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# **BMJ Open**

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

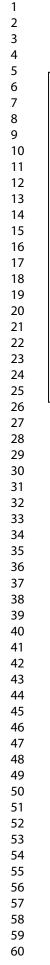
### Results

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



Word count: Abstract = 298; Main document = 3271

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.

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### Introduction

Non-communicable diseases (NCDs) are increasing in sub-Saharan Africa (SSA). <sup>12</sup> NCDs account for 70% of global deaths; 80% occur in low- and middle-income countries.<sup>2</sup> A pooled analysis of 1698 population-based measurement studies comprising 19 million participants from 200 countries revealed an increasing trend of obesity globally.<sup>3</sup> 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 noncommunicable diseases, namely that of underweight/malnutrition and obesity.<sup>4 5</sup>

A pooled analysis of population-based studies from 1980-2014 in Africa demonstrated a significant increase in age-standardised mean BMI across the continent.<sup>6</sup> 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.<sup>7</sup> There is evidence suggesting obesity is increasing more quickly in developing countries, especially in SSA, compared with developed countries. <sup>8 9</sup>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.<sup>10-13</sup>

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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.<sup>14</sup> In a nationwide assessment among Gambians aged 16 years and above in 1996, 18% were underweight, 8% overweight and 2% obese. <sup>15</sup> 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. <sup>16</sup> 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. <sup>17</sup> 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.<sup>2 18 19</sup> 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.

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### 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.<sup>17</sup> Briefly, data were collected from a random sample of adults aged 25-64 years from January to March 2010 using the WHO STEPwise approach.<sup>17 20</sup>The anthropometric measurements were performed by field workers at participants' residences. Weight, height and waist circumference were measured using WHO STEP protocols.<sup>20</sup> 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<sup>2</sup>). We categorised BMI into underweight (BMI <18.5kg/m<sup>2</sup>), normal/desirable weight (18.5-24.9kg/m<sup>2</sup>), overweight (25.0-29.9kg/m<sup>2</sup>) and obese (BMI  $\ge$ 30kg/m<sup>2</sup>), using the WHO thresholds.<sup>21</sup> Secondly, we used abdominal obesity (high waist circumference) as the outcome, defined using the International Diabetes Federation thresholds ( $\ge$ 90 cm in men and  $\ge$ 80 cm in women).<sup>22</sup>

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### 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,

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 we did not include abdominal obesity in the models for BMI because of the collinearity of waist circumference and BMI.<sup>23</sup>

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

### **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 <sup>17</sup>, the results of this study will be shared with the public and will also be used to inform policy.

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### 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<sup>2</sup> (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).

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### 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).

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# BMJ Open Table 1: Multinomial logistic regression on factors associated with being underweight, overweight of obese in men a, b

		Model I (Age adjust		₹Nogel II (Fully adjusted)			
	Underweight	Overweight	Obese	Underweight	d &Overweight	Obese	
Variable	RRR(95% CI) <sup>c</sup>	RRR(95% CI) <sup>c</sup>	RRR(95% CI) <sup>c</sup>	ARRR (95% CI) <sup>c</sup>	AKRR (95% CI) <sup>c</sup>	ARRR (95% CI) <sup>c</sup>	
Age Group							
25 - 34	Reference	Reference	Reference		n derence	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)	<b>5 8 0 0</b> (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)		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)	<b>F 9 P</b> 3(0 63_2 03)	2.88(1.22-6.80)**	
Ethnicity							
Mandinka	Reference	Reference	Reference	Reference	a Berence	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)	<b>ች ፰.፬</b> 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)*	<b>an 9.6</b> 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)	<b>d 4</b> .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)**		a 1 92(0.45-1.88)	1.97(0.71-5.43)	
Years spent in school							
≤6 Years	Reference	Reference	Reference	Reference	erence	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)	1.38(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)**	
<b>Residence</b> (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)	<b>1</b> . <b>6</b> 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)	a 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)	a 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)*	<b>a</b> 0. <b>5</b> 5(0.38-1.48)	0.58(0.21-1.63)	
Servings of fruit and veg					<del>C 8</del>		
$\geq$ 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)	<b>a</b> 1. <b>%</b> (1.06-2.87)*	2.75(1.12-6.75)*	
Physical Activity <sup>d</sup>				, , , , , , , , , , , , , , , , , , ,	at ies		
≥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)	
lote: Data shown have been w ully adjusted models mutually	0 1	2	t into account the comple	ex survey design.	ce Bibliogra		

<sup>a</sup> BMI is categorised into underweight (BMI<18.5kg/m<sup>2</sup>), normal (18.5-24.9 kg/m<sup>2</sup>, the reference group), overweight (25.0-2 $\frac{1}{10}$  9kg/m<sup>2</sup>) and obese (BMI  $\geq$ 30kg/m<sup>2</sup>). Those with a desirable weight (normal) used as reference 11 <sup>b</sup> Those with a desirable weight (normal) used as reference

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Page 13 of 31	BMJ Open 6 jog
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		Model I (Age adjusted		Mgodegii (Fully adjusted)			
	Underweight	Overweight	Obese	Underweight	🔒 🚊 Overweight	Obese	
Variable	RRR(95% CI) <sup>c</sup>	RRR(95% CI) <sup>c</sup>	RRR(95% CI) <sup>c</sup>	ARRR (95% CI) <sup>c</sup>	₽.AI&RR (95% CI) <sup>c</sup>	ARRR (95% CI) <sup>c</sup>	
Age Group							
25 - 34	Reference	Reference	Reference	Reference	<b>Q</b> 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)	<b>5 h</b> ∄ <b>7</b> (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)	<b>\$ 2,5</b> (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)*	₫ <b>₿</b> (1.58-4.99)***	4.90(2.44-9.82)***	
Ethnicity					to perference		
Mandinka	Reference	Reference	Reference	Reference	<b>R</b> egerence	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)	<b>PFB</b> (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)	<b>£6</b> (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)	<b><u><u><u></u></u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u></b>	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)**	<b><u><u><u></u></u></u></b> <u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u></u>	1.21(0.62-2.36)	
Years spent in school					in fro		
≤6 Years	Reference	Reference	Reference	Reference	T C C C C C C C C C C C C C C C C C C C	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)	<b>Ξ: 0</b> (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)	<b>₫</b> 2.49(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)*	<b>5</b> ·2. <b>3</b> (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)	<b>3</b> .( <b>5</b> (1.86-5.01)***	4.71(2.72-8.15)***	
Servings of fruits and					, a		
vegs					nd Ön		
$\geq$ 5/day	Reference	Reference	Reference	Reference	<b>⊈</b> 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)	<b>1</b> . <b>₽</b> (0.73-1.66)	1.13(0.74-1.75)	
Physical					un Jun		
Activity <sup>d</sup>					ecl		
≥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)	6 1.63 (0.63-1.82) gie at	1.02(0.55-1.91)	

BMJ Open Table 2: Multinomial logistic regression on factors associated with generalised underweight, over weight and obesity in women a, b

Note: Data shown have been weighted for non-response and the analysis took into account the complex survey design. 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 <sup>a</sup> BMI is categorised into underweight (BMI<18.5kg/m<sup>2</sup>), normal (18.5-24.9 kg/m<sup>2</sup>, the reference group), overweight (25.0-29.9gg/m<sup>2</sup>) and obese (BMI ≥30kg/m<sup>2</sup>).

<sup>b</sup> Those with a desirable weight(normal) used as reference; <sup>c</sup>RRR= Relative Risk Ratio adjusted for age (except for age group at the independent variable), ARRR= Fully Adjusted Relative Risk Ratio ; d METS = Metabolic equivalents . \*p<0.05, \*\*p≤0.01, \*\*\* p≤0.001 ibliographique de l

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).

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Table 3: Multivaria	ate logistic regressi	on on factors assoc	ciated with high wais	st circumference (ab	vbmjopen-2019-033881 d by copyright, including doing	
		Men			q _Women	
	Model I <sup>b</sup>	Model II b	Model III <sup>b</sup>	Model I <sup>b</sup>	б п Model II <sup>ь</sup>	Model III <sup>b</sup>
Variable	OR(95% CI) <sup>c</sup>	AOR (95% CI) <sup>c</sup>	AOR (95% CI) <sup>c</sup>	OR(95% CI) <sup>c</sup>	AORig 95% CD °	AOR (95% CI)
Age Group					Reference	
25 - 34	Reference	Reference	Reference	Reference	Rate for the nee	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)***	2,60-2.92)***	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)***	2000 (0.60-2.92)*** 1007 (\$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)***	3339(207-5.56)***	3.19(2.09-4.87)*
Ethnicity					aed	
Mandinka	Reference	Reference	Reference	Reference	365607-5.56)***	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)	1,00,00,00,000	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)		0.69(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)	058 0 55-1.21) 058 0 55-1.21)	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)	1000(654-1.84)	0.74(0.43-1.28)
Years spent in	0.01(0.30-1.74)	0.71(0.30-1.07)	0.03(0.27-1.44)	0.56(0.55-1.01)	• • •	0.74(0.45-1.26)
school					Altra	
≤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)	1210(278-1.55)	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 2 ( <b>1</b> 37-2.24)	0.82(0.32-2.06)
Residence (Local	1.21(0.00 2.20)	1.20(0.00 2.01)	1.00(0.00 1.77)	0.70(0.02 1.70)		0.02(0.02 2.00)
government area) <sup>d</sup>					sii N	
LRR	Reference	Reference		Reference	nd on	
CRR	1.75(0.32-9.53)	1.92(0.44-8.32)		0.89(0.33-2.41)	1,20(€45-3.18)	
NBR	1.94(0.66-5.65)	1.63(0.55-4.85)		1.18(0.64-2.20)	108(257-2.06)	
URR	0.08(0.01-0.65)**	0.14(0.02-0.98)*		0.24(0.11-0.51)***	0226(111-065)**	
WCR	2.66(1.02-6.96)	2.43(0.94-6.32)		1.62(0.83-3.15)	1059(11-005)	
Banjul & KM	0.71(0.25-2.03	0.71(0.24-2.07)		0.32(0.15-0.71)	0537(614-1.00)	
<b>Residence</b> (Rurality)	0.71(0.25 2.05	0./1(0.2+2.0/)		0.52(0.15 0.71)	0/	
Rural	Reference		Reference	Reference	Agence	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	0.32(0.12-0.82)		0.82(0.41-1.65)	0.82(0.49-1.37)		0.97(0.58-1.62)
Smoking	0.09(0.45-1.75)		0.02(0.41-1.03)	0.02(0.49-1.37)	<b>0</b>	0.97(0.36-1.02)
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)			
Current SHIOKEIS	0.72(0.72-1.20)	0.49(0.20-0.00)		1	Bibliographique	1
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		Men			it, 19-033882Women	
	Model I <sup>b</sup>	Model II <sup>b</sup>	Model III <sup>b</sup>	Model I <sup>b</sup>	💁 🖾 Model II b	Model III <sup>b</sup>
Variable	OR(95% CI) <sup>c</sup>	AOR (95% CI) <sup>c</sup>	AOR (95% CI) <sup>c</sup>	OR(95% CI) <sup>c</sup>	AOR-(95% CI) <sup>c</sup>	AOR (95% CI)
Ex-smokers	1.44(0.92-2.27)	1.24(0.81-1.91)	1.56(1.04-2.36)*		Uses contractions	
Servings of fruit and vegetables					es relate ଅନ୍ତି ଅନ୍ତି	
$\geq$ 5/day	Reference	Reference	Reference	Reference	Retence	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)	$0^{28}\vec{k}(\Phi_{50-1} 49)$	0.81(0.48-1.20)
Physical Activity				, , , , , , , , , , , , , , , , , , ,	033	, , , , , , , , , , , , , , , , , , ,
<600METS/week	Reference	Reference	Reference	Reference	Received and the second	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)	1348(881-2.62)	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.

Note: Data shown have been weighted for non-response and the analysis took into account the complex survey design. <sup>a</sup>Based on the definition of the International Diabetes Federation (High waist circumference, indicating abdominal obesity defined as  $\geq 90$  cm in men or  $\geq 80$  cm in women)

<sup>b</sup> Model I adjusted for age only; Model II adjusted for all variables except local government area; Model III adjusted for all variables except rurality

<sup>c</sup> OR= odds ratio adjusted for age (except for age group as the independent variable); AOR= Adjusted odds ratio (fully adjusted). //bmjopen.bmj.com/site/about/guidelines.xhtml <sup>e</sup> METS =Metabolic equivalents

\*p<0.05, \*\*p≤0.01, \*\*\* p≤0.001

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### 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. <sup>15</sup> 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 <sup>24</sup>, Eritrea <sup>25</sup> and Mozambique <sup>26 27</sup> but is less than that reported in The Republic of Seychelles. <sup>28</sup> The high prevalence of obesity in The Gambia is a cause for concern, given the increasing burden of NCDs, notably hypertension. <sup>17</sup>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.<sup>15 16</sup> Despite the health risks associated with overweight/obesity, Gambians are culturally obesity tolerant. <sup>29 30</sup>It has been well documented that perceptions of body weight vary across different parts of the world. <sup>31 32</sup>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. <sup>31 32</sup> This is the case in The Gambia.; a study on the

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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. <sup>29</sup> 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. <sup>29</sup> 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. <sup>30</sup> 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 <sup>33 34</sup> and in Zambia. <sup>35</sup> 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. <sup>36-39</sup> 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:

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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. <sup>40</sup> 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. <sup>41</sup> 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. <sup>42 43</sup> 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. <sup>44</sup> 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.

### **BMJ** Open

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

### 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 selfreported 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

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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	1011	1722	5555
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<0.9	37	
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<0.0	01	
Ethnicity		20 2(22 4 45 6)	40 7/25 6 46 0
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) 8.7(6.6-11.5)	15.1(11.1-20.2)	13.6(9.8-18.6)
Other	8.7(0.0-11.5) P=0.1	11.1(8.5-14.4)	9.9(7.8-12.5)
Years spent in school	r –0.1	04	
≤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<0.0		(
Residence (Local			
government area) <sup>a</sup>			
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=0.1	31	
Residence (Rurality)			57 Q(49 Q 65 7)
	57.7(48.2-66.6)	56.8(47.8-65.4)	57.2(48.3-65.7)
Urban Sami arban	07(12170)	(0/2 1 1 4 4)	
Semi urban	8.7(4.3-17.0)	6.8(3.1-14.4)	7.8(3.7-15.5)
	33.6(27.4-40.5)	36.4(29.8-43.6)	35.0(28.9-41.7)
Semi urban Rural	· /	36.4(29.8-43.6)	
Semi urban Rural Physical Activity <sup>b</sup>	33.6(27.4-40.5) P=0.1	36.4(29.8-43.6) 87	35.0(28.9-41.7)
Semi urban Rural Physical Activity <sup>b</sup> ≥600METS/week	33.6(27.4-40.5) P=0.1 88.9(84.0-92.5)	36.4(29.8-43.6) 87 80.2(72.1-86.4)	35.0(28.9-41.7) 84.6(78.2-89.3)
Semi urban Rural Physical Activity <sup>b</sup>	33.6(27.4-40.5) P=0.1 88.9(84.0-92.5) 11.1(7.5-16.1)	36.4(29.8-43.6) 87 80.2(72.1-86.4) 19.8(13.6-27.9)	35.0(28.9-41.7)
Semi urban Rural Physical Activity <sup>b</sup> ≥600METS/week	33.6(27.4-40.5) P=0.1 88.9(84.0-92.5)	36.4(29.8-43.6) 87 80.2(72.1-86.4) 19.8(13.6-27.9)	35.0(28.9-41.7) 84.6(78.2-89.3)

Variable	Men	Women	Total
	%(95% CI)	%(95% CI)	%(95% CI)
	1611	1922	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<0.0	01	
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= 0.9	034	
BMI <sup>c</sup>			
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. (		
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 <sup>2</sup> )	23.6(23.1-24.1)	25.6(24.9-26.3)	24.6(24.1-25.1)
Waist circumference <sup>d</sup>			
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	72.1(65.1-75.0)	76.0(72.9-79.1)	74.0(71.1-76.9)
circumference			
Waist-to-Hip Ratio <sup>e</sup>			
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<0.0	01	
Waist-Height Ratio			
Normal ( $\leq 0.5$ )	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<0.0	001	. ,
Mean Hip	89.3(87.0-91.6)	94.2(92.1-96.3)	91.7(89.7-93.8)
Circumference (cm)			<pre></pre>

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

<sup>a</sup> 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 <sup>b</sup> METS =Metabolic equivalents

<sup>c</sup> BMI is categorised into underweight (BMI<18.5kg/m<sup>2</sup>), normal (18.5-24.9 Kg/m<sup>2</sup>), overweight (25.0-29.9kg/m<sup>2</sup>) and obese (BMI  $\ge$  30kg/m<sup>2</sup>).

<sup>d</sup> Based on the definition of the International Diabetes Federation (High waist circumference, indicating abdominal obesity defined as  $\geq$ 90 cm in men or  $\geq$ 80 cm in women)

<sup>e</sup> 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

Page 29 of 31

31	BMJ Open by cope
	Supplementary Table 2: Prevalence of BMI categories by selected socio-demographic, behavioural and biological factors in men <sup>a, b, c</sup>

Variable	Normal (desirable) %(95% CI)	Underweight %(95% CI)	Overweight %(95% CI)	ର୍ଜ୍ଞ ଲୁ 20bese ଓ ୫/ସ୍ଟି95% CI)	χ <sup>2</sup> P value
Total	56.2(50.8-61.4)	9.7(7.6-12.4)	26.0(21.1-31.6)	<b>e</b> ( <b>g</b> ) <b>2</b> 8.1(6.0-11.0) <b>e</b> ( <b>g</b> ) <b>2</b> .8.1(6.0-11.0) <b>e</b> ( <b>g</b> ) <b>2</b> .8.1(7.0) <b>e</b> ( <b>g</b> ) <b>2</b> .8.1(7	
Age Group				ate	
25 - 34	59.0(52.2-65.6)	11.6(8.4-15.9)	22.0(16.3-29.0)	<b>T D</b> 7.3(4.9-10.7)	0.00
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)	a = 012.4(0.0-17.3)	
55-64	61.0(53.4-68.1)	8.0(5.1-12.3)	21.8(16.0-29.0)	and 9.1(4.6-17.4) det f dat f table 8.7(4.8-15.2)	
Marital status					
Never married	55.1(45.1-64.7)	11.9(7.4-18.4)	24.3(16.0-35.2)	at 3 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)	$\exists \square = 8.2(5.8-11.6)$	
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		
Cohabiting	60.4(48.7-71.0)	16.3(8.6-29.0)	16.2(9.6-25.8)	≥ 37.1(3.5-13.9)	
Ethnicity					
Mandinka	56.8(50.5-62.8)	11.5(8.6-15.1)	25.5(19.1-33.1)	tra op in n 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)	<b>1</b> 0.2(6.2-16.4)	
Fula	59.1(50.8-66.9)	8.4(5.3-13.1)	25.2(18.3-33.5)	a 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)	<b>a 9</b> 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)	<b>S</b> i <b>o</b> 16.5(9.8-26.4)	
Residence (LGA) <sup>d</sup>	``			nila u	
Banjul & KM	33.4(25.4-42.8)	3.2(1.7-6.0)	47.2(37.6-57.0)	<b>15</b> .2(11.0-23.1)	<0.00
WCR	68.5(63.5-73.2)	15.3(11.7-19.7)	11.9(9.0-15.4)	<b>6 6</b> 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)	3.8(8.9-20.9)	
NBR	65.6(54.9-74.9)	13.9(9.1-20.6)	19.1(13.0-27.1)	<b>0 2 1</b> .5(1.6-3.4)	
CRR	67.1(54.1-77.9)	15.5(9.6-23.9)	15.6(10.1-23.4)	<b>e</b> at 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)	<b>&gt;</b> 0.5(0.1-3.1)	
<b>Residence</b> (Rurality)	``	· · · · · · · · · · · · · · · · · · ·	· · · · · · · · · · · · · · · · · · ·	er	
Urban	49.1(41.2-57.1)	9.2(6.2-13.5)	30.9(23.2-39.9)	<b>6</b> 10.7(7.4-15.4)	0.00
Semi urban	54.1(40.1-67.5)	8.4(3.3-19.5)	27.7(17.6-40.8)	<b>D</b> .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				g	
No formal education	59.4(54.4-64.1)	9.3(7.1-12.0)	24.9(20.5-29.8)	<b>b</b> 6.5(4.6-9.3)	0.00

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Variable	Normal (desirable) %(95% CI)	Underweight %(95% CI)	Overweight %(95% CI)	La Cobese	χ <sup>2</sup> P value
Primary/ Middle	61.3(51.9-69.9)	13.4(8.3-21.0)	19.4(13.4-27.4)	<b>9 9</b> 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)	<b>9 1</b> 2.1(8.2-17.7)	
Years spent in school	, , ,	· · · · · · · · · · · · · · · · · · ·	``````````````````````````````````````	ũπ	
≤6 Years	60.5(55.7-65.1)	9.4(7.3-12.1)	23.7(19.6-28.3)	<b>8 5 6</b> 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)	<u>e.e.</u> 89.1(5.8-14.1)	
>12 Years	48.5(35.4-61.7)	4.3(2.2-8.5)	34.3(24.8-45.3)	<b>e e 9</b> 2.9(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)	6 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)	x μ ο 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)	an e d 6.3(3.2-12.1)	
Servings of fruits and vegs				deu du	
$\geq$ 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)	<b>B 7</b> .8(5.1-10.1)	
Physical Activity <sup>e</sup>					
<600METS/week	46.5(36.3-57.0)	4.7(2.3-9.4)	31.3(22.7-41.4)	<b>.</b> 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)	≥ 3 7.1(5.2-9.7)	<0.001
Waist circumference <sup>f</sup>				op	
Normal	57.4(51.3-63.2)	10.9(8.4-14.1)	24.2(18.6-30.7)	<b>n</b> 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)	<b>1</b> 3.8(8.8-21.6)	

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

<sup>b</sup> Results adjusted for complex survey design and weighted for non-response

<sup>c</sup> Row percentages are presented, i.e the prevalence of being in that BMI category for people with that socio-demographic and the percentages are presented, i.e the prevalence of being in that BMI category for people with that socio-demographic and the percentage of being in that BMI category for people with that socio-demographic and the percentage of being in that BMI category for people with that socio-demographic and the percentage of being in that BMI category for people with that socio-demographic and the percentage of being in that BMI category for people with that socio-demographic and the percentage of being in that BMI category for people with that socio-demographic and the percentage of being in that BMI category for people with that socio-demographic and the percentage of being in that BMI category for people with that socio-demographic and the percentage of being in that BMI category for people with that socio-demographic and the percentage of being in that BMI category for people with that socio-demographic and the percentage of being in that BMI category for people with that socio-demographic and the percentage of being in that BMI category for people with that socio-demographic and the percentage of being in that BMI category for people with that socio-demographic and the percentage of being in that BMI category for people with that socio-demographic and the percentage of being in that BMI category for people with that socio-demographic and the percentage of being in that BMI category for people with that socio-demographic and the percentage of being in the percentage of being in that BMI category for people with that socio-demographic and the percentage of being in the percen

River Region North ; LRR= Lower River Region. Regions ordered from most to least urban Agen

<sup>e</sup> METS =Metabolic equivalents

<sup>f</sup> Based on the definition of the International Diabetes Federation (High waist circumference, indicating abdominal obesity defined  $\frac{2}{8}$  s  $\ge$  90 cm in men or  $\ge$  80 cm in women)

Page 31 of 31

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# BMJ Open nentary Table 3: Prevalence of BMI categories by selected socio-demographic, behavioural and biological factors in women <sup>a, b, c</sup>

Variable	Normal (desirable) %(95% CI)	Underweight %(95% CI)	Overweight %(95% CI)	G → Obese S m ∰ (95% CI)	χ <sup>2</sup> P value
Total	46.6(42.8-50.5)	7.6(6.1-9.5)	28.8(25.8-31.9)	<b>S S O</b> 17.0(14.7-19.7)	1 value
Age Group	40.0(42.8-30.3)	7.0(0.1-9.5)	20.0(25.0-51.9)		
25 -34	51.6(46.9-56.2)	8.3(6.3-10.9)	27.4(23.7-31.5)	<b>a b c 12.8</b> (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)	<b>6 9 9 1 9 1 1 1 1 1 1 1 1 1 1</b>	0.001
45-54	43.3(35.9-51.0)	6.4(3.8-10.5)	32.6(26.5-39.2)	<b>6 1</b> 7.7(12.5-24.4)	
55-64	30.3(22.6-39.2)	10.1(5.5-17.9)	29.3(20.3-40.4)		
Marital status	50.5(22.0 57.2)	1011(010 1113)	29.3(20.5 10.1)	* up 030.3(20.9-41.7)	
Never married	46.8(36.0-57.9)	6.3(3.1-12.7)	36.2(26.4-47.2)	<b>a a b</b> 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)		0.001
Separated	32.5(22.5-44.4)	9.6(4.5-19.2)	40.8(29.6-53.1)	<b>10.7(6.3-17.4)</b> <b>10.7(6.3-17.4)</b> <b>11.6(15.8-21.8)</b> <b>11.1(9.3-29.5)</b>	
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)	<b>G</b> · <b>B</b> 7.3(4.8-10.7)	
Ethnicity				≥ 3.	
Mandinka	51.1(46.0-56.2)	9.0(6.7-11.9)	26.4(22.6-30.7)	a 213.5(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)	<b>16.0(12.2-20.6)</b>	
Jola	45.1(37.0-53.4)	8.9(5.1-15.0)	26.4(20.0-33.9)	<b>a</b> (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)	<b>a 18.3</b> (12.5-26.1)	
<b>Residence</b> (LGA) <sup>d</sup>				in o	
Banjul & KM	32.6(27.2-38.4)	2.3(1.1-4.6)	38.8(33.1-44.8)	a <u>26.3(22.1-31.1)</u>	<0.001
WCR	49.8(42.8-56.7)	11.4(8.1-15.7)	25.4(20.3-31.2)	<b>6 1</b> 3.5(10.0-18.1)	
URR	53.9(45.9-61.6)	9.5(4.7-18.2)	22.7(15.1-32.7)	<b>S o</b> 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)	τ         π         13.5(10.0-18.1)           τ         τ         τ         τ           τ         τ         τ         τ         τ           τ         τ         τ         τ         τ         τ           τ	
CRR	67.3(51.3-80.1)	7.5(5.0-11.0)	17.7(10.6-27.9)		
LRR	57.9(44.8-70.0)	7.4(2.9-20.9)	25.6(17.1-36.3)	<b>es a</b> 9.1(4.4-17.9)	
<b>Residence</b> (Rurality)				Ag	
Urban	38.0(33.1-43.2)	5.1(3.3-7.7)	34.2(29.7-39.0)	<b>5</b> 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)	<b>ö</b> 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				liö	
No formal education	49.5(45.3-53.7)	7.6(5.9-9.9)	27.4(24.1-31.0)	<b>91</b> 5.6(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)	<b>9</b> 17.9(13.2-23.9)	

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	Page 3	2 of 31
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	Normal (desirable) %(95% CI)	Underweight %(95% CI)	Overweight %(95% CI)	nt, 19 9 10 10 10 10 10 10 10 10 10 10 10 10 10	χ <sup>2</sup> P value
Secondary/Tertiary	32.0(25.0-39.8)	6.3(4.0-9.5)	37.9(30.8-45.5)	<b>9</b> 23.9(17.7-31.6)	
Years spent in school		, /		<u>ē</u> <u>,</u> <u>,</u> <u>,</u>	
≤6 Years	49.2(45.2-53.2)	8.0(6.3-10.1)	26.9(23.8-30.3)	נה ב15.9(13.5-18.6)	0.01
7-12 Years	38.5(31.0-46.7)	5.6(3.3-9.3)	35.5(28.8-43.0)	\$ 5 6 20.4(15.1-26.9)	01012
>12 Years	31.0(18.9-46.5)	7.5(3.0-17.8)	41.5(26.7-57.9)	ego 20.0(9.1-38.3)	
Servings of fruits and vegs				20. ate	
$\geq$ 5/day	45.1(39.8-50.6)	9.5(6.0-14.7)	27.9(22.7-33.8)	<b>G D</b> 17.5(12.9-23.2)	0.62
< 5/day	46.2(41.3-51.3)	7.0(5.2-9.4)	29.6(26.1-33.4)	<b>5 1</b> 7.2(14.5-20.3)	
Physical activity				Sup	
<600METS/week	39.0(32.6-45.8)	5.7(3.2-9.9)	31.6(23.8-40.5)	an e <u>6</u> 23.7(18.4-30.1)	0.02
≥600METS/week	48.3(43.5-53.0)	8.0(6.3-10.4)	28.0(24.9-31.3)	<b>a a b a</b> 15.7(13.1-18.6)	
Waist circumference <sup>e</sup>		``````````````````````````````````````	· · · · · ·	ror r (A	
Normal	51.8(46.1-57.5)	10.3(7.7-13.8)	24.5(20.1-29.3)	<b><u><u></u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u></b>	<0.00
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)	
S =Metabolic equivalents d on the definition of the Internation	nal Diabetes Federation (High v	vaist circumference, indicatin	ng abdominal obesity def	Fred as ≥90 cm in men c	
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# **BMJ Open**

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

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Secondary Subject Heading:	Global health, Public health
Keywords:	Obesity, non-communicable diseases, sub-Saharan Africa, The Gambia, WHO STEP survey

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4	2	population-based cross-sectional health examination survey
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1 2		
2 3 4	17	Abstract
5	18	Objectives
6	19	Non-communicable diseases account for 70% of global deaths; 80% occur in low- and
7 8	20	middle-income countries. The rapid increase of obesity in sub-Saharan Africa is a concern.
9	21	We assessed generalised- and abdominal-obesity and their associated risk factors among
10	22	adults in The Gambia.
11	23	
12 13	23	Design: Nationwide cross-sectional health examination survey using WHO STEPwise
14	24 25	survey methods.
15		survey methods.
16 17	26	Satting. The Cambia
18	27	Setting: The Gambia.
19	28	
20	29	<b>Participants</b> : This study uses secondary analysis of a 2010 nationally-representative
21 22	30	random sample of adults aged 25-64y (78% response rate). The target sample size was
23	31	5280; 4111 responded. Analysis was restricted to non-pregnant participants with valid
24	32	weight and height measurements (n=3533).
25 26	33	
20 27	34	Primary and secondary outcome measures
28	35	The primary outcome variable was generalised obesity, using WHO body mass index
29	36	(BMI) thresholds. Analyses used non-response weighting and adjusted for the complex
30 31	37	survey design. We conducted multinomial logistic regression analysis to identify factors
32	38	associated with BMI categories. A secondary outcome variable was abdominal obesity
33	39	defined as high waist circumference (using the International Diabetes Federation
34 25	40	thresholds for Europeans).
35 36	41	
37	42	Results
38	43	Two-fifths of adults were overweight/obese, with a higher obesity prevalence in women
39 40	44	(17%, 95%CI: 14.7-19.7; men 8%, 6.0-11.0). 10% of men and 8% of women were
40 41	45	underweight. Urban residence (adjusted relative risk ratio (ARRR) 5.8, 95%CI 2.4-14.5),
42	46	higher education (2.3, 1.2-4.5), older age, ethnicity, and low fruit and vegetable intake
43	47	(2.8, 1.1-6.8) were strongly associated with obesity among men. Urban residence (4.7, 2.7-
44 45	48	8.2), higher education (2.6, 1.1-6.4), older age and ethnicity were associated with obesity
46	49	in women.
47	50	
48 49	51	Conclusion
49 50	52	
51	53	There is a high burden of overweight/obesity in The Gambia. While obesity rates in rural
52	54	areas were lower than in urban areas, obesity prevalence was higher among rural residents
53 54	55	in this study compared with previous findings. Preventive strategies should be directed at
55	56	raising awareness; discouraging harmful beliefs on weight; and promotion of healthy diets
56	57	and physical activity.
57 58	58	· · · · · · · · · · · · · · · · · · ·
59	59	Key words: Obesity, non-communicable diseases, sub-Saharan Africa, The Gambia, WHO
60	60	STEP survey, health examination survey

## Word count: Abstract = 295; Main document =3802 63

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 socioeconomic position (education) as missing information on income was high.

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**INTRODUCTION** 

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05	in induction
66	Non-communicable diseases (NCDs) are increasing in sub-Saharan Africa (SSA), <sup>12</sup> NCDs
67	account for 71% of all deaths globally. They also account for 15 million premature deaths
68	among adults aged 30-69 years; 85% of these premature deaths occur in low- and middle-
69	income countries. <sup>2</sup> A pooled analysis of 1698 population-based measurement studies
70	comprising 19 million participants from 200 countries revealed an increasing trend of
71	obesity globally. <sup>3</sup> If these trends continue, meeting the WHO global NCD target of halting
72	the rise of obesity by 2025 is almost impossible. <sup>4</sup>
73	
74	A great concern is the rapid increase of obesity in SSA. <sup>1</sup> Countries in SSA face the
75	challenge of the double burden of communicable and non-communicable diseases, and
76	also the double burden of underweight/malnutrition and obesity. <sup>567</sup> A pooled analysis of
77	population-based studies from 1980-2014 in Africa demonstrated a significant increase in
78	age-standardised mean BMI across the continent. <sup>8</sup> A recent analysis of Demographic and
79	Health Surveys conducted between 1991 and 2014 in 24 African countries revealed a
80	significant increase in obesity among women; rates in some countries tripled. <sup>9</sup> There is
81	evidence suggesting obesity is increasing more quickly in developing countries, especially
82	in SSA, compared with developed countries. <sup>1011</sup> This is associated with a range of factors,
83	including epidemiological and nutritional transition; adoption of western life styles;
84	decreased physical activity; low fruit and vegetable consumption; increased consumption
85	of processed foods; and urbanisation. <sup>12-15</sup>
86	

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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-

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> communicable diseases with communicable diseases exacerbated by malnutrition.<sup>16</sup> In a nationwide assessment among Gambians aged 16 years and above in 1996, 18% were underweight, 8% overweight and 2% obese.<sup>17</sup> 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.<sup>18</sup> 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.<sup>19</sup> There is also a high prevalence of smoking among Gambian men.<sup>20</sup> 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.<sup>2 21 22</sup> Halting the rise of obesity is also one of the WHO 2025 targets for the reduction of NCD mortality.<sup>4</sup> 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.

Page 7 of 37

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112	METHODS
113	
114	Participants, sampling strategy and data collection
115	Our study is based on secondary analysis of data from the most recent nationally-
116	representative, population-based health examination survey conducted in The Gambia. The
117	study setting and design, sampling, and research instruments have been previously
118	described. <sup>19 20</sup> Briefly, data were collected from a random sample of adults aged 25-64
119	years from January to March 2010 using the WHO STEPwise approach. <sup>19 23</sup> Participants
120	were selected using a multi-stage stratified sampling technique based on the 2003
121	population census of The Gambia. The country's eight local government areas (LGAs)
122	served as strata for the sampling; 264 of the 408 enumeration areas (EAs) were then
123	selected across the country and 20 households selected from each EA, both stages by
124	simple random sampling. One eligible participant aged 25-64 years was sampled from
125	each selected household, using the Kish Method. Sampled participants who were not
126	reached after three or more visits and those who declined were not replaced. The target
127	sample was set at 5280; 4111 responded (response rate 78%). Because of the complex
128	sampling design, sample weights and post-stratification weights were applied to account
129	for differences in the selection probability and to adjust for differences between the
130	national age-sex distribution and that of the achieved sample.
131	

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The anthropometric measurements were performed by field workers at the participant's residence. Weight, height and waist circumference were measured using WHO STEP protocols.<sup>23</sup> 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

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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<sup>2</sup>). We categorised BMI into underweight (BMI  $\leq 18.5$  kg/m<sup>2</sup>), normal/desirable weight (18.5-24.9 kg/m<sup>2</sup>), overweight  $(25.0-29.9 \text{kg/m}^2)$  and obese (BMI  $\geq 30 \text{kg/m}^2$ ), using the WHO thresholds.<sup>24</sup> We used abdominal obesity (high waist circumference) as the second outcome variable, defined using the International Diabetes Federation thresholds ( $\geq 90$  cm in men and  $\geq 80$  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:  $\leq 6$ ; 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. 

Page 9 of 37

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161 Complete case analysis was performed as fewer than 1% of adults with valid weight and
162 height had missing information on other variables. In descriptive analyses, we summarised
163 the participants' sociodemographic characteristics as well as their behavioural risk factors.
164

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. 

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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.<sup>26</sup>

184 We explored the factors associated with abdominal obesity (high waist circumference as185 defined above) by conducting multivariable binary logistic regression analysis. BMI was

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> 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,<sup>19 20</sup> the results of this study will be shared with the public and will also be used
to inform policy.

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RESULTS

**Characteristics of participants** 

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200	Characteristics of participants
209	Descriptions of respondents' socio-demographic, behavioural risk factors and
210	anthropometry data are presented in Table S1. The unadjusted mean age was 38.3±10.9
211	years. More than two-fifths of the participants (44%) were in the youngest age-group (25-
212	34 years), particularly among women (53% vs 33% of men). However, there was no age
213	difference by gender after weighting and adjusting for the complex survey design
214	(P=0.937, Table S1). The adjusted mean BMI was 24.6 kg/m <sup>2</sup> (95% CI 24.1-25.1) and the
215	mean waist circumference was 74.0cm (71.1-76.9). Mean BMI and waist circumference
216	were both higher among women: BMI in men 23.6 kg/m <sup>2</sup> (23.1-24.1kg/m <sup>2</sup> ) vs 25.6kg/m <sup>2</sup>
217	(24.9-26.3kg/m <sup>2</sup> ) in women and waist circumference 72.1cm (65.1-75.0cm) in men
218	compared with 76.0cm (72.9-79.1cm) in women.
219	
220	Prevalence of underweight, overweight and obesity
221	The prevalence of BMI categories by selected socio-demographic and behavioural
222	characteristics are presented for men and women in Tables S2 and S3 respectively. Among
223	men, more than half had a normal/desirable weight (56%, 95% CI: 50.8-61.4%) and one in
224	ten was underweight (10%, 7.6-12.4%). The prevalence of overweight and obesity in men
225	were 26% (21.1-31.6%) and 8% (6.0-11.0%) respectively (Table S2). Almost a half of
226	women were either overweight (29%, 25.8-31.9%) or obese (17%, 14.7-19.7%), while 8%
227	(6.1-9.5%) were underweight (Table S3). Among both men and women, the prevalence of
228	
	overweight and of obesity were substantially higher among urban residents; those with a
229	higher level of education; and those physically inactive. More than 60% of the residents in
229 230	

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).

#### 235 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). 

#### 

# BMJ Open Table 1: Multinomial logistic regression on factors associated with being underweight, overweight of obese in men<sup>a</sup>

	Model I (Age adjusted)			Model II (Fully adjusted)				
	Underweight <sup>b</sup>	<b>Overweight</b> <sup>b</sup>	Obese <sup>b</sup>	Underweight <sup>b</sup>	<sup>∞</sup> Noverweight <sup>b</sup>	Obese		
Variable	RRR (95% CI) <sup>c</sup>	RRR (95% CI) <sup>c</sup>	RRR (95% CI) <sup>c</sup>	ARRR (95% CI) <sup>cq</sup>	<b>A</b> RRR (95% CI) <sup>c</sup> →	ARRR (95% CI)		
Age-group					Reference 2200(1.38-2.90)***			
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)	200(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) <b>a</b>	<b>? ?</b> .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)	0 1.13(0.63-2.03)	2.88(1.22-6.80)**		
Ethnicity					± >			
Mandinka	Reference	Reference	Reference	Reference <b>A</b>	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)	Reference 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)	<b>1</b> .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)*		1.97(0.71-5.43		
Years spent in school						,		
≤6 Years	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)≱	<b>2</b> 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)	<b>2</b> 1.66(1.02-2.71)*	2.29 (1.16-4.53)**		
<b>Residence</b> (Rurality)					<b>.</b>			
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)**		<b>i</b> 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)	2576(1.52-5.01)***	5.83(2.35-14.50)***		
Smoking				<b>S</b>	0			
Never smokers	Reference	Reference	Reference	Reference	<b>Z</b> Reference	Reference		
Current smokers	1.71(1.18-2.48)**	0.53(0.38-0.74)***	0.52(0.32-0.84)***		0552(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)*	<b>x</b> 0.75(0.38-1.48)	0.58(0.21-1.63		
Servings of fruit and		· · · · · · · · · · · · · · · · · · ·	\/	noto	2025	``````````````````````````````````````		
vegetables				<u> </u>				
$\geq$ 5/day	Reference	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)	<b>A</b> 1.74(1.06-2.87)*	2.75(1.12-6.75)		
Physical Activity <sup>d</sup>					eno			
≥600METS/week	Reference	Reference	Reference	Reference	Reference	Referenc		
<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)	<b>B</b> 1.20(0.53-2.73)	2.23 (0.87-5.70)		

<sup>a</sup>Data shown have been weighted for non-response and the analysis took into account the complex survey design. <sup>b</sup>BMI is categorised into underweight (BMI<18.5kg/m<sup>2</sup>), normal/desirable weight (18.5-24.9 kg/m<sup>2</sup>, the reference group), over weight (25.0-29.9kg/m<sup>2</sup>) and obese (BMI  $\geq$  30kg/m<sup>2</sup>). Those with a desirable weight (normal) used as reference. 12 For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml 

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254 255 256 257 258	BMU Open "RRB- Relative Risk Ratio adjusted for nge (except for age group as the independent variable). ARRR- Fully Adjusted Right, Including for uses rolladed to tox and data multiful, Arraning, and similar robusted for the variables shown in the table. "METS - Metabolic equivalents." "p=0.05, +*p=0.01, +** p=0.001.
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				ght	01	
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	Reference	Reference	Reference	Reference <b>•</b>	- Reference	Reference
				0 79(0 52-1 19) \$		2.25(1.31-3.85)**
			· · · · · · · · · · · · · · · · · · ·	0.88(0.48-1.62)	<b>26</b> 98(1 33-2 96)***	2.66(1.43-4.94)**
	· · · · · · · · · · · · · · · · · · ·			2 30(1 10-4 80)*	<b>28</b> 1(1 58-4 99)***	4.90(2.44-9.82)***
	2.09(1.01 1.10)	1.02(1.05 5.21)	1.01(2.2017.5)	<u>a</u>		1.90(2.11.9.02)
	Reference	Reference	Reference	Reference	<b>D</b> Reference	Reference
				0.69(0.36-1.29)	<b>E</b> 1 19(0 75-1 87)	1.50(0.90-2.48)
				0.87(0.47-1.58)	<b>69</b> (1 20-2 38)**	1.78(1.09-2.92)*
				1 01(0 57-1 77)		1.10(0.66-1.84)
				0.34(0.14-0.80)**		1.21(0.62-2.36)
	0.05(0.51 1.27)	1.54(0.90 2.47)	1.57(0.04 2.92)			1.21(0.02 2.50)
	Reference	Reference	Reference	Reference	<b>R</b> eference	Reference
				1 12(0 63-1 99)		1.67(1.00-2.77)*
	· · · · · · · · · · · · · · · · · · ·			1.93 (0.52-7.18)	2 40(1 10-5 20)*	2.58(1.05-6.36)*
	1.57(0.40 4.14)	5.07(1.55 0.22)	5.47(1.57 0.07)	1.95 (0.52 7.10)	2.40(1.10 5.20)	2.30(1.03 0.30)
· · · · · · · · · · · · · · · · · · ·	Reference	Reference	Reference	Reference #	• Reference	Reference
						2.25(1.22-4.14)**
	· · · · · · · · · · · · · · · · · · ·	· · · · · · · · · · · · · · · · · · ·				4.71(2.72-8.15)***
	0.00(0.41 1.15)	5.05(2.00 4.40)	5.00(5.24 7.50)	0.04(0.40 1.35)	305(1.00 5.01)	4.71(2.72 0.15)
				and and	8	
	Reference	Reference	Reference	Reference 9:	Reference	Reference
						1.13(0.74-1.75)
2	0.71(0.11 1.21)	1.05(0.75 1.10)	0.55(0.02 1.10)	0.00(0.07 1.10)		1.15(0.711.70)
				tec	ne	
	Reference	Reference	Reference	Reference #	Reference	Reference
					<b>8</b> 1 07(0 63-1 82)	1.02(0.55-1.91)
	riable ge-group -34 -44 -54 -64 hnicity andinka ollof la a hers ars spent in school Years 2 Years 2 Years 2 Years 2 Years sidence (Rurality) ral mi urban ban rvings of fruits and getables 5/day 5/day ysical tivity <sup>d</sup> 00METS/week ta have been weighted f	UnderweightbriableRRR(95% CI)cge-group	Underweight <sup>b</sup> Overweight <sup>b</sup> riable         RRR(95% CI) <sup>c</sup> RRR(95% CI) <sup>c</sup> e-group         Reference         Reference           -34         Reference         Reference           -44 $0.85(0.55-1.31)$ $1.16(0.83-1.61)$ -54 $0.92(0.50-1.71)$ $1.42(1.01-1.99)^*$ -64 $2.09(1.04-4.18)^*$ $1.82(1.03-3.24)^*$ hnicity         Reference         Reference           ondinka         Reference         Reference           ollof $0.64(0.32-1.25)$ $1.31(0.80-2.16)$ la $1.03(0.60-1.78)$ $1.43(1.01-2.00)^*$ a $1.15(0.64-2.08)$ $1.14(0.72-1.82)$ hers $0.63(0.31-1.27)$ $1.54(0.96-2.47)$ ars spent in school         Years         Reference           Years $0.10(0.58-1.69)$ $1.93(1.31-2.85)^{***}$ 2 Years $0.10(0.58-1.69)$ $1.93(1.31-2.85)^{***}$ 2 Years $0.37(0.46-4.14)$ $3.09(1.53-6.22)^{**}$ sidence (Rurality)         Image: Sidence         Reference           ral         Reference         Reference	riable         RRR(95% CI) <sup>c</sup> RRR(95% CI) <sup>c</sup> RRR(95% CI) <sup>c</sup> RRR(95% CI) <sup>c</sup> $34$ Reference         Reference         Reference $34$ Reference         Reference         Reference $44$ $0.85(0.55-1.31)$ $1.16(0.83-1.61)$ $1.67(1.10-2.54)^*$ $54$ $0.92(0.50-1.71)$ $1.42(1.01-1.99)^*$ $1.65(1.00-2.73)$ $64$ $2.09(1.04-4.18)^*$ $1.82(1.03-3.24)^*$ $4.04(2.20-7.39)$ minity $1.64(0.32-1.25)$ $1.31(0.80-2.16)$ $2.07(1.19-3.61)^{**}$ la $1.03(0.60-1.78)$ $1.43(1.01-2.00)^*$ $1.51(0.94-2.41)$ a $1.15(0.64-2.08)$ $1.14(0.72-1.82)$ $1.68(0.92-3.07)$ hers $0.63(0.31-1.27)$ $1.54(0.96-2.47)$ $1.57(0.84-2.92)$ ars spent in school $2$ Years $2.93(1.85-4.64)^{***}$ 2 Years $0.10(0.58-1.69)$ $1.93(1.31-2.85)^{***}$ $2.93(1.85-4.64)^{***}$ 2 Years $0.10(0.58-1.69)$ $1.93(1.31-2.85)^{***}$ $2.93(1.85-4.64)^{***}$ 2 Years $0.10(0.25-0.75)^{**}$ $2.52(1.75-3.63)^{***}$ $2.7$	$\begin{tabular}{ c c c c c c c c c c c c c c c c c c c$	Underweight*         Overweight*         Obese*         Underweight*         Overweight*           riable         RRR(95% CI)*         RRR(95% CI)*         RRR(95% CI)*         ARRR (95% CI)*         RRR(95% CI)*         Reference         Reference

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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). 

Page 17 of 37

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Table 3: Multivaria	te binary logistic re	gression on factors	associated with hig	h waist circumferen	c 🛱 🛱 c c (a Redominal obesit	y) <sup>a</sup>
		Men			Q -Women	
	Model I <sup>b</sup>	Model II <sup>b</sup>	Model III <sup>b</sup>	Model I <sup>b</sup>	моdel II <sup>ь</sup>	Mod
Variable	OR (95% CI) <sup>c</sup>	AOR (95% CI) <sup>c</sup>	AOR (95% CI) <sup>c</sup>	OR (95% CI) <sup>c</sup>	<sup>8</sup> م AOR (95% CI) <sup>c</sup>	AOR (959
Age-group					202 rela	
25-34	Reference	Reference	Reference	Reference	Reference	Re
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)***	₫ ₫. ₽7 (1.60-2.92)***	2.04(1.49-2
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)***	<b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporation</b> <b>Contemporat</b>	1.91(1.33-2.
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)***	x 6 (1.5 + 2.72) x 6 (309)(2.07-5.56)*** an eric dec Reference	3.19(2.09-4.
Ethnicity					an	
Mandinka	Reference	Reference	Reference	Reference	a c c Reference	Re
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)	a (An 1.01(0.64-1.58) m 0.82(0.55-1.21)	0.81(0.5
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)	<b>B B 0.82(0.55-1.21)</b>	0.69(0.48
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)	<b>a</b> 0.82(0.49-1.36)	0.97(0.6
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)	<b>نو ·</b> المجانية • المحافظة • المحاف	0.74(0.4
Years spent in school			0		► 3 ► 3 ► 3 ► 3 ► 8 ► 1.10(0.78-1.55)	
≤6 Years	Reference	Reference	Reference	Reference	<b>B</b> Reference	Re
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)	<b>G</b> 1.10(0.78-1.55)	0.81(0.6
>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)		0.82(0.3
<b>Residence</b> (Local government area) <sup>d</sup>				W_	a 0.92(0.37-2.24) d o sin o Reference	,
LRR	Reference	Reference	_	Reference	Reference	
CRR	1.75(0.32-9.53)	1.92(0.44-8.32)	-	0.89(0.33-2.41)	<b>E</b> 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)	<b>E</b> 1.20(0.45-3.18) <b>E</b> 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)***	<b>2</b> ( <b>1</b> )26(0.11-065)**	
WCR	2.66(1.02-6.96)	2.43(0.94-6.32)	-	1.62(0.83-3.15)	<b>o i</b> 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)	ο <u>ω</u> 0.37(0.14-1.00)	
<b>Residence</b> (Rurality)	`	, , , , , , , , , , , , , , , , , , , ,		· · · · · ·	<u>, Þ</u>	
Rural	Reference	-	Reference	Reference	er -	Re
Semi urban	0.32(0.12-0.82)**	-	0.36(0.15-0.90)*	1.53(0.75-3.10)	geer- Ce-	2.11(1.21-
Urban	0.89(0.45-1.75)	-	0.82(0.41-1.65)	0.82(0.49-1.37)	<u>.</u> -	0.97(0.5
Smoking <sup>e</sup>			, , , , , , , , , , , , , , , , , , , ,	· · · · · · · · · · · · · · · · · · ·	blie	X
Never smokers	Reference	Reference	Reference	-	g -	
Current smokers	0.72(0.42-1.26)	0.49(0.28-0.86)**	0.60(0.35-1.03)	-	ap -	
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				y copyright, incl	mjopen-2019-03;		
		Men			udir	Women	
	Model I <sup>b</sup>	Model II <sup>b</sup>	Model III <sup>b</sup>	Model I <sup>b</sup>	DG 1	9 Model II <sup>b</sup>	Model III
Variable	OR (95% CI) <sup>c</sup>	AOR (95% CI) °	AOR (95% CI) <sup>c</sup>	OR (95% CI) <sup>c</sup>	Ŷ	AOR (95% CI) <sup>c</sup>	AOR (95% CI)
Ex-smokers	1.44(0.92-2.27)	1.24(0.81-1.91)	1.56(1.04-2.36)*	-	Ens uses		
Servings of fruit and vegetables					nseignen es relate	ne 20	
$\geq$ 5/day	Reference	Reference	Reference	Reference	ate	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)	ä n t	<b>0.86(0.50-1.49)</b>	0.81(0.48-1.20
Physical Activity <sup>f</sup>			``````````````````````````````````````	, , , , , , , , , , , , , , , , , , , ,			<u>,</u>
<600METS/week	Reference	Reference	Reference	Reference	Sup	Reference	Referenc
≥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)	an	<b>G</b> 1.46(0.81-2.62)	1.22(0.71-2.10

ě

Note: Data shown have been weighted for non-response and the analysis took into account the complex survey design. <sup>a</sup>Based on the definition of the International Diabetes Federation (High waist circumference, indicating abdominal obesity, defined as  $\geq$ 90cm in men and  $\geq$ 80cm in women). 

<sup>b</sup>Model I adjusted for age only; Model II adjusted for all variables except local government area; Model III adjusted for all variables except rurality. 

<sup>c</sup>OR=odds ratio adjusted for age (except for age group as the independent variable); AOR= Adjusted odds ratio (fully adjusted **b**); AOR= Adjusted b); AOR= Adjusted training, and similar technologies open.bmj.com/ on June 8, 2025 at Agence Bibliographique de

<sup>e</sup>Smoking status not included in the analyses for women due to the low prevalence. 

<sup>f</sup>METS =Metabolic equivalents

\*p<0.05, \*\*p≤0.01, \*\*\* p≤0.001

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296 <b>DISCUSSION</b>	
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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.<sup>17</sup> 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<sup>27</sup>, Eritrea<sup>28</sup> and Mozambique<sup>29 30</sup> but is less than that reported in The Republic of Seychelles.<sup>31</sup> The high prevalence of obesity in The Gambia is a cause for concern, given the increasing burden of NCDs, notably hypertension.<sup>19</sup> 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.<sup>1718</sup> Despite the health risks associated with overweight/obesity, Gambians are culturally obesity tolerant.<sup>32 33</sup> It has been well documented that perceptions of body weight vary across 

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different parts of the world.<sup>34 35</sup> 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.<sup>34 35</sup> 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.<sup>32</sup> 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.<sup>32</sup> 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.<sup>33</sup> 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<sup>36 37</sup> and in Zambia.<sup>38</sup> 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.<sup>39-42</sup> 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 

Page 21 of 37

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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.<sup>43</sup> 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. 

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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.<sup>45 46</sup> 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

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vegetables.<sup>47</sup> 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, 

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particularly the use of objective measurements taken by trained field staff instead of areliance 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 ( $\geq 94$  cm in men;  $\geq$ 80 cm in women) for adults in SSA.<sup>25</sup>However, a study that utilised data from different countries 

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as part of the Africa Partnerships for Chronic Diseases Research revealed optimal waist

417 circumference cut-off-point for identifying men at increased cardiometabolic risk is lower ( $\geq$ 81.2 cm)

418 than current guidelines for men in SSA, and similar to that of women . <sup>48</sup>We therefore used the

419 International Diabetes Federation thresholds for Asians ( $\geq$ 90 cm in men;  $\geq$ 80 cm in women).<sup>25</sup>

420 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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12 13	440	The authors have no conflict of interest to declare.
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20 21	444	Author Contributions
22	445	BC conceptualised the paper, analysed the data and wrote the first draft of the manuscript.
23	446	J.S.M, SS, N.E.G and L.N.F revised the work critically for important academic content. OB
24	447	supervised the survey data collection process and contributed in the revision of the
25 26	448	manuscript. All the authors approve the final version of the manuscript.
20 27 28	449	Data Availability
29	450	The Gambia 2010 WHO STEP data is not publicly available but can be obtained from a third
30 31	451	party upon request.
32 33	452	Figure legend
34	453	
35	454	Figure 1: Flow diagram of study participants with number excluded and
36 37	455	reason for exclusion
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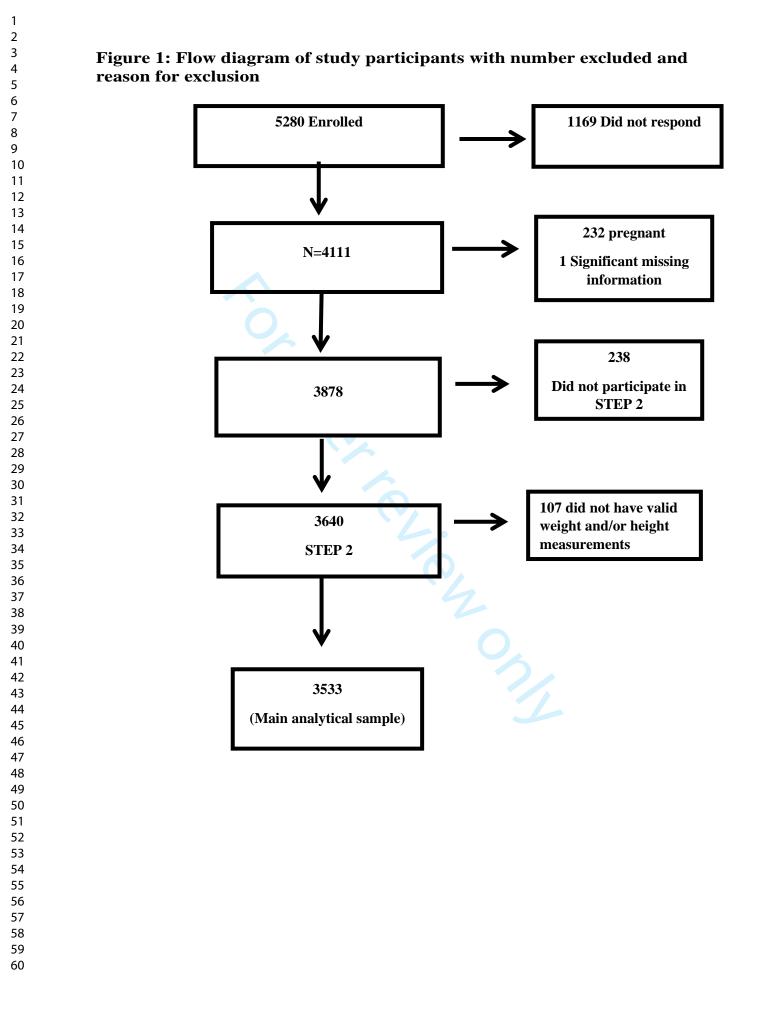
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### Supplementary Table 1: Characteristics of study participants by selected demographic, behavioural and biological risk factors

Variable	Men %(95% CI)	Women %(95% CI)	Total %(95% CI)
Caralan	1611	1922	3533
Gender			50 2(47 ( 52 0)
Men			50.2(47.6-52.9)
Women			49.8(47.1-52.4)
<b>Age Group</b> 25 -34	46 8(42 8 50 8)	45 0(42 8 40 1)	46 2(42 0 49 9)
35-44	46.8(42.8-50.8)	45.9(42.8-49.1)	46.3(43.9-48.8)
45-54	<u>26.5(24.0-29.2)</u> 16.8(14.7-19.2)	27.0(24.3-29.8) 17.6(15.7-19.6)	<u>26.7(24.9-28.7</u> 17.2(15.8-18.7)
<u>43-34</u> 55-64	9.9(8.2-11.9)	9.6(7.5-12.1)	9.7(8.2-11.5)
55-04	9.9(8.2-11.9) P<0.9	( /	9.7(8.2-11.3)
	F<0.9	57	
Mean age	37.8(37.0-38.6)	37.6(36.8-38.3)	37.7(37.1-38.2)
Marital Status	37.8(37.0-38.0)	37.0(30.8-38.3)	37.7(37.1-30.2)
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)
Conabiling	P<0.0	× /	10.0(3.2-18.3)
Ethnicity	1 <0.0	01	
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)
Other	P=0.1		9.9(7.0-12.3)
Years spent in school	1-0.1		
≤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<0.0		
Residence (Local			
government area) <sup>a</sup>			
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=0.1	31	
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=0.1	87	
Physical Activity <sup>b</sup>			
≥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<0.0	01	
Smoking			
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Variable	Men	Women	Total
	%(95% CI)	%(95% CI)	%(95% CI)
	1611	1922	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<0.0	01	
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=0.9	034	
BMI <sup>c</sup>			
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<0.0	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 <sup>2</sup> )	23.6(23.1-24.1)	25.6(24.9-26.3)	24.6(24.1-25.1
Waist circumference <sup>d</sup>			
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	72.1(65.1-75.0)	76.0(72.9-79.1)	74.0(71.1-76.9)
circumference			
Waist-to-Hip Ratio <sup>e</sup>			
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<0.0	01	
Waist-Height Ratio			
Normal ( $\leq 0.5$ )	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<0.0	01	, ,
Mean Hip	89.3(87.0-91.6)	94.2(92.1-96.3)	91.7(89.7-93.8
Circumference (cm)			

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

<sup>a</sup> 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 <sup>b</sup> METS =Metabolic equivalents

<sup>c</sup> BMI is categorised into underweight (BMI<18.5kg/m<sup>2</sup>), normal (18.5-24.9 Kg/m<sup>2</sup>), overweight (25.0-29.9kg/m<sup>2</sup>) and obese (BMI  $\geq$ 30kg/m<sup>2</sup>).

<sup>d</sup> Based on the definition of the International Diabetes Federation (High waist circumference, indicating abdominal obesity defined as  $\geq$ 90 cm in men or  $\geq$ 80 cm in women)

<sup>e</sup> 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

	f DMI - 4	BMJ Open		/bmjopen-2019-03	<b>a</b> h
Variable	Normal (desirable) %(95% CI)	Underweight %(95% CI)	Overweight %(95% CI)	al and biological factor a s s o o o fo 1 us m 50 bese g 3/3 95% CI)	$\frac{\chi^2}{P \text{ value}}$
Total	56.2(50.8-61.4)	9.7(7.6-12.4)	26.0(21.1-31.6)		1 value
Age Group	30.2(30.8-01.4)	9.7(7.0-12.4)	20.0(21.1-51.0)	eig 28.1(6.0-11.0)	
25 -34	59.0(52.2-65.6)	11.6(8.4-15.9)	22.0(16.3-29.0)	C 444 1 0 7	0.00
35-44	54.0(47.3-60.6)	7.3(4.9-10.8)	32.4(25.7-39.8)	$6 4 (1 1_0 7)$	0.00
45-54	48.7(40.5-56.9)	9.3(5.7-14.8)	29.6(23.4-36.7)	6.4(4.1-9.7)	
55-64	61.0(53.4-68.1)	8.0(5.1-12.3)	29.0(25.4-30.7) 21.8(16.0-29.0)		
Marital status	01.0(55.4-00.1)	0.0(5.1-12.5)	21.0(10.0-29.0)	an er de 9.1(4.6-17.4)	
Never married	55.1(45.1-64.7)	11.9(7.4-18.4)	24.3(16.0-35.2)	<b>d u f</b> <b>o</b> 8.7(4.8-15.2)	0.22
Married	56.1(50.7-61.4)	7.9(6.0-10.4)	27.7(23.1-32.9)	BB 8.2(5.8-11.6)	0.22
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	<b>G</b> · <b>S</b> 0.0	
Cohabiting	60.4(48.7-71.0)	16.3(8.6-29.0)	16.2(9.6-25.8)	≥ <u></u> 7.1(3.5-13.9)	
Ethnicity	00.1(10.7 71.0)	10.5(0.0 29.0)	10.2().0 25.0)	<b>T</b>	
Mandinka	56.8(50.5-62.8)	11.5(8.6-15.1)	25.5(19.1-33.1)	<b>5</b> 6.3(4.1-9.6)	0.04
Wollof	46.8(38.0-55.8)	10.8(6.2-17.9)	32.3(24.4-41.4)	<b>T</b> <b>D</b> <b>D</b> <b>D</b> <b>D</b> <b>D</b> <b>D</b> <b>D</b> <b>D</b> <b>D</b> <b>D</b>	
Fula	59.1(50.8-66.9)	8.4(5.3-13.1)	25.2(18.3-33.5)	a 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)	<b>Si o</b> 16.5(9.8-26.4)	
<b>Residence</b> (LGA) <sup>d</sup>				nila (	
Banjul & KM	33.4(25.4-42.8)	3.2(1.7-6.0)	47.2(37.6-57.0)	<b>15</b> .2(11.0-23.1)	<0.00
WCR	68.5(63.5-73.2)	15.3(11.7-19.7)	11.9(9.0-15.4)	<b>C w</b> 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)	3.8(8.9-20.9)	
NBR	65.6(54.9-74.9)	13.9(9.1-20.6)	19.1(13.0-27.1)	<b>0 1 1 5 1 5 1 5 1 5 1 5 1 5 1 5 1 1 5 1 1 5 1 1 5 1 1 5 1 1 5 1 1 1 1 1 1 1 1 1 1</b>	
CRR	67.1(54.1-77.9)	15.5(9.6-23.9)	15.6(10.1-23.4)	<b>Ö</b> at 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)	<b>&gt;</b> 0.5(0.1-3.1)	
Residence (Rurality)				Jen	
Urban	49.1(41.2-57.1)	9.2(6.2-13.5)	30.9(23.2-39.9)	<b>G</b> 10.7(7.4-15.4)	0.00
Semi urban	54.1(40.1-67.5)	8.4(3.3-19.5)	27.7(17.6-40.8)	<b>B</b> 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)	<b>bli</b> 3.2(1.8-5.6)	
Education level				ogr	
No formal education	59.4(54.4-64.1)	9.3(7.1-12.0)	24.9(20.5-29.8)	<b>b</b> 6.5(4.6-9.3)	0.00

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		BMJ Open		njopen-2019-0 r copyright, in	
Variable	Normal (desirable) %(95% CI)	Underweight %(95% CI)	Overweight %(95% CI)	CL 20 Dese Luci % 20 5% CI)	χ <sup>2</sup> P value
Primary/ Middle	61.3(51.9-69.9)	13.4(8.3-21.0)	19.4(13.4-27.4)	<b>6 9</b> 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)	<b>9 1</b> 2.1(8.2-17.7)	
Years spent in school				egi 29.1(5.8-14.1)	
≤6 Years	60.5(55.7-65.1)	9.4(7.3-12.1)	23.7(19.6-28.3)	s s e 6.4(4.6-8.9)	0
7-12 Years	49.7(41.7-57.8)	13.3(8.6-19.9)	27.9(20.1-37.2)	<b>9.1</b> (5.8-14.1)	
>12 Years	48.5(35.4-61.7)	4.3(2.2-8.5)	34.3(24.8-45.3)	<b>TCCCCCCCCCCCCC</b>	
Smoking				Do d to	
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
Current smokers	61.6(54.8-68.1)	13.8(11.0-17.3)	18.8(13.5-25.4)	9.8(6.8-13.8)	
Ex-smokers	55.5(46.8-63.9)	11.8(6.7-20.0)	26.4(18.3-36.6)	a 5.8(3.2-12.1) det 6.3(3.2-12.1) det f ta point 5.8(3.5-9.6)	
Servings of fruits and vegs				d f	
$\geq$ 5/day	61.8(54.1-68.8)	9.1(6.5-12.7)	23.3(17.7-29.9)	ata 5.8(3.5-9.6)	0
< 5/day	54.1(47.2-60.8)	10.5(7.6-14.3)	27.8(21.5-35.1)	<b>B</b> 7.8(5.1-10.1)	
Physical Activity <sup>e</sup>				ttp S)	
<600METS/week	46.5(36.3-57.0)	4.7(2.3-9.4)	31.3(22.7-41.4)	<b>.</b> 5(11.5-25.7)	
≥600METS/week	56.8(51.0-62.3)	10.5(8.1-13.5)	25.7(20.2-32.0)	<b>≥ ∃</b> 7.1(5.2-9.7)	<0
Waist circumference <sup>f</sup>				op	
Normal	57.4(51.3-63.2)	10.9(8.4-14.1)	24.2(18.6-30.7)	<b>5</b> 7.6(5.3-10.7)	<0
High	43.2(34.4-52.4)	1.5(0.5-4.7)	41.5(33.2-50.3)	<b>1</b> 3.8(8.8-21.6)	

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Note: Data shown have been weighted for non-response and the analysis took into account the complex survey design. <sup>a</sup> BMI is categorised into underweight (BMI<18.5kg/m<sup>2</sup>), normal (18.5-24.9 kg/m<sup>2</sup>), overweight (25.0-29.9kg/m<sup>2</sup>) and obese (BMI 30kg/m<sup>2</sup>).

<sup>b</sup> Results adjusted for complex survey design and weighted for non-response

<sup>c</sup> 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 <sup>d</sup> KM= Kanifing Municipality; WCR =West Coast Region; URR =Upper River Region.; NBR =North Bank Region ; CRRS= Grant Region South ; CRRN = Central

River Region North ; LRR= Lower River Region. Regions ordered from most to least urban Ager

<sup>e</sup> METS =Metabolic equivalents

<sup>f</sup> Based on the definition of the International Diabetes Federation (High waist circumference, indicating abdominal obesity defined  $\frac{2}{8}$  s  $\geq$  90 cm in men or  $\geq$  80 cm in women)

Variable	Normal (desirable) %(95% CI)	Underweight %(95% CI)	Overweight %(95% CI)	२ → Obese हू मुई%(95% CI)	χ <sup>2</sup> P value
Total	46.6(42.8-50.5)	7.6(6.1-9.5)	28.8(25.8-31.9)	<b>5 6</b> 17.0(14.7-19.7)	
Age Group		, , , , , , , , , , , , , , , , , , , ,	· · · ·	elar 02	
25 - 34	51.6(46.9-56.2)	8.3(6.3-10.9)	27.4(23.7-31.5)	<b><u><u><u></u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u></u></b>	0.001
35-44	46.1(39.5-52.9)	6.3(4.4-8.9)	28.5(22.9-34.8)	<b>6 9 9</b> 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)	to 517.7(12.5-24.4)	
55-64	30.3(22.6-39.2)	10.1(5.5-17.9)	29.3(20.3-40.4)	x 0 30.3(20.9-41.7)	
Marital status		``	· · · ·	ande	
Never married	46.8(36.0-57.9)	6.3(3.1-12.7)	36.2(26.4-47.2)	<b>a</b> ⊆ <u>⇒</u> 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)	a 10.7(6.3-17.4)	
Separated	32.5(22.5-44.4)	9.6(4.5-19.2)	40.8(29.6-53.1)	<b>3 H</b> 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)	<b>26.5(16.1-40.5)</b>	
Cohabiting	57.6(46.8-67.6)	12.5(7.9-19.2)	22.7(16.1-31.1)	<b>Ģ</b> · <b>B</b> 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)	a 213.5(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)	<b>9 1</b> 6.0(12.2-20.6)	
Jola	45.1(37.0-53.4)	8.9(5.1-15.0)	26.4(20.0-33.9)	<b>a b</b> 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)	<b>a b b 19.7(13.4-28.0)</b> <b>c b 18.3(12.5-26.1)</b>	
<b>Residence</b> (LGA) <sup>d</sup>		, , , , , , , , , , , , , , , , , , , ,			
Banjul & KM	32.6(27.2-38.4)	2.3(1.1-4.6)	38.8(33.1-44.8)	a <u>26.3(22.1-31.1)</u>	<0.001
WCR	49.8(42.8-56.7)	11.4(8.1-15.7)	25.4(20.3-31.2)	<b>6</b> 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)	<b>S (8.5-21.8)</b>	
NBR	53.8(46.8-60.6)	13.4(8.2-20.9)	20.9(16.0-26.8)	<b>2</b> 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)	<b>G S</b> 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)	<b>8 2</b> 9.1(4.4-17.9)	
<b>Residence</b> (Rurality)			, , , , , , , , , , , , , , , , , , ,	- Ag	
Urban	38.0(33.1-43.2)	5.1(3.3-7.7)	34.2(29.7-39.0)	<b>5</b> 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)	<b>6</b> 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		· · · · · · · · · · · · · · · · · · ·		lio	
No formal education	49.5(45.3-53.7)	7.6(5.9-9.9)	27.4(24.1-31.0)	<b>G</b> 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)	<b>9</b> 17.9(13.2-23.9)	
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# BMJ Open Supplementary Table 3: Prevalence of BMI categories by selected socio-demographic, behavioural and biological factors in women <sup>a, b, c</sup>

Variable	Normal (desirable) %(95% CI)	Underweight %(95% CI)	Overweight %(95% CI)	Vbmjopen-2019-03.3862 9 copyright, includir	χ <sup>2</sup> P value
Secondary/Tertiary	32.0(25.0-39.8)	6.3(4.0-9.5)	37.9(30.8-45.5)		r value
Years spent in school	32.0(23.0-37.8)	0.3(4.0-9.5)	37.9(30.0-43.3)	<b>g</b> 23.9(17.7-31.6)	
$\leq 6$ Years	49.2(45.2-53.2)	8.0(6.3-10.1)	26.9(23.8-30.3)	ច្ចπ <u></u> <u></u> <u></u> [15.9(13.5-18.6)	0.01
7-12 Years	38.5(31.0-46.7)	5.6(3.3-9.3)	35.5(28.8-43.0)	<b>S S e</b> 20.4(15.1-26.9)	0.01
>12 Years	31.0(18.9-46.5)	7.5(3.0-17.8)	41.5(26.7-57.9)		
Servings of fruits and vegs	51.0(10.5 10.5)	/.5(5.0 17.0)	11.5(20.7 57.5)	Te 0.	
$\geq 5/day$	45.1(39.8-50.6)	9.5(6.0-14.7)	27.9(22.7-33.8)	<b>T</b> <b>T</b> <b>T</b> <b>T</b> <b>T</b> <b>T</b> <b>T</b> <b>T</b> <b>T</b> <b>T</b>	0.62
< 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)	0.02
Physical activity	10.2(+1.5 51.5)	1.0(5.2 ).4)	27.0(20.1 33. <del>4</del> )	Sn17.2(14.3-20.3)	
<600METS/week	39.0(32.6-45.8)	5.7(3.2-9.9)	31.6(23.8-40.5)	an e e e 23.7(18.4-30.1)	0.02
≥600METS/week	48.3(43.5-53.0)	8.0(6.3-10.4)	28.0(24.9-31.3)	<b>a c a</b> 15 7(13 1-18 6)	0.02
Waist circumference <sup>e</sup>	10.5(15.5 55.0)	0.0(0.5 10.1)	20.0(21.9 51.5)	deu f15.7(13.1-18.6)	
				0 D I	
Normal	51 8(46 1-57 5)	10 3(7 7-13 8)	24 5(20 1-29 3)	<b>⊐ 00 </b> 13 4(9 6-18 4)	<0.00
is categorised into underweight (E Its adjusted for complex survey de percentages are presented, i.e the weighted sample/observations	BMI<18.5Kg/m <sup>2</sup> ), normal (18.5- sign and weighted for non-response prevalence of being in that BMI	24.9 Kg/m <sup>2</sup> ), overweight (25 onse category for people with tha	34.3(29.9-39.1) lex survey design. 5.0-29.9Kg/m <sup>2</sup> ) and obeso t socio-demographic, bel	$\begin{array}{c c} 13.4(9.6-18.4) \\ \hline 13.4$	haracteristic
High Data shown have been weighted for is categorised into underweight (E lts adjusted for complex survey de percentages are presented, i.e the weighted sample/observations <sup>a</sup> KM=Kanifing Municipality; Wo	39.7(34.2-45.4) or non-response and the analysis BMI<18.5Kg/m <sup>2</sup> ), normal (18.5- esign and weighted for non-response prevalence of being in that BMI CR =West Coast Region; URR =	4.7(3.1-7.1) took into account the compl 24.9 Kg/m <sup>2</sup> ), overweight (25 onse category for people with tha =Upper River Region.; NBR	34.3(29.9-39.1) lex survey design. 5.0-29.9Kg/m <sup>2</sup> ) and obeso t socio-demographic, bel	$\begin{array}{c c} 13.4(9.6-18.4) \\ \hline 13.4$	
High Data shown have been weighted for is categorised into underweight (E lts adjusted for complex survey de percentages are presented, i.e the weighted sample/observations <sup>a</sup> KM=Kanifing Municipality; W0 I River Region North ; LRR= Low	39.7(34.2-45.4) or non-response and the analysis BMI<18.5Kg/m <sup>2</sup> ), normal (18.5- esign and weighted for non-response prevalence of being in that BMI CR =West Coast Region; URR = ver River Region. Regions order	4.7(3.1-7.1) took into account the compl 24.9 Kg/m <sup>2</sup> ), overweight (25 onse category for people with tha Upper River Region.; NBR red from most to least urban	34.3(29.9-39.1) lex survey design. 5.0-29.9Kg/m <sup>2</sup> ) and obeso t socio-demographic, bel =North Bank Region ; C	$\begin{array}{c c} 13.4(9.6-18.4) \\ \hline 13.4$	haracteristic on South ; CR
High Data shown have been weighted for is categorised into underweight (E lts adjusted for complex survey de percentages are presented, i.e the weighted sample/observations a KM=Kanifing Municipality; W0 I River Region North ; LRR= Low	39.7(34.2-45.4) or non-response and the analysis BMI<18.5Kg/m <sup>2</sup> ), normal (18.5- esign and weighted for non-response prevalence of being in that BMI CR =West Coast Region; URR = ver River Region. Regions order	4.7(3.1-7.1) took into account the compl 24.9 Kg/m <sup>2</sup> ), overweight (25 onse category for people with tha Upper River Region.; NBR red from most to least urban	34.3(29.9-39.1) lex survey design. 5.0-29.9Kg/m <sup>2</sup> ) and obeso t socio-demographic, bel =North Bank Region ; C	$\begin{array}{c c} 13.4(9.6-18.4) \\ \hline 13.4$	haracteristic on South ; CR
High Data shown have been weighted for is categorised into underweight (E lts adjusted for complex survey de percentages are presented, i.e the weighted sample/observations a KM=Kanifing Municipality; W0 I River Region North ; LRR= Low	39.7(34.2-45.4) or non-response and the analysis BMI<18.5Kg/m <sup>2</sup> ), normal (18.5- esign and weighted for non-response prevalence of being in that BMI CR =West Coast Region; URR = ver River Region. Regions order	4.7(3.1-7.1) took into account the compl 24.9 Kg/m <sup>2</sup> ), overweight (25 onse category for people with tha Upper River Region.; NBR red from most to least urban	34.3(29.9-39.1) lex survey design. 5.0-29.9Kg/m <sup>2</sup> ) and obeso t socio-demographic, bel =North Bank Region ; C	$\begin{array}{c c} 13.4(9.6-18.4) \\ \hline 13.4$	haracteristic on South ; CR
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STROBE Statement—Checklist of items that should be included in reports of cross-sectional studies

	ltem 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
		( <i>b</i> ) 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	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	<ul><li>(a) Describe all statistical methods, including those used to control for confounding</li><li>(b) Describe any methods used to examine</li></ul>	Yes Yes
		subgroups and interactions (c) Explain how missing data were addressed	Yes

		( <i>d</i> ) If applicable, describe analytical methods taking account of sampling strategy	Yes
		( <u>e</u> ) Describe any sensitivity analyses	We conducted a number of regression analyses adjusting for different variables.
Results		· · - · · · · · · · · · · · · · · · · ·	
Participants	13*	<ul> <li>(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</li> </ul>	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
		( <i>b</i> ) 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)

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		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.