day) was associated with obesity in our study, especially among men. There is a strong linkage between low fruit and vegetable consumption and increased NCD risk. Regular consumption of fruits and vegetables may help prevent unhealthy weight gain, especially when taken as part of a healthy diet.[45 46] A systematic analysis for the Global Burden of Diseases study in 2010 attributed more than 6 million deaths globally to inadequate consumption of fruits and vegetables.[47] An additional finding from our data was that the consumption of fruits and vegetables was low; consumption of fruits and vegetables as part of healthy diets should therefore be widely promoted. Future health examination surveys to monitor indicators such as overweight/obesity in The Gambia should include a more comprehensive assessment of diet (including unhealthy or fast food consumption) than that collected in the 2010 survey.

Being an ex-smoker in men and older age in women, were positively associated with being underweight (versus normal weight) in the fully-adjusted analyses presented here. Semi-urban residents were less likely to be underweight (versus normal weight) compared with rural residents. The association of underweight with being an ex-smoker might be at least partly explained by the associations of both with ill-health. It is possible that ex-smokers were advised to quit smoking because of their illness. Moreover, the association of underweight with older age in women could also be associated with age-related illnesses. Poverty, especially in rural areas, may explain the inverse association of underweight with semi-urban compared with rural residence among women.

A potential positive finding from this study is that higher rates of obesity were found among those with higher education and more urban based members of the population, the very people who may be most effectively reached by public health campaigns.

Strengths and limitations of this study

This study presents the most recent nationally-representative data on obesity among adults in The Gambia. It gives a better picture of the true burden of obesity in the country and hence could serve as a baseline study from which future changes can be assessed. The complex sampling strategy and the stringent WHO STEP protocols applied in collecting the data, particularly the use of objective measurements taken by trained field staff instead of a reliance on self-reported anthropometric data, minimised biases.

Our main limitation is the cross-sectional nature of the study, which prevents attribution of causality to the associations. However, it does identify population sub-groups to prioritise with health promotion measures. There is a possibility of misclassifying obesity in people who are physically active and have large muscle mass. For this reason we explored abdominal obesity as an additional outcome variable. 3% of the participants who took part in the physical measurements did not have valid weight and height measurements, which could have led to non-response bias. However, we compared the two groups and there were no systematic differences between those with and without valid anthropometric measurements (data not shown). We had only one complete measure of socio-economic position (education) as missing information on household income was high, a common finding in surveys. Therefore, we were unable to estimate the associations between education and the outcome variables after adjustment for income. Our findings could have been influenced by this, and other unmeasured confounders such as fast food intake.

Currently, there is no standard threshold for high waist circumference in sub-Saharan Africa but the International Diabetes Federation recommends using the thresholds for Europeans (≥94 cm in men; ≥80 cm in women) for adults in SSA.[25] However, a study that utilised data from different countries as part of the Africa Partnerships for Chronic Diseases Research revealed optimal waist circumference cut-off-point for identifying men at increased cardiometabolic risk is lower (≥81.2 cm) than current guidelines for men in SSA, and similar to that of women .[48] We therefore used the International Diabetes Federation thresholds for Asians (≥90 cm in men; ≥80 cm in women).[25] The data shown on waist-circumference levels may therefore be under- or over-estimated compared to alternative thresholds for abdominal obesity. Finally, the survey did not collect information on beliefs about body size and weight management, which are important in The Gambian context to assess and monitor trends on beliefs and practices.

CONCLUSION

This study reveals a high prevalence of obesity among Gambian adults, while the burden of underweight in this population may be decreasing. There are likely to be socio-cultural norms that promote overweight, especially among women. Preventive strategies should be directed at raising awareness of the importance of achieving and maintaining a healthy weight; discouraging harmful socio-cultural practices and beliefs about weight; and the promotion of healthy diets and regular physical activity during leisure-time, particularly in urban areas and among women.

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Conflict of interest

The authors have no conflict of interest to declare.

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Author Contributions

BC conceptualised the paper, analysed the data and wrote the first draft of the manuscript. J.S.M, SS, N.E.G and L.N.F revised the work critically for important academic content. OB supervised the survey data collection process and contributed in the revision of the manuscript. All the authors approve the final version of the manuscript.

Data Availability

The Gambia 2010 WHO STEP data is not publicly available but can be obtained from a third party upon request.

Figure legend

Figure 1: Flow diagram of study participants with number excluded and reason for exclusion

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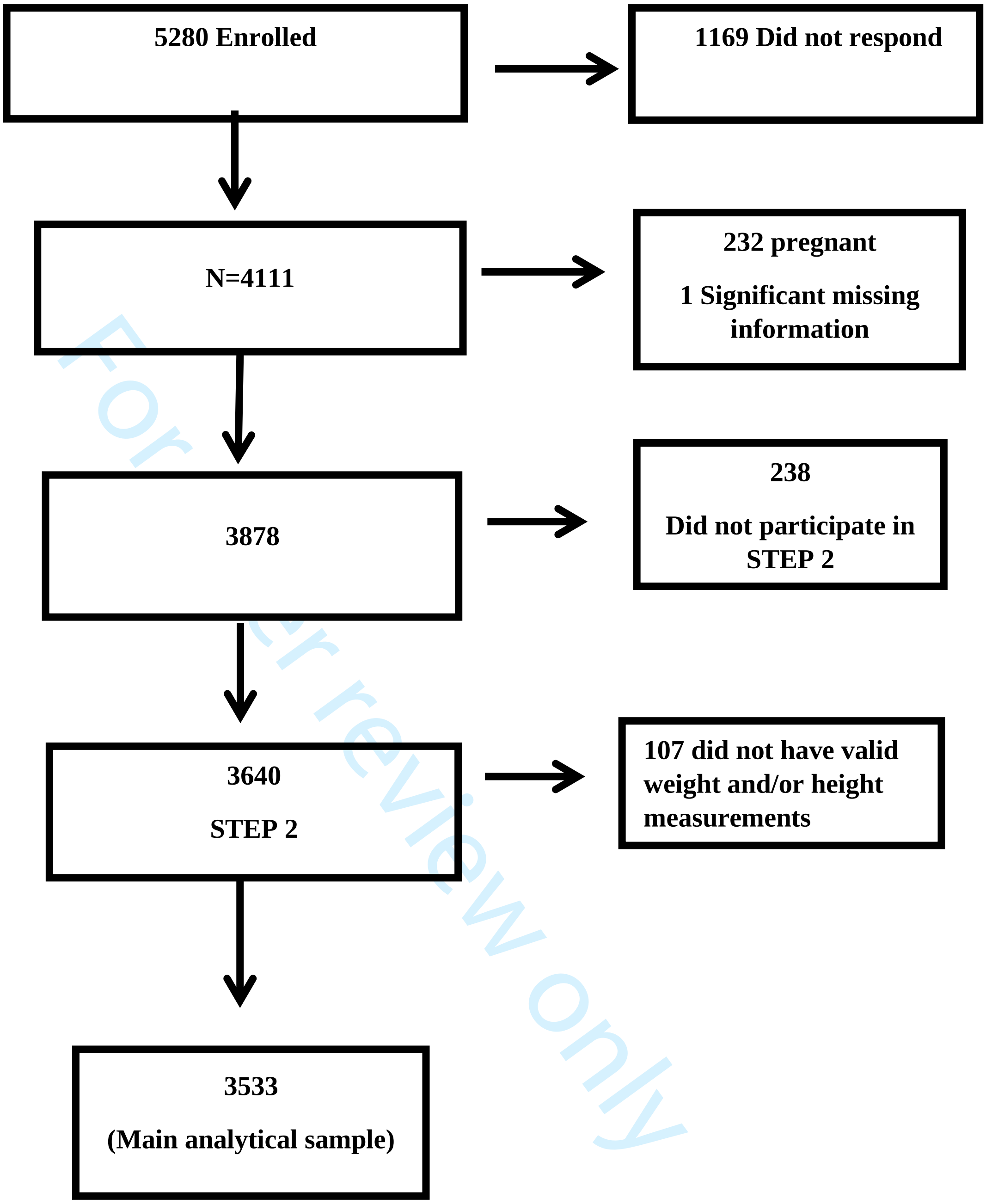
Figure 1: Flow diagram of study participants with number excluded and reason for exclusion



Supplementary Table 1: Characteristics of study participants by selected demographic, behavioural and biological risk factors

Variable	Men %(95% CI) 1611	Women %(95% CI) 1922	Total %(95% CI) 3533
Gender			
Men			50.2(47.6-52.9)
Women			49.8(47.1-52.4)
Age Group			
25 -34	46.8(42.8-50.8)	45.9(42.8-49.1)	46.3(43.9-48.8)
35-44	26.5(24.0-29.2)	27.0(24.3-29.8)	26.7(24.9-28.7
45-54	16.8(14.7-19.2)	17.6(15.7-19.6)	17.2(15.8-18.7)
55-64	9.9(8.2-11.9)	9.6(7.5-12.1)	9.7(8.2-11.5)
	P<0.937		
Mean age	37.8(37.0-38.6)	37.6(36.8-38.3)	37.7(37.1-38.2)
Marital Status			
Never married	22.6(20.1-25.2)	7.3(5.7-9.4)	15.0(13.4-16.7)
Married	66.4(59.8-72.3)	70.8(63.2-77.4)	68.6(61.9-74.6)
Separated/divorced	2.3(1.7-3.3)	4.8(3.8-6.0)	3.5(2.9-4.4)
Widowed	0.3(0.1-0.9)	5.5(4.2-7.3)	2.9(2.2-3.8)
Cohabiting	8.4(4.3-15.9)	11.6(5.9-21.5)	10.0(5.2-18.5)
	P<0.001		
Ethnicity			
Mandinka	42.1(36.9-47.6)	39.3(33.4-45.6)	40.7(35.6-46.0)
Wollof	16.2(12.1-21.4)	16.1(12.4-20.5)	16.2(12.5-20.7)
Fula	20.7(17.1-25.0)	18.5(15.1-22.4)	19.6(16.4-23.3)
Jola	12.2(8.2-17.8)	15.1(11.1-20.2)	13.6(9.8-18.6)
Other	8.7(6.6-11.5)	11.1(8.5-14.4)	9.9(7.8-12.5)
	P=0.104		
Years spent in school			
≤6 Years	55.0(50.5-59.5)	74.3(69.4-78.6)	64.3(60.1-68.2)
7-12 Years	31.5(28.1-35.2)	22.4(18.7-26.6)	27.1(24.2-30.3)
>12 Years	13.4(11.2-16.0)	3.4(2.3-4.9)	8.6(7.2-10.2)
	P<0.001		
Residence (Local government area) [a]			
Banjul	7.8(2.5-21.9)	7.1(2.2-21.0)	7.5(2.4-20.7)
KMC	23.2(15.1-33.9)	28.2(18.9-39.8)	25.7(17.2-36.6)
WCR	35.7(24.3-48.8)	30.9(20.6-45.5)	33.3(22.6-46.0)
LRR	7.6(3.3-16.8)	7.9(3.4-17.6)	7.8(3.4-16.9)
NBR	8.2(4.4-14.6)	10.3(5.6-18.11)	9.2(5.1-16.3)
CRRN	2.5(0.7-8.9)	2.8(0.7-9.9)	2.7(0.7-9.4)
CRRS	6.1(2.5-14.2)	6.4(2.6-14.7)	6.3(2.6-14.2)
URR	8.9(4.1-18.2)	6.4(2.8-14.1)	7.7(3.5-16.0)
	P=0.131		
Residence (Rurality)			
Urban	57.7(48.2-66.6)	56.8(47.8-65.4)	57.2(48.3-65.7)
Semi urban	8.7(4.3-17.0)	6.8(3.1-14.4)	7.8(3.7-15.5)
Rural	33.6(27.4-40.5)	36.4(29.8-43.6)	35.0(28.9-41.7)
	P=0.187		
Physical Activity [b]			
≥600METS/week	88.9(84.0-92.5)	80.2(72.1-86.4)	84.6(78.2-89.3)
< 600METS/week	11.1(7.5-16.1)	19.8(13.6-27.9)	15.4(10.7-21.8)
	P<0.001		
Smoking			
Never smokers	57.3(52.3-62.1)	98.1(96.9-98.8)	77.6(74.2-80.6)

Variable	Men %(95% CI) 1611	Women %(95% CI) 1922	Total %(95% CI) 3533
Current smokers	33.0(29.0-37.2)	1.2(0.7-1.8)	17.2(14.8-19.8)
Ex-smokers	9.8(7.7-12.4)	0.8(0.3-1.7)	5.3(4.1-6.9)
	P<0.001		
Servings of fruits and vegetables			
≥5 /day	24.0(18.2-30.9)	23.8(18.1-30.6)	23.9(18.4-30.4)
< 5/day	76.0(69.1-81.9)	76.2(69.4-81.9)	76.1(69.6-81.6)
	P= 0.934		
BMI[c]			
Underweight	56.2(50.8-61.4)	46.6(42.8-50.5)	51.4(47.6-55.2)
Normal	9.7(7.6-12.4)	7.6(6.19.5)-	8.7(7.2-10.4)
Overweight	26.0(21.1-31.6)	28.8(25.8-31.9)	27.4(24.0-31.1)
Obese	8.1(6.0-11.0)	17.0(14.7-19.7)	12.6(10.5-14.9)
	P<0. 001		
Mean height (cm)	166.9(165.1-168.7)	160.5(159.5-161.5)	163.7(162.4-165.0)
Mean weight (kg)	65.2(64.1-66.3)	65.5(63.8-67.3)	65.4(64.2-66.5)
Mean BMI(kg/m^2)	23.6(23.1-24.1)	25.6(24.9-26.3)	24.6(24.1-25.1)
Waist circumference [d]			
Normal	89.7(86.7-92.2)	54.2(47.4-60.7)	72.3(67.8-76.3)
High	10.3(7.8-13.4)	45.9(39.3-52.6)	27.7(23.7-32.2)
Mean waist circumference	72.1(65.1-75.0)	76.0(72.9-79.1)	74.0(71.1-76.9)
Waist-to-Hip Ratio [e]			
Normal	83.2(79.4-86.4)	60.6(54.8-66.1)	72.1(68.1-75.8)
High	16.8(13.6-20.6)	39.4(33.9-45.2)	27.9(24.2-31.9)
	P<0.001		
Waist-Height Ratio			
Normal (≤0.5)	81.9(77.9-85.4)	59.9(53.2-66.3)	71.1(66.2-75.6)
High (>0.5)	18.1(14.6-22.1)	40.1(33.7-46.8)	28.9(24.4-33.8)
	P<0.001		
Mean Hip Circumference (cm)	89.3(87.0-91.6)	94.2(92.1-96.3)	91.7(89.7-93.8)

Note: Data shown have been weighted for non-response and the analysis took into account the complex survey design.

[a] KM=Kanifing Municipality; WCR =West Coast Region; LRR= Lower River Region; NBR =North Bank Region; CRRN = Central River Region North, CRRS=Central River Region South; URR =Upper River Region

[b] METS =Metabolic equivalents

[c] BMI is categorised into underweight (BMI<18.5kg/m^2), normal (18.5-24.9 Kg/m^2), overweight (25.0-29.9kg/m^2) and obese (BMI ≥30kg/m^2).

[d] Based on the definition of the International Diabetes Federation (High waist circumference, indicating abdominal obesity defined as ≥90 cm in men or ≥80 cm in women)

[e] Based on the WHO definitions (high WHR defined as >0.90 in men and >85 in women)

NB: The p value indicates the statistical significance of the difference in proportions between men and women obtained using Pearson's chi-squared test

Supplementary Table 2: Prevalence of BMI categories by selected socio-demographic, behavioural and biological factors in men [a, b, c]

Variable	Normal (desirable) %(95% CI)	Underweight %(95% CI)	Overweight %(95% CI)	Obese %(95% CI)	χ^2 P value
Total	56.2(50.8-61.4)	9.7(7.6-12.4)	26.0(21.1-31.6)	8.1(6.0-11.0)	
Age Group					
25 -34	59.0(52.2-65.6)	11.6(8.4-15.9)	22.0(16.3-29.0)	7.3(4.9-10.7)	**0.003**
35-44	54.0(47.3-60.6)	7.3(4.9-10.8)	32.4(25.7-39.8)	6.4(4.1-9.7)	
45-54	48.7(40.5-56.9)	9.3(5.7-14.8)	29.6(23.4-36.7)	12.4(8.8-17.3)	
55-64	61.0(53.4-68.1)	8.0(5.1-12.3)	21.8(16.0-29.0)	9.1(4.6-17.4)	
Marital status					
Never married	55.1(45.1-64.7)	11.9(7.4-18.4)	24.3(16.0-35.2)	8.7(4.8-15.2)	0.222
Married	56.1(50.7-61.4)	7.9(6.0-10.4)	27.7(23.1-32.9)	8.2(5.8-11.6)	
Separated	49.6(34.1-65.2)	14.6(5.7-32.4)	32.1(19.4-48.0)	3.8(0.8-15.6)	
Widowed	63.3(17.6-93.3)	36.8(6.7-82.4)	0.0	0.0	
Cohabiting	60.4(48.7-71.0)	16.3(8.6-29.0)	16.2(9.6-25.8)	7.1(3.5-13.9)	
Ethnicity					
Mandinka	56.8(50.5-62.8)	11.5(8.6-15.1)	25.5(19.1-33.1)	6.3(4.1-9.6)	**0.042**
Wollof	46.8(38.0-55.8)	10.8(6.2-17.9)	32.3(24.4-41.4)	10.2(6.2-16.4)	
Fula	59.1(50.8-66.9)	8.4(5.3-13.1)	25.2(18.3-33.5)	7.3(4.2-12.2)	
Jola	62.6(52.8-71.4)	8.2(4.7-14.1)	22.1(15.3-30.8)	7.1(3.5-13.9)	
Others	55.0(45.2-64.4)	4.8(2.3-9.9)	23.8(16.0-33.7)	16.5(9.8-26.4)	
Residence (LGA) [d]					
Banjul & KM	33.4(25.4-42.8)	3.2(1.7-6.0)	47.2(37.6-57.0)	16.2(11.0- 23.1)	**<0.001**
WCR	68.5(63.5-73.2)	15.3(11.7-19.7)	11.9(9.0-15.4)	4.4(2.9-6.6)	
URR	49.6(38.9-60.3)	4.2(2.0-8.6)	32.4(26.1-39.3)	13.8(8.9-20.9)	
NBR	65.6(54.9-74.9)	13.9(9.1-20.6)	19.1(13.0-27.1)	1.5(1.6-3.4)	
CRR	67.1(54.1-77.9)	15.5(9.6-23.9)	15.6(10.1-23.4)	1.9(0.7-4.4)	
LRR	75.9(62.0-85.9)	5.7(3.0-10.7)	17.9(8.5-34.0)	0.5(0.1-3.1)	
Residence (Rurality)					
Urban	49.1(41.2-57.1)	9.2(6.2-13.5)	30.9(23.2-39.9)	10.7(7.4-15.4)	**0.001**
Semi urban	54.1(40.1-67.5)	8.4(3.3-19.5)	27.7(17.6-40.8)	9.8(4.7-19.1)	
Rural	68.8(62.6-74.3)	10.9(8.1-14.6)	17.1(13.0-22.2)	3.2(1.8-5.6)	
Education level					
No formal education	59.4(54.4-64.1)	9.3(7.1-12.0)	24.9(20.5-29.8)	6.5(4.6-9.3)	**0.007**

Variable	**Normal (desirable) %(95% CI)**	**Underweight %(95% CI)**	**Overweight %(95% CI)**	**Obese %(95% CI)**	**χ^2 P value**
Primary/ Middle	61.3(51.9-69.9)	13.4(8.3-21.0)	19.4(13.4-27.4)	5.9(3.0-11.2)	
Secondary/Tertiary	47.7(38.6-56.9)	8.0(4.6-13.7)	32.1(23.6-42.1)	12.1(8.2-17.7)	
Years spent in school					
≤6 Years	60.5(55.7-65.1)	9.4(7.3-12.1)	23.7(19.6-28.3)	6.4(4.6-8.9)	**0.003**
7-12 Years	49.7(41.7-57.8)	13.3(8.6-19.9)	27.9(20.1-37.2)	9.1(5.8-14.1)	
>12 Years	48.5(35.4-61.7)	4.3(2.2-8.5)	34.3(24.8-45.3)	12.9(7.1-22.4)	
Smoking					
Never smokers	53.1(46.8-59.3)	7.0(5.1-9.7)	30.1(24.3-36.7)	9.8(6.8-13.8)	**<0.001**
Current smokers	61.6(54.8-68.1)	13.8(11.0-17.3)	18.8(13.5-25.4)	5.8(3.9-8.7)	
Ex-smokers	55.5(46.8-63.9)	11.8(6.7-20.0)	26.4(18.3-36.6)	6.3(3.2-12.1)	
Servings of fruits and vegs					
≥ 5/day	61.8(54.1-68.8)	9.1(6.5-12.7)	23.3(17.7-29.9)	5.8(3.5-9.6)	0.321
< 5/day	54.1(47.2-60.8)	10.5(7.6-14.3)	27.8(21.5-35.1)	7.8(5.1-10.1)	
Physical Activity [e]					
<600METS/week	46.5(36.3-57.0)	4.7(2.3-9.4)	31.3(22.7-41.4)	17.5(11.5-25.7)	**<0.001**
≥600METS/week	56.8(51.0-62.3)	10.5(8.1-13.5)	25.7(20.2-32.0)	7.1(5.2-9.7)	
Waist circumference [f]					
Normal	57.4(51.3-63.2)	10.9(8.4-14.1)	24.2(18.6-30.7)	7.6(5.3-10.7)	**<0.001**
High	43.2(34.4-52.4)	1.5(0.5-4.7)	41.5(33.2-50.3)	13.8(8.8-21.6)	

Note: Data shown have been weighted for non-response and the analysis took into account the complex survey design.

[a] BMI is categorised into underweight (BMI<18.5kg/m^2), normal (18.5-24.9 kg/m^2), overweight (25.0-29.9kg/m^2) and obese (BMI≥30kg/m^2).
[b] Results adjusted for complex survey design and weighted for non-response
[c] Row percentages are presented, i.e the prevalence of being in that BMI category for people with that socio-demographic and behavioural or biological characteristic
N= unweighted sample/observations
[d] KM= Kanifing Municipality; WCR =West Coast Region; URR =Upper River Region.; NBR =North Bank Region ; CRRS=Central River Region South ; CRRN = Central River Region North ; LRR= Lower River Region. Regions ordered from most to least urban
[e] METS =Metabolic equivalents
[f] Based on the definition of the International Diabetes Federation (High waist circumference, indicating abdominal obesity defined as ≥90 cm in men or ≥80 cm in women)

Supplementary Table 3: Prevalence of BMI categories by selected socio-demographic, behavioural and biological factors in women [a, b, c]

Variable	Normal (desirable) %(95% CI)	Underweight %(95% CI)	Overweight %(95% CI)	Obese %(95% CI)	χ^2 P value
Total	46.6(42.8-50.5)	7.6(6.1-9.5)	28.8(25.8-31.9)	17.0(14.7-19.7)	
Age Group					
25 -34	51.6(46.9-56.2)	8.3(6.3-10.9)	27.4(23.7-31.5)	12.8(10.0-16.2)	**0.001**
35-44	46.1(39.5-52.9)	6.3(4.4-8.9)	28.5(22.9-34.8)	19.1(14.9-24.2)	
45-54	43.3(35.9-51.0)	6.4(3.8-10.5)	32.6(26.5-39.2)	17.7(12.5-24.4)	
55-64	30.3(22.6-39.2)	10.1(5.5-17.9)	29.3(20.3-40.4)	30.3(20.9-41.7)	
Marital status					
Never married	46.8(36.0-57.9)	6.3(3.1-12.7)	36.2(26.4-47.2)	10.7(6.3-17.4)	**0.001**
Married	46.6(42.3-51.0)	6.9(5.2-9.1)	27.9(24.7-31.3)	18.6(15.8-21.8)	
Separated	32.5(22.5-44.4)	9.6(4.5-19.2)	40.8(29.6-53.1)	17.1(9.3-29.5)	
Widowed	37.1(26.6-48.9)	6.0(2.6-13.4)	30.4(21.0-41.8)	26.5(16.1-40.5)	
Cohabiting	57.6(46.8-67.6)	12.5(7.9-19.2)	22.7(16.1-31.1)	7.3(4.8-10.7)	
Ethnicity					
Mandinka	51.1(46.0-56.2)	9.0(6.7-11.9)	26.4(22.6-30.7)	13.5(10.7-16.8)	0.066
Wollof	42.4(33.1-52.4)	4.8(2.7-8.2)	29.3(22.7-36.9)	23.5(17.8-30.4)	
Fula	44.6(37.8-51.6)	7.7(5.2-11.3)	31.7(26.5-37.4)	16.0(12.2-20.6)	
Jola	45.1(37.0-53.4)	8.9(5.1-15.0)	26.4(20.0-33.9)	19.7(13.4-28.0)	
Others	42.5(32.4-53.3)	4.8(2.8-8.1)	34.4(26.8-42.8)	18.3(12.5-26.1)	
Residence (LGA) [d]					
Banjul & KM	32.6(27.2-38.4)	2.3(1.1-4.6)	38.8(33.1-44.8)	26.3(22.1-31.1)	**<0.001**
WCR	49.8(42.8-56.7)	11.4(8.1-15.7)	25.4(20.3-31.2)	13.5(10.0-18.1)	
URR	53.9(45.9-61.6)	9.5(4.7-18.2)	22.7(15.1-32.7)	13.9(8.5-21.8)	
NBR	53.8(46.8-60.6)	13.4(8.2-20.9)	20.9(16.0-26.8)	12.0(9.5-15.2)	
CRR	67.3(51.3-80.1)	7.5(5.0-11.0)	17.7(10.6-27.9)	7.6(3.1-17.1)	
LRR	57.9(44.8-70.0)	7.4(2.9-20.9)	25.6(17.1-36.3)	9.1(4.4-17.9)	
Residence (Rurality)					
Urban	38.0(33.1-43.2)	5.1(3.3-7.7)	34.2(29.7-39.0)	22.7(19.3-26.6)	**<0.001**
Semi urban	43.5(37.5-49.7)	4.2(2.8-6.3)	35.2(30.0-40.8)	17.1(13.8-21.1)	
Rural	60.6(54.9-66.1)	12.1(9.3-15.6)	19.1(15.6-23.2)	8.1(6.1-10.6)	
Education level					
No formal education	49.5(45.3-53.7)	7.6(5.9-9.9)	27.4(24.1-31.0)	15.6(12.9-18.4)	**0.002**
Primary/ Middle	46.7(39.9-53.6)	8.2(5.4-12.4)	27.2(21.6-33.7)	17.9(13.2-23.9)	

Variable	Normal (desirable) %(95% CI)	Underweight %(95% CI)	Overweight %(95% CI)	Obese %(95% CI)	χ^2 P value
Secondary/Tertiary	32.0(25.0-39.8)	6.3(4.0-9.5)	37.9(30.8-45.5)	23.9(17.7-31.6)	
Years spent in school					
≤6 Years	49.2(45.2-53.2)	8.0(6.3-10.1)	26.9(23.8-30.3)	15.9(13.5-18.6)	**0.012**
7-12 Years	38.5(31.0-46.7)	5.6(3.3-9.3)	35.5(28.8-43.0)	20.4(15.1-26.9)	
>12 Years	31.0(18.9-46.5)	7.5(3.0-17.8)	41.5(26.7-57.9)	20.0(9.1-38.3)	
Servings of fruits and vegs					
≥ 5/day	45.1(39.8-50.6)	9.5(6.0-14.7)	27.9(22.7-33.8)	17.5(12.9-23.2)	0.621
< 5/day	46.2(41.3-51.3)	7.0(5.2-9.4)	29.6(26.1-33.4)	17.2(14.5-20.3)	
Physical activity					
<600METS/week	39.0(32.6-45.8)	5.7(3.2-9.9)	31.6(23.8-40.5)	23.7(18.4-30.1)	**0.022**
≥600METS/week	48.3(43.5-53.0)	8.0(6.3-10.4)	28.0(24.9-31.3)	15.7(13.1-18.6)	
Waist circumference [e]					
Normal	51.8(46.1-57.5)	10.3(7.7-13.8)	24.5(20.1-29.3)	13.4(9.6-18.4)	**<0.001**
High	39.7(34.2-45.4)	4.7(3.1-7.1)	34.3(29.9-39.1)	21.3(17.8-25.2)	

Note: Data shown have been weighted for non-response and the analysis took into account the complex survey design.

[a] BMI is categorised into underweight (BMI<18.5Kg/m^2), normal (18.5-24.9 Kg/m^2), overweight (25.0-29.9Kg/m^2) and obese (BMI ≥30Kg/m^2).
[b] Results adjusted for complex survey design and weighted for non-response
[c] Row percentages are presented, i.e the prevalence of being in that BMI category for people with that socio-demographic, behavioral or biological characteristic
N= unweighted sample/observations
[d] KM= [a] KM=Kanifing Municipality; WCR =West Coast Region; URR =Upper River Region.; NBR =North Bank Region ; CRRS=Central River Region South ; CRRN = Central River Region North ; LRR= Lower River Region. Regions ordered from most to least urban
[e] METS =Metabolic equivalents
[f] Based on the definition of the International Diabetes Federation (High waist circumference, indicating abdominal obesity defined as ≥90 cm in men or ≥80 cm in women)

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

	Item No	Recommendation	This manuscript
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	The term 'cross-sectional surveys' survey' in the title and the abstract
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	Yes
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	Yes
Objectives	3	State specific objectives, including any prespecified hypotheses	Yes
Methods			
Study design	4	Present key elements of study design early in the paper	Yes (In the title and abstract)
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	Yes (In the abstract and methods)
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	Yes (In the abstract and methods)
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	Yes (In the abstract and methods)
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	Yes (In the methods)
Bias	9	Describe any efforts to address potential sources of bias	Yes
Study size	10	Explain how the study size was arrived at	Yes
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	Yes
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	Yes
		(*b*) Describe any methods used to examine subgroups and interactions	Yes
		(*c*) Explain how missing data were addressed	Yes

		(*d*) If applicable, describe analytical methods taking account of sampling strategy	Yes
		(*e*) Describe any sensitivity analyses	We conducted a number of regression analyses adjusting for different variables.
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	Yes (See Figure 1)
		(b) Give reasons for non-participation at each stage	Yes
		(c) Consider use of a flow dia9(gram	Yes (Figure 1)
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	Yes (Table S1)
		(b) Indicate number of participants with missing data for each variable of interest	Not done
Outcome data	15*	Report numbers of outcome events or summary measures	N/A
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	Yes
		(*b*) Report category boundaries when continuous variables were categorized	NA
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	Yes
Discussion			
Key results	18	Summarise key results with reference to study objectives	Yes
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	Yes (Lines 411-435)
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations,	Yes

		multiplicity of analyses, results from similar studies, and other relevant evidence	
Generalisability	21	Discuss the generalisability (external validity) of the study results	Yes
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	Yes

*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.