High level of co-occurrence of risk factors for non-communicable diseases among Gambian adults: A national population-based health examination survey

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Abstract

Non-communicable diseases (NCDs) are the leading causes of morbidity and mortality globally. Co-occurrence of risk factors predisposes an individual to NCDs; the burden increases cumulatively with the number of risk factors. Our study aimed to examine the co-occurrence of NCD risk factors among adults in The Gambia. This study is based on a random nationally representative sample of 4111 adults aged 25-64 years (78% response rate) with data collected between January and March 2010 in The Gambia using the WHO STEPwise survey methods. We restricted our analysis to non-pregnant participants with valid information on five NCD risk factors: high blood pressure, smoking, obesity, low fruit and vegetable consumption, and physical inactivity (n=3000 adults with complete data on all risk factors). We conducted age-adjusted and fully-adjusted gender stratified multinomial logistic regression analysis to identify factors associated with the number of NCD risk factors. More than 90% of adults had at least one risk factor. Only 7% (95% CI: 5.2-9.8) had no risk factor; 22% (95% CI: 19.1-24.9) had at least three. Older age and ethnicity were significantly associated with having three or more risk factors (versus none) among men in the fully adjusted model. Lower education, older age, and urban residence were significantly associated with three or more risk factors (versus none) among women. The burden of NCDs is expected to increase in The Gambia if preventive and control measures are not taken. There should be an integrated approach targeting all risk factors, including wider treatment and control of hypertension.

Key words: Non-communicable diseases, co-occurrence, sub-Saharan Africa, The Gambia, WHO STEP survey, high blood pressure, smoking, obesity, poor diet, physical inactivity

1. Introduction

Non-communicable diseases (NCDs) including cardiovascular diseases (CVDs), diabetes, cancers and chronic respiratory diseases are the leading causes of morbidity and mortality worldwide (Beale and Demaio, 2019). Research evidence has shown that mortality increases with co-occurrence of unfavourable lifestyle and other risk factors (Loef and Walach, 2012, Dobson et al., 2012, Behrens et al., 2013). Such co-occurrence (e.g. being both hypertensive and obese), predisposes an individual to NCDs (Scholes, 2018); the burden increases cumulatively with the number of risk factors (Zaman et al., 2015, Martin-Diener et al., 2014, Wesonga et al., 2016). Evidence suggests that the multiplicative effects of a combination of risk factors is more detrimental to people's health than the additive effects of each individual risk alone (Poortinga, 2007, Alageel et al., 2016). Addressing multiple risks is therefore important from a public health perspective.

The WHO STEPwise approach to Surveillance (STEPS) survey reporting template, that estimates co-occurrence, focuses on five risk factors for NCDs (World Health Organization, 2005, World Health Organization, 2016a). These include: current daily smoking; overweight /obesity (body mass index: BMI ≥25 kg/m^2); poor diet (fewer than five combined servings of fruits and vegetables/day); insufficient physical activity (<150 minutes/week moderate intensity or <75 minutes/week of vigorous intensity or an equivalent combination); and hypertension (raised blood pressure ≥140/90 mmHg and/or currently on medication for raised blood pressure). These risk factors have sufficient implications for wider development concerns (Clark, 2013). They pose a barrier to poverty alleviation and can hinder the attainment of the United Nations Sustainable Development Goals (SDGs), particularly Goal 3, target 3.4, which calls for relative reduction in premature mortality due to NCDs by one third by 2030 (Clark, 2013, Lal et al., 2013). Controlling the rise of these risk factors is therefore key in the global crusade to halt the rise of NCD related morbidity and mortality as well as to attaining the UN SDGs.

Mortality and disability-adjusted life years (DALYs) associated with communicable diseases, including malaria and diarrhoeal diseases, significantly decreased from 2007 to 2017 in The Gambia (Institute for Health Metrics and Evaluation, 2019). However, NCDs are on the increase and now account for 34% of all deaths in the country (World Health Organization, 2018).

One third of Gambian adults (aged 25-64 years) were hypertensive in 2010 (Cham et al., 2018) and one in every ten adults were overweight or obese (Cham et al., 2020). The risk of premature mortality from NCDs among adults aged 30-70 years in The Gambia is 20% (World Health Organization, 2018). In terms of the present burden of these risk factors, according to the recent NCD country profile based on hospital data and projections from past surveys, an estimated 22% of the adult population aged 18 years and above in The Gambia were hypertensive in 2015 (World Health Organization, 2018). The prevalence of physical inactivity, obesity and current smoking among adults aged 18 years and above in 2016 were 19%, 9% and 15% respectively based on projections from past surveys (World Health Organization, 2018).

Ischaemic heart disease (IHD) is now the leading cause of mortality in The Gambia and stroke is fourth on the list (Institute for Health Metrics and Evaluation, 2019). Age-standardised mortality rates associated with IHD and stroke are significantly higher in The Gambia than most of the countries in Sub-Saharan Africa (SSA) with data on these indicators (Institute for Health Metrics and Evaluation, 2019). These include Eritrea, Ivory-Coast, Rwanda, Tanzania, Togo and Uganda. Therefore, The Gambia is undergoing the "epidemiological transition" i.e. the shift in the leading causes of morbidity and mortality from infectious to non-communicable diseases.

Despite the evidence of the burden of NCDs, only a few studies have examined the co-occurrence of risk factors for NCDs in SSA. A WHO report in 2015 on the status of major health risk factors for NCDs in the African region revealed a high level of co-occurrence of three or more risk factors in almost all the countries where data was available (World Health Organization, 2016a). A nationwide study in Uganda using the WHO STEPS revealed that only 5% of the population had no risk factors and that 56% had at least two risk factors (Wesonga et al., 2016). Similar studies were conducted among urban slum dwellers in Nairobi, Kenya (Haregu et al., 2015) and among rural based adolescents in South West Nigeria (Idowu et al., 2016). Both studies revealed a high level of co-occurrence of multiple NCD risk factors. A nationwide study in Kenya focused on 12 risk factors including tobacco use, hypertension, obesity, insufficient physical activity, excessive alcohol intake, excessive sugar intake, diabetes, low fruit and vegetable intake, use of unhealthy cooking fats and oils and high salt consumption (Wekesah et al., 2018).

The study revealed that 76% of the participants had four to six risk factors and 10% had seven or more risk factors.

Although WHO STEP survey data from the Gambia and a number of other countries has been used in the WHO Report on the status of NCD risk factors in Africa (World Health Organization, 2016a), few studies have been conducted on co-occurrence of risk factors in this region. Furthermore, no subgroup analysis (e.g. by gender) on the co-occurrence of NCD risk factors has been conducted in The Gambia. Our present study highlights the prevalence and sociodemographic factors associated with the co-occurrence of risk factors for NCDs. The future burden of NCDs will hinge to some extent on the progress made in reducing the key risk factors for NCDs such as hypertension, smoking, obesity, low fruit and vegetable intake, and insufficient physical activity focusing more on the population sub-groups at a higher risk, including older people, urban residents, and those with lower education. Our study aimed to examine the co-occurrence of multiple risk factors among Gambian adults aged 25-64 years and to explore the associations with socio-demographic characteristics.

2. Materials and Methods

2.1. Data source, setting and design

This study is based on secondary analysis of data from the 2010 WHO STEPS survey, which is the most recent nationally representative population-based health examination survey conducted among adults (25-64 years) in The Gambia. A detailed description of the data has been published elsewhere (Cham et al., 2018, Cham et al., 2020, Cham et al., 2019). Briefly, data were collected from January to March 2010 using STEPS, a standard population-based health examination survey approach to NCD surveillance (World Health Organization, 2003, Cham et al., 2018). Data is collected through face to face interviews (Step one), physical measurements (Step two) and biochemical measurement of blood glucose and cholesterol (Step three). However, the STEPS survey in The Gambia was limited to Steps one and two only.

Participants were selected using a multi-stage, stratified sampling technique based on the 2003 population census. There are eight local government areas (LGAs) and 4098 enumeration areas (EAs) in the country. The LGAs were used as sampling strata and 264 EAs were selected across the country by simple random sampling. From each selected EA, 20 households were selected by simple random sampling. Only one eligible participant was enrolled from each selected household, sampled using the Kish Method. Selected participants who declined and those who were not reached after three visits were not replaced. The target number of adults sampled was 5280, of whom 4111 responded (77.9% response rate).

We restricted our analysis in the present study to non-pregnant participants with valid information on all of the five NCD risk factors defined below (n=3000). Each of the risk factors was assigned a score of one or zero depending on the presence or absence of the risk factor, defined as follows:

1. **Hypertension:** Hypertension was defined as measured systolic blood pressure ≥140mmHg and/or diastolic blood pressure ≥90mmHg and/or self-reported hypertension diagnosed by a doctor or other health professional. We included only

participants with three valid blood pressure measurements; the mean of the second and third readings were used in our analysis.

2. **Overweight/obesity:** This was based on physical measurements of weight and height and was defined as BMI (calculated as weight in kilogrammes divided by height in metres squared) greater than or equal to 25.0kg/m^2.
3. **Low fruit and vegetable intake**: This was self-reported in response to separate questions for fruit and for vegetables on how many days in a typical week fruit / vegetables are eaten, and how many servings are eaten on one of those days (with a show card of a single portion of local fruit and vegetables). Low fruit and vegetable intake was defined as consuming less than five combined servings of fruits and vegetables a day.
4. **Physical inactivity:** The questions on physical activity in the STEPS survey questionnaire are adopted from the Global Physical Activity Questionnaire (World Health Organization, 2012). The questionnaire captures work, transport and recreation related physical activity. A low level of physical activity was defined as not meeting the minimum WHO recommendations in a typical week (75 minutes/week of vigorous intensity physical activity, or 150 minutes/week of moderate intensity, or a combination of moderate and vigorous physical activity of at least 600 metabolic equivalents (METS)/week).
5. **Smoking:** Smoking was also self-reported and defined as current daily smoking of any tobacco products.

2.2. Dependent and independent variables

The dependent variable was based on the number of risk factors, which we derived from the five variables defined above. The independent variables comprised sociodemographic variables, including gender; age-group; marital status; ethnicity (Mandinka, Fula, Wollof, Jola, plus the other five minority ethnic groups combined as 'Others'); years of education (grouped as ≤6y, 7-12y, >12y); and residence (either local government areas or rurality). We combined the five smallest ethnic groups to ensure sufficient numbers for analysis. We used the Gambia Bureau of Statistics bench marks to classify respondents' residence (Gambia Bureau of Statistics, 2013).

2.3. Data Analysis

We coded each of the risk factors by assigning them scores of one or zero depending on the presence or absence of the risk factor in question. We computed the total number of risk factors per participant by adding all the scores together. The number of risk factors per participant ranged from zero (no risk factor) to five risk factors. We described the unweighted socio-demographic characteristics (Table S1) among survey participants and calculated the distribution of the weighted general population prevalence of all of the five risk factors by selected socio-demographic variables. In conformity with a report on the co-occurrence of NCD risk factors in Africa that used WHO STEP data (World Health Organization, 2016a), we calculated the distribution of the number of risk factors using four categories; no risk factor, one risk factor, two risk factors and three or more risk factors. We compared the weighted distribution of the risk factors by sociodemographic characteristics using chi-square statistics. We also conducted gender-stratified analysis to obtain the distribution of the number of risk factors among men and women.

We conducted age-adjusted and fully adjusted, gender-stratified, multivariable, multinomial logistic regression analysis to identify factors associated with the number of NCD risk factors. The dependent variable had three categories: no risk factor; one or two risk factors; and three or more risk factors. Multinomial logistic regression models were used as we were assessing the correlates associated with the number of NCD risk factors (the three categories listed above) rather than the number of individual risk factors. We used no risk factors as the reference category. Fully adjusted relative risk ratios (ARRR) with their corresponding 95% confidence intervals (95% CI) are reported. We further stratified our analysis by gender because of the possibility of different correlates and the low smoking prevalence among women in The Gambia. Apart from the description of the characteristics of study participants (Table S1), all our analyses are weighted for non-response and adjusted for the complex survey design, using Stata 15 (StataCorp, College Station, Texas, US). Ethical approval for the survey was obtained from The Gambia Government/Medical Research Council Unit Joint Ethics Committee; participants gave verbal or written informed consent.

3. Results

Table S1 is a summary of the unweighted characteristics of participants included in this study. The size of the analytical sample (N=3000) is lower than the samples used in our previous publications using the same data set (Cham et al., 2018, Cham et al., 2020), because 1111 participants did not have complete information on all the risk factors considered. However, the distribution of the socio-demographic characteristics is similar to those described previously. We have also compared the survey sample, the analytical sample and the sample excluded (Table S2). The distribution of the samples are similar in terms of age, gender, education and area of residence. Most of the excluded sample with missing data were in the younger age group, those who lived in urban areas, and those who had a low level of education (Table S2). However, this corresponds with the survey sample and hence we believe our analytical sample is representative.

3.1. Prevalence of the five NCD risk factors included in the analysis of the number of risk factors

The prevalence of each NCD risk factor by selected socio-demographic variables for the complete cases included in our analyses is shown in Table 1. The prevalence of each risk factor by age-group among men and women is shown in Figure 1.

Table 1: Prevalence of NCD risk factors by selected socio-demographic variables (The Gambia, 2010) [a] (n=3000)

Variable	Hypertension %(95% CI)	Overweight/ obesity %(95% CI)	Physical inactivity %(95% CI)	Low fruit and veg. intake %(95% CI)	Smoking %(95% CI)
Total	29.3(26.5-32.3)	40.2(35.0-45.6)	13.7(9.6-19.0)	77.6(71.2-82.9)	17.3(14.9-20.1)
Gender					
Men	27.9(24.4-31.7)	34.4(27.6-41.9)	10.2(6.9-14.7)	77.4(70.7-83.0)	33.3(29.1-37.7)
Women	30.8(27.6-34.2)	46.1(41.5-50.8)	17.2(11.9-24.4)	77.8(70.9-83.4)	1.1(0.6-1.8)
	P=0.167	P<0.001	P=0.001	P=0.861	P<0.001
Age Group					
25 -34	17.6(14.6-20.9)	34.5(28.4-40.9)	10.5(6.9-15.8)	76.9(70.0-82.6)	18.2(14.5-22.6)
35-44	29.1(25.0-33.5)	44.2(38.5-50.2)	13.2(8.3-20.2)	77.7(70.9-83.2)	17.5(14.6-20.9)
45-54	44.8(39.4-50.3)	47.2(39.8-54.8)	15.3(10.3-22.2)	78.5(70.8-84.6)	16.6(13.1-20.8)
55-64	58.7(50.1-66.8)	45.1(36.1-54.0)	26.7(18.0-37.7)	79.2(68.7-86.9)	14.0(10.6-18.2)
	P<0.001	P<0.001	P<0.001	P=0.845	P=0.462
Marital status					
Never married	18.7(14.1-24.3)	34.9(24.8-46.6)	11.0(6.5-18.1)	72.1(61.0-81.0)	25.2(18.4-33.4)
Married	29.4(26.4-32.6)	42.4(37.1-48.0)	15.5(11.0-21.4)	81.3(74.9-86.4)	16.3(13.8-19.2)
Separated	36.6(27.3-46.9)	52.6(41.5-63.4)	15.9(9.1-26.3)	84.1(74.1-90.8)	14.2(9.0-21.7)
Widowed^					
Cohabiting	34.4(28.8-40.4)	26.6(19.9-34.4)	1.4(0.5-4.0)	63.6(51.9-73.9)	16.3(12.9-20.4)
	P<0.001	P=0.001	P<0.001	P=0.001	P=0.003
Ethnicity					
Mandinka	30.4(26.5-34.7)	36.2(30.6-42.3)	11.6(8.2-16.2)	76.0(69.4-81.6)	18.8(15.22.7)
Wollof	30.7(25.4-36.5)	48.2(38.7-57.9)	14.6(9.0-22.7)	89.0(81.6-93.7)	12.8(9.1-17.7)
Fula	27.1(22.7-32.1)	40.6(33.4-48.1)	12.7(7.8-19.9)	79.9(72.2-85.9)	20.2(15.3-26.0)
Jola	25.4(20.5-30.9)	36.6(27.1-47.2)	13.9(7.7-23.6)	67.3(56.4-76.6)	18.6(14.5-23.6)
Others	32.0(25.4-39.4)	47.7(39.8-55.6)	22.0(13.7-33.4)	74.9(65.9-82.2)	11.2(7.3-17.0)
	P=0.357	P=0.037	P=0.065	P<0.001	P=0.027
Residence (Local government area)[b]					
Banjul & KM	21.6(17.2-26.7)	67.2(61.1-72.8)	29.2(18.4-43.0)	77.7(62.9-87.8)	10.5(7.2-15.1)
WCR	31.3(27.6-35.2)	24.9(20.7-29.6)	6.2(3.9-9.8)	69.5(60.8-77.0)	25.1(21.1-29.5)
LRR	40.4(34.6-46.3)	26.9(16.2-41.3)	1.2(0.3-4.2)	91.9(76.2-97.6)	17.1(13.3-21.6)
NBR	36.7(32.2-41.4)	26.7(22.1-31.8)	4.2(1.9-8.9)	81.7(61.2-92.7)	14.1(10.4-18.7)
CRR	36.2(30.3-42.7)	22.5(15.0-32.3)	6.3(3.9-10.1)	97.9(94.5-99.2)	18.8(11.6-29.1)
URR	21.7(15.5-29.6)	36.4(27.6-46.3)	9.1(4.7-17.0)	58.1(48.3-67.4)	17.7(10.1-29.1)
	P<0.001	P<0.001	P<0.001	P=0.009	P<0.001
Residence (Rurality)					
Urban	24.8(21.3-28.6)	50.8(42.8-58.8)	20.5(13.7-29.6)	76.4(67.2-83.6)	17.0(13.4-21.4)
Semi urban	40.2(30.9-50.2)	38.7(32.2-45.6)	7.9(3.4-17.3)	79.5(59.5-91.1)	17.2(12.4-23.2)
Rural	34.6(31.7-37.6)	23.2(19.4-27.6)	3.6(2.4-5.3)	79.2(68.5-87.0)	17.9(14.9-21.3)
	P<0.001	P<0.001	P<0.001	P=0.842	P=0.888
Education					
≤6 Years	33.6(30.8-36.6)	34.3(30.0-38.9)	5.1(3.7-7.0)	80.8(74.2-86.0)	17.2(14.7-20.0)
7-12 Years	23.2(18.2-29.1)	43.4(35.4-51.8)	13.3(8.4-20.4)	78.5(70.2-85.0)	19.3(15.4-23.9)
>12 Years	21.7(15.8-29.0)	54.0(41.2-66.4)	11.4(7.8-16.5)	73.4(60.1-83.5)	27.3(20.3-35.7)
	P<0.001	P<0.001	P<0.001	P=0.345	P=0.016

[a] Results adjusted for complex survey design and weighted for non-response

[b] KM=Kanifing Municipality; WCR =West Coast Region; LRR= Lower River Region; NBR =North Bank Region; CRR = Central River Region; URR =Upper River Region

NB: NCD risk factors are as defined in the Methods, section 2.2

^ N < 10: therefore estimates not shown

The prevalence of overweight/obesity was significantly higher in women (46%, 95% CI: 41.5-50.8) compared with men (34%, 95% CI: 27.1-41.9). Likewise, physical inactivity was significantly higher in women (17.2%, 95% CI: 11.9-24.4) than in men (10.2%, 95% CI: 6.9-14.7). The prevalence of smoking was significantly higher in men than in women (33%, 95% CI: 29.1-37.7 vs 1%, 95% CI:0.6-1.8). Unlike smoking, there was no gender difference in the prevalence of hypertension and in low fruit and vegetable intake. The prevalence of hypertension was significantly higher among semi-urban (40%, 95% CI: 30.9-50.2) and rural residents (35%, 95% CI: 31.7-37.6) compared with urban residents (25%, 95% CI: 21.3-28.6), while the prevalence of overweight/obesity and physical inactivity were significantly higher in urban compared with semi-urban and rural residents (Table 1). There was no significant difference in the prevalence of smoking and of low fruit and vegetable intake by rural vs urban residence (rurality) in both men and women. However, there was a significant difference in the prevalence of each of these risk factors when we used 'local government area' to denote residence (Table 1). Hypertension and smoking were lowest in Banjul and Kanifing Municipality (purely urban) but physical inactivity and overweight/obesity were highest in these regions.

3.2. Co-occurrence of risk factors by sociodemographic factors

The prevalence of the number of risk factors by selected socio-demographic characteristics is shown in Table 2. Only 7% (95% CI: 5.2-9.8) had no risk factor; 33% (95% CI: 29.7-35.8) had only one risk factor; 38% (95% CI: 35.2-41.4) had two risk factors; 19% (95% CI: 16.4-21.5) had three risk factors; 3% (95% CI: 2.2-3.7) had four risk factors and 0.2% (95% CI: 0.1-0.5) had five risk factors. When we combined those with three or more risk factors, 22% (95% CI: 19.1-24.9) had at least three risk factors. The prevalence of three or more risk factors increased with increasing age among both genders (Figure 2).

Table 2: Prevalence of number of NCD risk factors by selected socio-demographic variables (The Gambia 2010) [a,b]

Variable	No risk factor %(95% CI) n=214	One risk factor %(95% CI) n=1016	Two risk factors %(95% CI) n=1139	Three or more risk factors % (95% CI) n=631
Total	7.2(5.2-9.8)	32.7(29.7-35.8)	38.3(35.2-41.4)	21.9(19.1-24.9)
Gender	*P=0.032*			
Men	6.8(4.7-9.9)	29.4(25.6-33.5)	40.9(36.9-45.0)	22.9(19.7-26.4)
Women	7.5(5.2-10.7)	36.0(32.6-39.7)	35.6(31.8-39.5)	20.9(17.4-24.9)
Age Group	*P<0.001*			
25 -34	9.4(6.8-12.9)	39.3(35.3-43.4)	37.7(33.8-41.7)	13.7(11.1-16.7)
35-44	6.2(4.2-9.1)	31.6(27.4-36.0)	39.2(34.8-43.8)	23.0(18.8-27.8)
45-54	5.4(3.2-9.1)	23.5(19.3-28.4)	39.3(34.0-44.9)	31.8(26.2-37.9)
55-64	2.1(1.1-4.0)	20.3(14.7-27.3)	36.8(29.6-44.6)	40.9(33.0-49.2)
Marital status	*P<0.001*			
Never married	12.7(8.0-19.7)	34.4(27.8-41.7)	35.7(28.9-43.0)	17.2(11.8-24.4)
Married	5.0(3.4-7.1)	31.5(28.3-34.9)	39.9(36.4-43.5)	23.7(20.8-26.9)
Separated	5.9(2.5-13.1)	27.0(18.6-37.4)	35.2(27.2-44.4)	31.9(23.4-41.8)
Widowed [c]	[c]	[c]	[c]	[c]
Cohabiting	14.2(8.8-22.3)	41.2(37.5-45.1)	34.2(28.3-40.6)	10.4(7.7-13.8)
Ethnicity	*P=0.001*			
Mandinka	7.9(5.6-11.2)	35.2(31.5-39.1)	36.7(33.0-40.5)	20.2(17.5-23.3)
Wollof	2.5(1.2-5.4)	29.3(23.3-36.0)	41.0(34.9-47.4)	27.2(21.8-33.3)
Fula	5.2(3.1-8.7)	31.5(27.1-36.2)	43.2(37.5-49.1)	20.1(15.6-25.4)
Jola	13.1(7.6-21.6)	32.7(27.3-38.6)	36.3(29.1-44.2)	17.9(13.1-23.9)
Others	7.2(3.9-13.1)	30.1(23.8-37.4)	34.4(27.8-41.7)	28.3(21.4-36.4)
Residence (Local government area) [d]	*P<0.001*			
Banjul & KM	4.4(1.9-9.8)	20.7(16.0-26.3)	44.5(38.6-50.5)	30.5(25.2-36.3)
WCR	11.9(8.4-16.6)	38.0(34.5-41.8)	33.6(29.3-38.3)	16.5(12.9-20.7)
LRR	3.7(1.1-12.3)	38.4(33.9-43.0)	36.2(29.4-43.4)	21.7(14.1-31.9)
NBR	7.8(3.1-18.3)	38.0(32.0-44.4)	38.9(31.3-47.1)	15.2(10.7-21.2)
CRR	0.2(0.02-1.4)	42.9(37.1-48.9)	34.9(29.4-40.9)	22.0(15.9-29.8)
URR	13.0(8.8-18.8)	43.7(36.6-51.2)	33.0(26.1-40.7)	10.3(5.0-19.9)
Residence (Rurality)	*P<0.001*			
Urban	6.5(4.2-9.8)	27.2(23.0-32.0)	40.6(36.2-45.1)	25.7(21.7-30.2)
Semi urban	4.6(1.9-10.7)	37.7(34.1-41.5)	31.0(28.5-33.7)	26.7(19.5-35.4)
Rural	8.8(5.3-14.2)	40.6(37.4-43.8)	35.8(31.8-40.1)	14.8(12.0-18.2)
Education	P=0.210			
≤6 Years	7.6(5.2-10.9)	35.3(32.9-37.8)	38.1(34.7-41.6)	19.0(16.3-22.0)
7-12 Years	8.0(4.8-12.9)	32.2(26.5-38.5)	37.4(32.1-43.1)	22.5(18.1-27.5)
>12 Years	7.1(3.3-14.5)	23.4(16.5-32.1)	47.0(38.3-55.8)	22.5(16.3-30.4)

[a] NCD risk factors are as defined in the Methods section 2.2

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

[c] < 10: therefore estimates not shown.

[d] KM=Kanifing Municipality; WCR =West Coast Region; LRR= Lower River Region; NBR =North Bank Region; CRR = Central River Region; URR =Upper River Region .

The prevalence of having three or more risk factors was significantly higher in urban compared with rural areas (26%, 95% CI: 21.7-30.2 vs 15%, 95% CI: 12.0-18.2) (Table 3). The findings were similar when we stratified our analysis by gender (Table 3).

Table 3: Prevalence of number of NCD risk factors by selected socio-demographic variables by gender (The Gambia, 2010) (n=3000) [a]

	Men n=1372				Women n=1628			
Variable	**No risk factor %(95% CI) n=80**	**One risk factor %(95% CI) n=385**	**Two risk factors %(95% CI) n=576**	**Three to five risk factors %(95% CI) n=331**	**No risk factor %(95% CI) n=135**	**One risk factor %(95% CI) n=635**	**Two risk factors %(95% CI) n=562**	**Three to five risk factors %(95% CI) n=296**
Total	6.8(4.7-9.9)	29.4(25.5-33.5)	40.9(36.9-45.0)	22.9(19.7-26.4	7.5(5.3-10.7)	36.0(32.6-39.7)	35.5(31.8-39.5)	20.9(17.4-24.9)
Age Group								
25-34	8.4(5.2-13.2)	35.9(30.6-41.7)	39.9(34.5-45.3)	15.8(11.8-20.7)	10.5(7.3-14.8)	42.5(37.1-48.2)	35.4(30.3-41.0)	11.6(8.9-15.0)
35-44	7.0(4.2-11.4)	25.5(20.5-31.3)	42.8(36.2-49.7)	24.7(19.4-30.7)	5.4(3.3-8.9)	37.9(32.5-43.7)	35.4(30.0-41.2)	21.2(15.9-27.8)
45-54	4.3(2.1-8.5)	21.2(16.3-27.1)	44.1(37.5-50.9)	30.5(24.6-37.1)	6.7(3.5-12.3)	26.1(20.3-32.8)	34.2(27.8-41.1)	33.1(25.7-41.5)
55-64	3.8(2.0-7.1)	24.0(17.5-31.9)	34.8(28.0-42.4)	37.5(29.8-45.8)	0.3(0.04-2.3)	16.6(9.5-27.2)	38.7(26.2-52.9)	44.4(32.7-56.7)
	P<0.001				P<0.001			
Marital status								
Never married	13.6(8.0-22.4)	32.6(24.8-41.5)	35.5(28.2-43.6)	18.3(11.7-27.4)	10.0(4.6-20.3)	40.1(28.2-53.3)	36.1(25.1-48.7)	13.9(7.2-24.9)
Married	4.3(2.7-6.7)	26.9(23.0-31.2)	43.4(38.7-48.3)	25.4(21.9-29.3)	5.6(3.8-8.3)	35.9(31.8-40.3)	36.5(32.2-41.0)	22.0(18.0-25.9)
Separated	1.4(0.2-9.7)	39.2(21.2-60.8)	33.6(18.5-52.9)	25.9(11.9-47.5)	8.0(3.2-18.5)	21.2(13.3-32.2)	36.1(24.7-49.4)	34.7(22.5-49.2)
Widowed	^	^	^	^	2.4(0.5-11.2)	25.1(14.6-39.6)	31.6(16.5-51.9)	41.0(26.5-55.9)
Cohabiting	9.5(5.1-17.2)	37.0(28.5-46.4)	37.1(29.7-45.3)	16.3(11.0-23.6)	17.7(10.8-27.7)	44.4(39.3-49.6)	32.0(25.0-39.9)	5.9(3.5-10.0)
	P=0.004				P<0.001			
Ethnicity								
Mandinka	8.4(5.2-13.2)	32.1(26.5-38.2)	38.5(33.0-44.2)	21.1(17.5-25.2)	7.5(5.1-10.8)	38.6(34.6-42.7)	34.7(30.6-39.0)	19.3(15.7-23.4)
Wollof	2.2(0.7-6.5)	28.2(20.7-37.2)	40.7(33.0-48.8)	28.9(22.2-36.8)	2.9(1.2-6.8)	30.3(23.5-38.1)	41.4(34.3-49.0)	25.4(18.7-33.5)
Fula	5.2(2.5-10.5)	24.6(18.9-31.2)	48.4(40.0-56.9)	21.9(16.4-28.6)	5.3(2.9-9.6)	39.3(32.1-47.0)	37.4(31.1-44.0)	18.1(11.5-27.3)
Jola	11.3(5.8-20.9)	25.7(16.9-37.1)	44.4(33.3-56.0)	18.6(13.7-24.8)	14.6(7.7-26.1)	38.6(33.3-44.1)	30.0(22.3-40.2)	17.3(10.7-26.4)
Others	5.5(2.4-11.8)	34.9(26.3-44.5)	33.2(25.0-42.5)	26.5(17.8-37.4)	8.6(3.8-18.4)	26.3(18.2-36.4)	35.4(26.8-44.1)	29.7(20.6-40.8)
	P=0.041				P=0.007			
Residence (LGA) [b]								
Banjul & KM	5.1(2.0-12.2)	18.1(12.4-25.8)	43.3(35.7-51.3)	33.5(27.2-40.3	3.7(1.4-9.8)	23.0(17.9-29.2)	45.6(38.6-52.7)	27.7(21.0-35.6)
WCR	9.9(6.1-15.6)	35.9(30.4-41.8)	37.3(30.7-44.5)	16.9(13.6-20.8)	14.3(9.9-20.3)	40.7(35.8-45.8)	29.0(24.1-34.5)	16.0(10.9-22.8)
LRR	4.0(0.8-16.7)	34.4(27.3-42.2)	43.1(30.7-56.3)	18.6(12.3-27.2)	3.5(1.2-9.6)	42.3(33.3-51.8)	29.5(24.8-34.8)	24.7(14.2-39.3)
NBR	5.8(2.0-15.8)	33.1(22.3-46.1)	46.2(37.5-55.1)	14.9(8.7-24.3)	9.4(3.6-22.4)	41.9(37.0-46.9)	33.2(24.9-42.6)	15.5(10.8-21.8)
CRR	0.0	34.3(29.6-39.4)	41.7(33.350.7)	23.9(18.5-30.4)	0.4(0.05-2.8)	51.0(38.4-63.0)	28.4(25.0-32.1)	20.3(10.1-36.6)
URR	0.0	33.3(23.4-45.0)	36.0(26.1-47.1)	15.8(7.2-31.1)	10.7(5.3-20.5)	55.9(48.2-63.3)	29.6(22.6-37.6)	3.8(1.0-13.5)
	P=0.009				P<0.001			
Residence (Rurality)								

	Men n=1372				Women n=1628			
Variable	**No risk factor %(95% CI) n=80**	**One risk factor %(95% CI) n=385**	**Two risk factors %(95% CI) n=576**	**Three to five risk factors %(95% CI) n=331**	**No risk factor %(95% CI) n=135**	**One risk factor %(95% CI) n=635**	**Two risk factors %(95% CI) n=562**	**Three to five risk factors %(95% CI) n=296**
Urban	6.9(4.1-11.3)	25.3(20.3-31.1)	41.3(35.8-47.1)	26.6(21.9-31.8)	6.1(3.8-9.7)	29.3(24.3-35.0)	39.9(34.2-45.8)	24.7(19.0-30.6)
Semi urban	5.5(1.7-16.1)	39.2(32.6-46.2)	35.4(31.6-39.4)	20.0(13.3-29.0)	3.5(1.7-7.4)	36.0(28.5-44.2)	25.7(23.0-28.5)	34.8(24.7-46.6)
Rural	7.1(4.0-12.3)	34.6(28.9-40.8)	41.4(35.1-48.1)	16.9(13.1-21.5)	10.3(6.0-17.1)	45.9(42.1-49.7	30.8(27.0-34.9)	13.0(10.1-16.6)
	P=0.045				P<0.001			
Education								
≤6 Years	6.6(4.1-10.6)	29.9(26.2-33.9)	42.5(37.4-47.6)	21.0(17.9-24.5)	8.4(5.6-12.3)	39.7(36.5-43.0)	34.6(30.8-38.8)	17.3(13.7-21.6)
7-12 Years	8.3(4.4-15.2)	31.6(24.9-39.2)	39.0(32.4-45.9)	21.1(15.8-27.6)	7.5(4.3-12.8)	32.9(24.9-42.1)	35.3(28.0-43.4)	24.3(18.0-32.0)
>12 Years	7.0(3.0-15.1)	23.5(15.9-33.5)	44.2(35.3-53.5)	25.3(18.1-34.2)	7.8(2.3-22.4)	22.8(12.1-39.0)	59.0(38.3-76.9)	10.5(3.4-28.0)
	P=0.717				P=0.060			

[a] Results adjusted for complex survey design and weighted for non-response

[b] KM=Kanifing Municipality; WCR =West Coast Region; LRR= Lower River Region; NBR =North Bank Region; CRR = Central River Region; URR =Upper River Region

NB: NCD risk factors are as defined in the Methods, section 2.2

N <10: therefore estimates not shown

3.3. Factors associated with co-occurrence of NCD risk factors

Age and ethnicity were significantly associated with having three or more risk factors (versus none) among men in the fully adjusted multinomial logistic regression model (Table 4). Low level of education, older age, ethnicity and urban residence were significantly associated with having three or more risk factors (versus none) among women (Table 5).

In the fully adjusted models for all participants, those in the older age group (55-64 years) were more likely than the younger participants (25-34 years) to have three or more risk factors rather than have no risk factors. Urban residents were twice (ARRR 2.1, 95% CI: 1.1-4.1) as likely as rural residents to have three or more risk factors rather than have no risk factors. Wollofs were more likely (3.7, 95% CI: 1.7-7.9) than Mandinkas to have three or more risk factors rather than no have risk factors (Table S3).

Table 4: Multivariate multinomial logistic regression on factors associated with co-occurrence of NCD risk factors in men (The Gambia, 2010)

	Model I (Age adjusted)		Model II (Fully adjusted)	
	1-2 risk factors	**3-5 risk factors**	**1-2 risk factors**	**3-5 risk factors**
Variable	**[a]RRR(95% CI)**	**[a]RRR(95% CI)**	**ARRR (95% CI)**	**ARRR (95% CI)**
Age Group				
25-34	Reference	Reference	Reference	Reference
35-44	1.09(0.58-1.99)	1.88(0.92-3.82)	1.03(0.51-2.09)	1.98(0.88-4.46)
45-54	1.69(0.76-3.74)	3.80(1.65-8.77)	1.41(0.58-3.39)	3.43(1.39-8.43)
55-64	1.72(0.88-3.40)	5.29(2.38-11.76)	1.66(0.79-3.49)	6.39(2.69-15.14)
Ethnicity				
Mandinka	Reference	Reference	Reference	Reference
Wollof	3.65(1.23-10.80)	4.81(1.64-14.15)	3.64(1.22-10.88)	4.85(1.59-14.77)
Fula	1.65(0.71-3.84)	1.60(0.65-3.91)	1.78(0.67-4.75)	1.77(0.59-5.28)
Jola	0.73(0.31-1.71)	0.62(0.25-1.57)	0.75(0.31-1.79)	0.67(0.27-1.65)
Others	1.43(0.56-3.69)	1.76(0.63-4.94)	1.29(0.49-3.39)	1.79(0.65-4.92)
Education				
≤6 Years	Reference	Reference	Reference	Reference
7-12 Years	0.86(0.36-2.04)	1.26(0.50-3.17)	0.99(0.40-2.41)	1.15(0.45-2.94)
>12 Years	0.91(0.35-2.36)	1.27(0.47-3.41)	0.96(0.34-2.74)	1.00(0.34-2.90)
Residence (Rurality)				
Rural	Reference	Reference	Reference	Reference
Semi urban	1.31(0.36-4.78)	1.70(0.36-7.89)	1.34(0.32-5.66)	1.71(0.30-9.55)
Urban	0.95(0.44-2.06)	1.92(0.79-4.67)	0.88(0.39-1.96)	1.54(0.65-3.64)

Note: Data shown have been weighted for non-response and the analysis took into account the complex survey design.
Fully adjusted models mutually adjusted for the variables shown in the table
[a]RRR= Relative Risk Ratio adjusted for age (except for age group as the independent variable),
ARRR= Adjusted Relative Risk Ratio(fully adjusted)
Reference = No risk factor

Table 5: Multinomial logistic regression on factors associated with co-occurrence of NCD risk factors in women (The Gambia, 2010)

	Model I(Age adjusted		Model II(Fully adjusted)	
	1-2 risk factors	**3-4 risk factors**	**1-2 risk factors**	**3-5 risk factors**
Variable	**[a]RRR(95% CI)**	**[a]RRR(95% CI)**	**ARRR (95% CI)**	**ARRR (95% CI)**
Age Group				
25 -34	Reference	Reference	Reference	Reference
35-44	1.81(1.18-2.80)	3.54(2.20-5.71)	2.23(1.45-3.48)	5.55(3.34-9.24)
45-54	1.21(0.66-2.28)	4.48(2.33-8.62)	1.31(0.75-2.30)	7.82(4.00-15.41)
55-64	^	^	^	^
Ethnicity				
Mandinka	Reference	Reference	Reference	Reference
Wollof	2.51(1.00-6.26)	3.18(1.39-7.29)	2.28(0.87-5.97)	2.58(1.07-6.21)
Fula	1.59(0.88-2.89)	1.72(0.79-3.73)	1.58(0.87-2.87)	1.49(0.64-3.47)
Jola	0.46(0.21-0.99)	0.44(0.14-1.36)	0.42(0.21-0.85)	0.38(0.14-1.00)
Others	0.73(0.31-1.71)	1.34(0.55-3.26)	0.64(0.27-1.54)	1.00(0.40-2.53)
Education				
≤6 Years	Reference	Reference	Reference	Reference
7-12 Years	1.06 (0.59-1.94)	2.16(1.09-4.31)	1.06(0.60-1.890	1.60(0.86-2.94)
>12 Years	1.28(0.66-2.48)	0.76(0.34-1.68)	0.98(0.55-1.74)	0.47(0.24-0.94)
Residence				
Rural	Reference	Reference	Reference	Reference
Semi urban	2.28 (1.04-5.00)	7.52(2.75-20.54)	1.82(0.89-3.74)	5.84(2.36-14.43)
Urban	1.70(0.79-3.65)	4.48(1.76-11.41)	1.56(0.78-3.11)	2.77(1.28-5.97)

Note: Data shown have been weighted for non-response and the analysis took into account the complex survey design.
Fully adjusted models mutually adjusted for the variables shown in the table
[a]RRR= Relative Risk Ratio adjusted for age (except for age group as the independent variable),
ARRR= Adjusted Relative Risk Ratio(fully adjusted)
Reference = No risk factor
^ Number with no risk factor (the reference category) is extremely small (<5) resulting in very wide confidence intervals

4. Discussion

This study reveals a high prevalence of NCD risk factor co-occurrence in The Gambian adult population (aged 25-64 years). Over 90% had at least one risk factor, which is a cause for concern considering the strong association between co-occurrence of risk factors and chronic NCDs (Zaman et al., 2015, Wesonga et al., 2016). The high prevalence of each individual risk factor as well as the high level of risk factor co-occurrence is worrying in terms of future NCD burden.

Co-occurrence of risk factors was associated with older age and urban residence, especially in women, in whom low education was also associated with having multiple risk factors. The association of increasing age with risk factor co-occurrence is not a surprise as some of the NCD risk factors increase with age, especially age-related biological/metabolic risk factors such as hypertension and obesity. Behavioural risk factors, such as physical inactivity, are also more common among older people. Our findings on the prevalence of having multiple risk factors concur with findings from similar studies elsewhere in Africa and in Asia (Wesonga et al., 2016, Pelzom et al., 2017, Li et al., 2012). However, a study in Spain which focused on the simultaneous presence of three to four behavioural risk factors including smoking, alcohol use, physical inactivity and an unbalanced diet (consumption of less than two servings of fruit, juice or vegetables in the previous 24 hours) found higher levels of co-occurrence among the younger age groups compared with the older age groups (Galan et al., 2005). This could be because strongly age-related biological risk factors such as obesity and hypertension were not considered in that study and behavioural risk factors such as alcohol consumption and smoking are more common among younger age cohorts.

Urban residence was significantly associated with having three or more risk factors compared with rural residence (26% and 15% with three or more risk factors respectively) in the present study. This is in agreement with some studies in the literature (Pelzom et al., 2017, Rawal et al., 2017). However, a study in Uganda found co-occurrence of one to two risk factors to be associated with rural residence (RRR=1.54,$p< 0.001$) (Wesonga et al., 2016). The proportion with three or more risk factors was significantly higher among urban residents in that study but there was no statistically significant difference between urban and rural residents in the multivariate regression (RRR=1.16, $p=0.376$). Another study, conducted in China, that focused on behavioural risk factors only, also found having more risk factors to be associated

with rural residence (Li et al., 2012). There is evidence on the linkage between urbanisation and the increasing burden of obesity and other NCDs, especially in low-income countries (Godfrey and Julien, 2005, Kruger et al., 2001, Ojiambo, 2016, Vorster, 2002), but our data from The Gambia underscore the fact that these issues are also of concern in rural areas as well.

The prevalence of multiple risk factors was lower among those with higher education in women. Higher education appeared to be inversely associated with three or more risk factors in the fully adjusted models in women. There was no significant difference between those with lower and higher education among men (ARRR=1.0). Overweight/obesity and physical inactivity were found in our present study to be higher among women with higher education. Some previous studies from countries including China (Li et al., 2012, Hong et al., 2018), Spain (Galan et al., 2005), and Brazil (Ferreira da Costa et al., 2013), that looked at the association of multiple risk factors with education, found the co-occurrence of risk factors to be associated with lower education. This could be because people with low level of education may have lower awareness of the risk factors and hence may be less likely to take preventive measures compared with those with higher levels of education. However, having multiple risk factors was associated with increasing level of education in a joint study conducted in Bangladesh, India, Indonesia, Thailand, and Vietnam (Ahmed et al., 2009). Other studies in Bangladesh and Nigeria also found the co-occurrence of risk factors to be higher among those with higher levels of education (Zaman et al., 2015, Idowu et al., 2016). It is argued that increased level of education is associated with affluence and access to diets rich in fat and sugar (Ahmed et al., 2009). This can explain the higher level of co-occurrence of NCD risk factors found in these countries. Socio-cultural factors may also have an influence on the association between affluence and risk factors including obesity and its associated risk factors including physical inactivity and hypertension (Gele and Mbalilaki, 2013, Scott et al., 2012). In some communities, being overweight is not perceived as a risk factor for NCDs but rather as a sign of wealth and prestige (Scott et al., 2012, Gele and Mbalilaki, 2013). This can also explain the association between higher education and co-occurrence of risk factors in some of these countries. Therefore, it is difficult to make direct comparisons because of different risk factors, analytical approaches, age ranges and socio-cultural settings.

We did not find any significant difference between men and women in the co-occurrence of three or more risk factors in the fully adjusted multinomial logistic regression model which

combined data from both genders. Previous studies have found gender differences in the co-occurrence of NCD risk factors. We could not find any study that assessed this in sub-Saharan Africa, but in a Chinese study, having more behavioural risk factors was significantly associated with being male (Li et al., 2012). However, in a similar study in Pakistan, the prevalence of multiple risk factors was significantly higher among women, although multivariable regression analyses were not conducted to control for potential confounders (Khuwaja and Kadir, 2010). Factors that could explain why Wollofs were more likely than Mandinkas to have three or more risk factors rather than no risk factors are not known but warrant future research.

4.1. Strengths and limitations of this study

Only a few studies have examined the co-occurrence of risk factors for NCDs in sub-Saharan Africa. To our knowledge, this is the only study conducted to date that has assessed the co-occurrence of NCD risk factors at the population level in The Gambia.

The main limitation of this analysis is the cross-sectional nature of the data, which limits making causal inferences on the findings. Additionally, the approach taken in our study involved counting the number of risk factors. However, this approach has been criticised for focusing on the presence of risk factors: adding the scores depending on the presence and absence of a risk factor gives each factor an equal weight. For example, smoking tobacco may be more detrimental to health compared with low fruit and vegetable intake but the weighting of each risk factor to the overall score is assumed equal. Three of the five risk factors considered in our analyses (smoking, low fruit and vegetable intake and physical inactivity) were based on self-reported data, which might be subjected to biases.

Another important limitation is the omission of biochemical risk factors such as diabetes and raised cholesterol. Our data has information only on self-reported diabetes and does not have information on blood cholesterol. These were not collected due to costs and for technical reasons. However, our analysis is comparable with the other studies reported in academic journals that used the WHO STEPS approach as well as the WHO fact sheets (World Health Organization, 2016b), as they used the same five risk factors used in our analysis.

4.2. Policy implications of our findings

There is a high degree of NCD risk factor co-occurrence in The Gambia. Addressing the burden of NCDs in The Gambia and by extension in other countries in sub-Saharan Africa calls for policies and programmes that do not only target individual CVD risk factors but also the co-occurrence of multiple risk factors.

The Ministry of Health should further strengthen its health education and promotion activities in the electronic and print media. Since there are communities that do not have access to radio and television, there should be more community outreach programmes to sensitise communities in basic preventive measures. Such community outreach programmes must also take into consideration several additional variables specific to The Gambia. These include the fact that historically and culturally, being overweight or obese has been seen as a sign of prosperity among both men and women in The Gambia and therefore attempts to reduce weight requires cultural reinterpretation of these beliefs (Siervo et al., 2006a). Additionally, while previous research has shown high rates of smoking among men but very low rates among women (Walraven et al., 2001, Siervo et al., 2006b), more recent studies have shown that these rates are changing with a rapid rise of smoking among younger adult women and among adolescents (Jallow et al., 2017). The WHO Package of Essential Non-communicable Disease Interventions (WHO PEN) should be used to ensure the prevention of NCDs and the early detection and control of cases.

5. Conclusion

Our analysis revealed that the co-occurrence of multiple NCD risk factors among Gambian adults aged 25-64 years was high: more than one in five adults had three or more risk factors. The burden of NCDs is expected to increase in The Gambia if preventive and control measures are not taken. Interventions geared towards the prevention and control of NCDs in The Gambia should focus on all five risk factors and should apply an integrated approach. As all the risk factors considered in this analysis are modifiable, lifestyle changes should be widely promoted throughout the country. There should be an integrated approach targeting all risk factors.

Contributors

B.C. conceptualised the paper, analysed the data and wrote the first draft of the manuscript. J.S.M., S.S. and N.E.G. 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 approved the final version of the manuscript and are responsible for research governance.

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Conflict of interest

The authors have no conflict of interest to declare.

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References

Ahmed, S. M., Hadi, A., Razzaque, A., Ashraf, A., Juvekar, S., Ng, N., Kanungsukkasem, U., Soonthornthada, K., Van Minh, H. & Huu Bich, T. 2009. Clustering of chronic non-communicable disease risk factors among selected Asian populations: levels and determinants. *Glob Health Action,* 2.

Alageel, S., Wright, A. J. & Gulliford, M. C. 2016. Changes in cardiovascular disease risk and behavioural risk factors before the introduction of a health check programme in England. *Prev Med,* 91**,** 158-163.

Beale, A. L. & Demaio, A. R. 2019. Non-communicable disease risk factors: a call for primary care clinicians to act and to refer. Brief intervention, not silent abdication. *Br J Sports Med,* 53**,** 322-323.

Behrens, G., Fischer, B., Kohler, S., Park, Y., Hollenbeck, A. R. & Leitzmann, M. F. 2013. Healthy lifestyle behaviors and decreased risk of mortality in a large prospective study of U.S. women and men. *Eur J Epidemiol,* 28**,** 361-72.

Cham, B., Scholes, S., Groce, N. E. & Mindell, J. S. 2019. Prevalence and Predictors of Smoking among Gambian Men: A Cross-Sectional National WHO STEP Survey. *International Journal of Environmental Research and Public Health,* 16**,** 4719.

Cham, B., Scholes, S., Ng Fat, L., Badjie, O., Groce, N. E. & Mindell, J. S. 2020. The silent epidemic of obesity in The Gambia: evidence from a nationwide, population-based, cross-sectional health examination survey. *BMJ Open,* 10**,** e033882.

Cham, B., Scholes, S., Ng Fat, L., Badjie, O. & Mindell, J. S. 2018. Burden of hypertension in The Gambia: evidence from a national World Health Organization (WHO) STEP survey. *International journal of epidemiology,* 47**,** 860-871.

Clark, H. 2013. NCDs: a challenge to sustainable human development. *Lancet,* 381**,** 510-1.

Dobson, A., Mclaughlin, D., Almeida, O., Brown, W., Byles, J., Flicker, L., Leung, J., Lopez, D., Mccaul, K. & Hankey, G. J. 2012. Impact of behavioural risk factors on death within 10 years for women and men in their 70s: absolute risk charts. *BMC Public Health,* 12**,** 669.

Ferreira Da Costa, F., Benedet, J., Leal, D. B. & Altenburg De Assis, M. A. 2013. Clustering of risk factors for non communicable diseases in adults from Florianopolis, SC. *Rev Bras Epidemiol,* 16**,** 398-408.

Galan, I., Rodriguez-Artalejo, F., Tobias, A., Diez-Ganan, L., Gandarillas, A. & Zorrilla, B. 2005. Clustering of behavior-related risk factors and its association with subjective health. *Gac Sanit,* 19**,** 370-8.

Gambia Bureau of Statistics 2013. The Gambia 2013 Population and Housing Census

Gele, A. A. & Mbalilaki, A. J. 2013. Overweight and obesity among African immigrants in Oslo. *BMC Res Notes,* 6**,** 119.

Godfrey, R. & Julien, M. 2005. Urbanisation and health. *Clin Med (Lond),* 5**,** 137-41.

Haregu, T. N., Oti, S., Egondi, T. & Kyobutungi, C. 2015. Co-occurrence of behavioral risk factors of common non-communicable diseases among urban slum dwellers in Nairobi, Kenya. *Global health action,* 8**,** 28697.

Hong, X., Ye, Q., He, J., Wang, Z., Yang, H., Qi, S., Chen, X., Wang, C., Zhou, H., Li, C., Qin, Z. & Xu, F. 2018. Prevalence and clustering of cardiovascular risk factors: a cross-sectional survey among Nanjing adults in China. *BMJ Open,* 8**,** e020530.

Idowu, A., Fatusi, A. O. & Olajide, F. O. 2016. Clustering of behavioural risk factors for non-communicable diseases (NCDs) among rural-based adolescents in south-west Nigeria. *Int J Adolesc Med Health,* 30.

Institute For Health Metrics And Evaluation. 2019. *Institute for Health Metrics and Evaluation (IHME) country proflie, The Gambia: Measuring what matters.* [Online]. Available: http://www.healthdata.org/gambia .

Jallow, I. K., Britton, J. & Langley, T. 2017. Prevalence and determinants of tobacco use among young people in The Gambia. *BMJ Glob Health,* 2**,** e000482.
Khuwaja, A. K. & Kadir, M. M. 2010. Gender differences and clustering pattern of behavioural risk factors for chronic non-communicable diseases: community-based study from a developing country. *Chronic Illn,* 6**,** 163-70.
Kruger, H. S., Venter, C. S. & Vorster, H. H. 2001. Obesity in African women in the North West Province, South Africa is associated with an increased risk of non-communicable diseases: the THUSA study. Transition and Health during Urbanisation of South Africans. *Br J Nutr,* 86**,** 733-40.
Lal, P., Jacob, A. & Buragohain, A. 2013. UN Development Programme and non-communicable diseases. *Lancet,* 382**,** 305.
Li, Y., Zhang, M., Jiang, Y. & Wu, F. 2012. Co-variations and clustering of chronic disease behavioral risk factors in China: China Chronic Disease and Risk Factor Surveillance, 2007. *PLoS One,* 7**,** e33881.
Loef, M. & Walach, H. 2012. The combined effects of healthy lifestyle behaviors on all cause mortality: a systematic review and meta-analysis. *Prev Med,* 55**,** 163-70.
Martin-Diener, E., Meyer, J., Braun, J., Tarnutzer, S., Faeh, D., Rohrmann, S. & Martin, B. W. 2014. The combined effect on survival of four main behavioural risk factors for non-communicable Diseases. *Prev Med,* 65**,** 148-52.
Ojiambo, R. M. 2016. Are lifestyle shifts fuelling the obesity epidemic in urbanised Africans? *Glob Health Promot,* 23**,** 73-75.
Pelzom, D., Isaakidis, P., Oo, M. M., Gurung, M. S. & Yangchen, P. 2017. Alarming prevalence and clustering of modifiable noncommunicable disease risk factors among adults in Bhutan: a nationwide cross-sectional community survey. *BMC Public Health,* 17**,** 975.
Poortinga, W. 2007. The prevalence and clustering of four major lifestyle risk factors in an English adult population. *Prev Med,* 44**,** 124-8.
Rawal, L. B., Biswas, T., Khandker, N. N., Saha, S. R., Bidat Chowdhury, M. M., Khan, A. N. S., Chowdhury, E. H. & Renzaho, A. 2017. Non-communicable disease (NCD) risk factors and diabetes among adults living in slum areas of Dhaka, Bangladesh. *PLoS One,* 12**,** e0184967.
Scholes, S. 2018. Health Survey for England, 2017: Multiple risk factors.
Scott, A., Ejikeme, C. S., Clottey, E. N. & Thomas, J. G. 2012. Obesity in sub-Saharan Africa: development of an ecological theoretical framework. *Health promotion international***,** das038.
Siervo, M., Grey, P., Nyan, O. A. & Prentice, A. M. 2006a. A pilot study on body image, attractiveness and body size in Gambians living in an urban community. *Eat Weight Disord,* 11**,** 100-9.
Siervo, M., Grey, P., Nyan, O. A. & Prentice, A. M. 2006b. Urbanization and obesity in The Gambia: a country in the early stages of the demographic transition. *European Journal of Clinical Nutrition,* 60**,** 455-463.
Vorster, H. H. 2002. The emergence of cardiovascular disease during urbanisation of Africans. *Public Health Nutr,* 5**,** 239-43.
Walraven, G. E., Nyan, O. A., Van Der Sande, M. A., Banya, W. A., Ceesay, S. M., Milligan, P. J. & Mcadam, K. P. 2001. Asthma, smoking and chronic cough in rural and urban adult communities in The Gambia. *Clin Exp Allergy,* 31**,** 1679-85.
Wekesah, F. M., Nyanjau, L., Kibachio, J., Mutua, M. K., Mohamed, S. F., Grobbee, D. E., Klipstein-Grobusch, K., Ngaruiya, C., Haregu, T. N., Asiki, G. & Kyobutungi, C. K. 2018. Individual and household level factors associated with presence of multiple non-communicable disease risk factors in Kenyan adults. *BMC Public Health,* 18**,** 1220.
Wesonga, R., Guwatudde, D., Bahendeka, S. K., Mutungi, G., Nabugoomu, F. & Muwonge, J. 2016. Burden of cumulative risk factors associated with non-communicable diseases among adults in Uganda: evidence from a national baseline survey. *Int J Equity Health,* 15**,** 195.
World Health Organization 2003. STEPS: A framework for surveillance: The WHO STEPwise approach to Surveillance of non-communicable diseases (STEPS).

World Health Organization 2005. World Health Organization STEPS surveillance manual: The WHO STEPwise approach to chronic disease risk factor surveillance.

World Health Organization 2012. Global physical activity questionnaire (GPAQ) analysis guide. *Geneva: World Health Organization*.

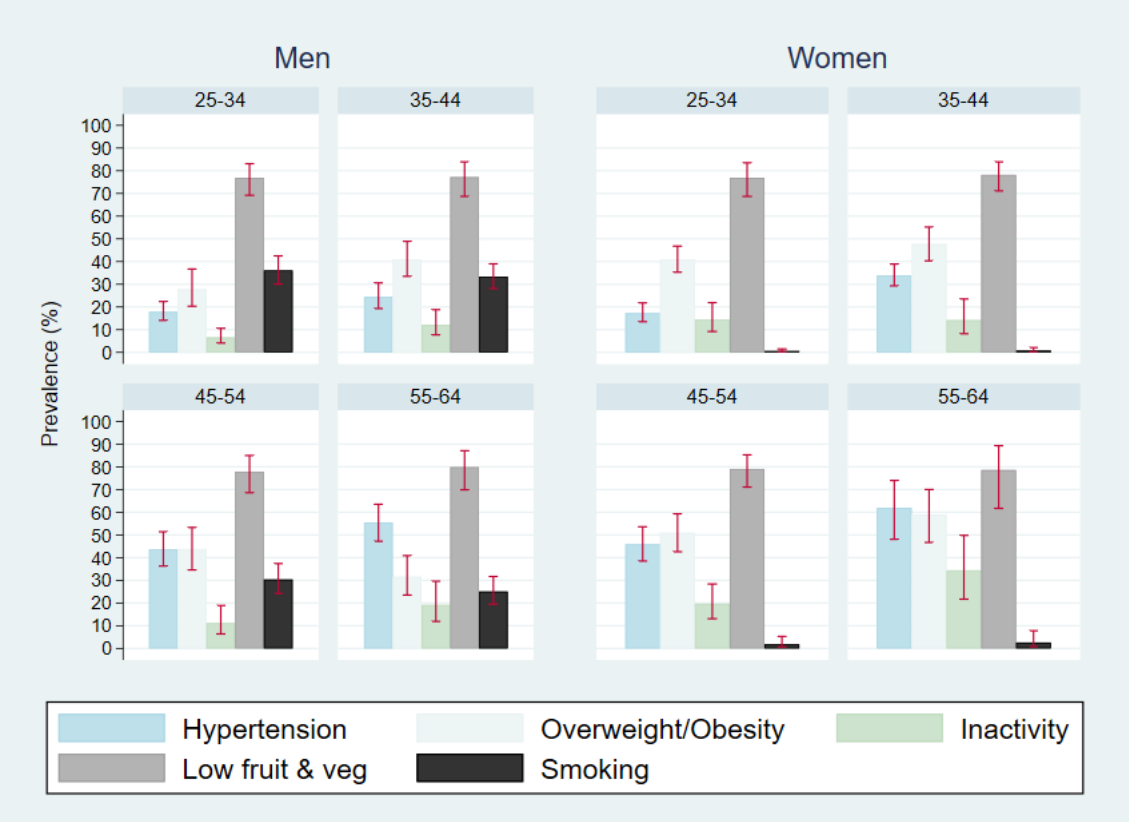
World Health Organization 2013. Global action plan for the prevention and control of noncommunicable diseases 2013-2020.

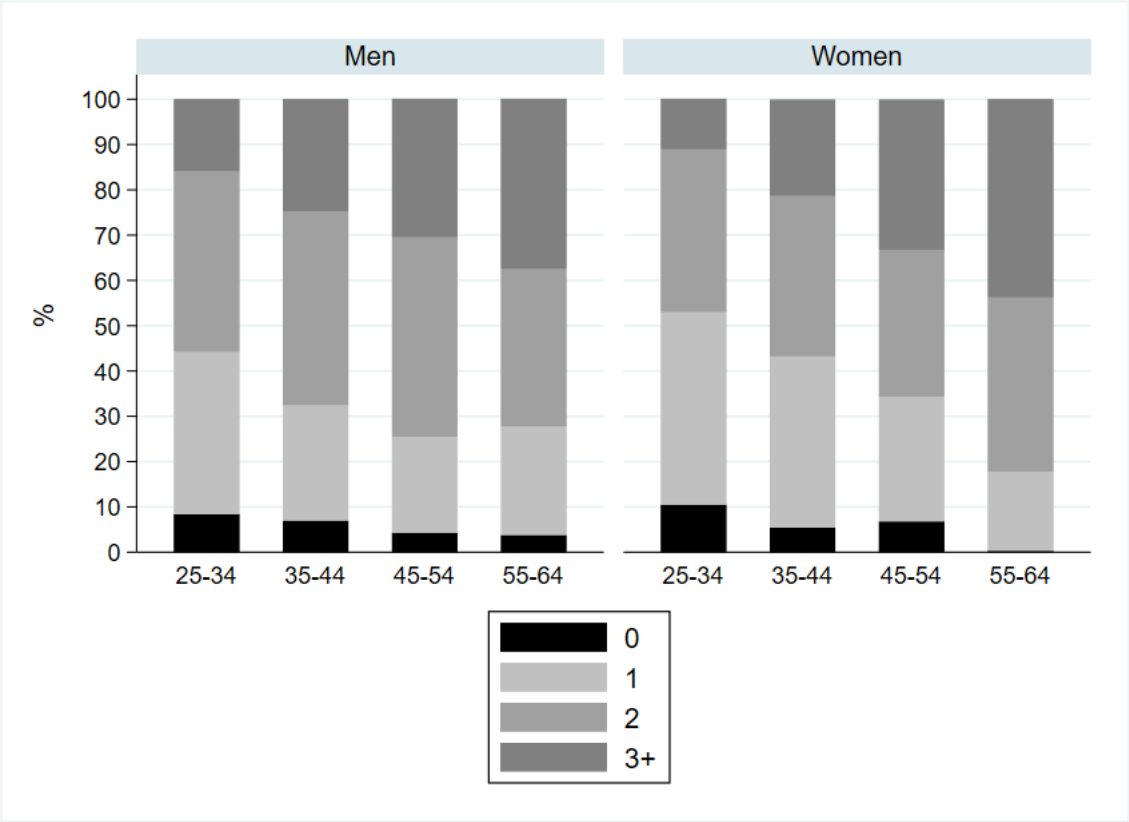
World Health Organization 2016a. Report on the status of major health risk factors for noncommunicable diseases: WHO African Region, 2015.

World Health Organization. 2016b. *WHO STEP Reports and Factsheets* [Online]. Available: http://www.who.int/chp/steps/reports/en/ [Accessed 27/06/2016].

World Health Organization. 2018. *World Health Organization - Noncommunicable Diseases (NCD) Country Profiles, 2018.* [Online]. Available: https://www.who.int/nmh/publications/ncd-profiles-2018/en/ [Accessed 25/07/2019].

Zaman, M. M., Bhuiyan, M. R., Karim, M. N., Moniruzzaman, Rahman, M. M., Akanda, A. W. & Fernando, T. 2015. Clustering of non-communicable diseases risk factors in Bangladeshi adults: An analysis of STEPS survey 2013. *BMC Public Health,* 15**,** 659.




Men
Women
100
90
80
70
60
50
40
30
20
10
0
%
25-34
35-44
45-54
55-64
25-34
35-44
45-54
55-64
0
1
2
3+

1

2

Supplementary Tables

Table S1: Characteristics of study participants by selected sociodemographic characteristics (unweighted & unadjusted for complex survey design)

Variable	Men		Women		Total 3000	
Variable	N	%	N	%	N	%
Gender						
Men	1372	45.7				
Women			1628	54.3		
Age Group						
25-34	439	32.0	883	54.2	1322	44.1
35-44	402	29.3	390	24.0	792	26.4
45-54	301	21.9	225	13.8	526	17.5
55-64	230	16.8	130	8.0	360	12.0
	P<0.001					
Mean age ± SD		41.3±11.2		36.0±10.3		38.4±11.0
Marital status						
Never married	208	15.2	105	6.5	313	10.5
Married	990	72.2	1177	72.4	2167	72.4
Separated/Divorced	36	2.6	75	4.6	111	3.7
Widowed	4	0.3	71	4.4	75	2.5
Cohabiting	132	9.6	197	12.1	329	11.0
	P<0.001					
Ethnicity						
Mandinka	601	43.9	704	43.3	1305	43.6
Wollof	221	16.1	253	15.6	474	15.8
Fula	257	18.8	291	17.9	548	18.3
Jola	165	12.1	219	13.5	384	12.8
Others	125	9.1	160	9.8	285	9.5
	P=0.719					
Residence (Local government area) [b]						
Banjul & KM	398	29.0	479	29.4	877	29.2
WCR	436	31.8	463	28.4	899	30.0
LRR	135	9.8	153	9.4	288	9.6
NBR	234	17.1	334	20.5	568	18.9
CRR	94	6.9	127	7.8	221	7.4
URR	75	5.5	72	4.4	147	4.9
	P= 0.069					
Residence (Rurality)						
Urban	712	51.9	783	48.1	1495	49.8
Semi urban	126	9.2	142	8.7	268	8.9
Rural	534	38.9	703	43.2	1237	41.2
	P= 0.060					
Education						
≤6 Years	790	61.8	1110	74.9	1900	68.8
7-12 Years	317	24.8	319	21.5	636	23.0
>12 Years	172	13.5	54	3.6	226	8.2
	P<0.001					

NB: The p value indicates the difference between men and women using chi-squared test of association for two-way tables

1