

Prevalence and correlates of multiple non-communicable diseases risk factors among male and female adults in Sudan: results of the first national STEPS survey in 2016

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Abstract

Background: Non-communicable diseases (NCDs) are on the rise in low- and middle-income countries. The aim of this study was to assess the prevalence and correlates of multiple NCD risk factors (inadequate fruit and vegetable intake, low physical activity, tobacco use, heavy alcohol use, diabetes, hypertension, raised total cholesterol and overweight/obesity) among adults in Sudan.

Methods: We conducted a cross-sectional study using nationally representative data. The analytic cohort included 7,722 participants who were between the ages of 18-69 years old individuals (median age=36 years) that took part in the “2016 Sudan STEPS survey.”

Results: In all, 34.2% had 0-1 NCD risk factor, 33.5% 2 risk factors, and 32.4% 3 or more NCD risk factors. In adjusted ordinal logistic regression analysis, the odds of having a higher count of NCD risk factors increased from 2.04 to 3.52 from the age group of 35-49 years to age group of 50-69 years when compared to the younger people aged 18-34 years. Men had higher odds (1.21) of higher NCD risk factor count than women. Individuals residing in urban areas had higher odds (1.86) of higher NCD risk factor count than individuals residing in rural areas.

Conclusion: Almost one in three participants had three or more NCD risk factors and several associated variables were identified for men and women that can facilitate in designing intervention programmes.

Keywords: Multiple non-communicable diseases; sociodemographic factors; adults; Sudan.

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Introduction

Non-communicable diseases (NCDs) are estimated to be responsible for 52% of all deaths in Sudan in 2016¹. More than 85% of NCD premature deaths occur in low- and middle-income countries². Cardiovascular diseases, cancers, respiratory diseases, and diabetes contribute to over 80% of all premature NCD deaths². Poor diets, tobacco use, harmful alcohol use, and low physical activity all increase the risk of dying from a NCD². In the

rapid increase of NCDs in sub-Saharan Africa and the Eastern Mediterranean region, it is important to gain insight in the local determinants of NCDs^{3,4}. Against this backdrop national community-based data on the prevalence of multiple NCD risk factors and associated factors among adults in Sudan are needed, a low-income country geographically in sub-Saharan Africa. Some population-based studies among adults in Sudan were sub-national and only focused on specific NCD risk factors, such as the prevalence of overweight/obesity was 56.1% in four states (Khartoum, Gezira, Blue Nile, and Kassala)⁵, 59.0% in Gadarif, Eastern Sudan⁶, hypertension was 16.6% in four states (Khartoum, Gezira, Blue Nile, and Kassala)⁷, 40.8% in Gadarif, Eastern Sudan⁸, the 35.7% in four main cities of the River Nile State, north Sudan⁹, 23.6% in the 2005-2006 Khartoum State STEPS survey¹⁰, and 27.6% in Khartoum State in Sudan¹¹. The prev-

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alence of diabetes was 19.1% in four main cities of the River Nile State, north Sudan¹², 18.7% in the Northern State and River Nile State¹³, and 19.8% in the 2005-2006 Khartoum State STEPS survey 10. In a community-based study in Khartoum state, Sudan, the prevalence of physical inactivity was 53.8%¹⁴, the prevalence of current smoking was 12.0% in the 2005-2006 Khartoum State STEPS survey 10, and in a cross-sectional survey of 403 households in Kassala State, Sudan, 72.8% and 36.2% rarely or did not consume fruit and vegetables, respectively¹⁵.

In the 2015 Kenya STEPS survey (18-69 years), 75.8% had 4-12 NCD risk factors (high blood total cholesterol: 10.1%, low blood HDL cholesterol: 57.7%, high sugar intake: 14.9%, inadequate fruit and vegetable intake: 99.8%, obesity: 22.4%, low physical activity: 89.3%, bad fat intake: 39.8%, high intake of salt: 89.5%, hypertension: 24.8%, diabetes: 2.6%, smoking: 10.2%, and harmful alcohol use: 13.8%)¹⁶. In the 2009 Malawi STEPS survey (24-64 years), 16.5% had 3-7 NCD risk factors (raised blood pressure: 32.9%, raised fasting blood glucose: 5.6%, raised cholesterol: 8.7%, overweight or obesity: 26.5%, tobacco smokers: 14.1%, excessive alcohol drinkers: 7.7%, and low physical activity: 9.5%)¹⁷. In the 2014 Uganda STEPS survey (18-69 years), 17.3% had 3-5 NCD risk factor (daily tobacco use, five servings fruit and vegetables, low physical activity, high body mass index and raised blood pressure)¹⁸. In the 2013 Nepal STEPS survey (15-69 years), 27.7% had 3-8 NCD risk factors (current smoking: 18.5%, harmful alcohol use: 2.0%, inadequate fruit and vegetable intake: 98.9%, low physical activity: 3.4%, overweight or obesity: 21.4%, raised blood pressure: 25.7%, raised blood glucose: 3.6%, and raised total cholesterol: 22.6%)¹⁹.

Factors associated with multiple behavioural and biological NCD risk factors include older age^{16,19-22}, men^{19,20}, currently married¹⁹, geographic region^{18,19}, less than higher education¹⁹, higher level of education²⁰, type of residence¹⁸, better quality of housing²⁰, higher income level²², salaried employment²², and urban residence^{20,22}. The investigation aimed to estimate the prevalence and correlates of multiple NCD risk factors among 18-69-year-old persons in Sudan.

Methods

A four-stage stratified cluster sampling method was used to generate representative data of adults aged 18 to 69

years in the cross-sectional Sudan STEPS Survey in 2016, more details of the sample design²³. A total of 7,722 individuals (Median age=36 years; IQR: 23-43) participated in the study. Information on socio-demographic and behavioural NCD risk factors was gathered in Step 1²³. "Physical measurements such as height, weight and blood pressure were collected in Step 2"²³. "Biochemical measurements were collected to assess blood glucose and cholesterol levels in Step 3"²³. Respondents' responses were recorded by the survey administrator on survey tablets (Samsung tablet 4)²³. Blood glucose and cholesterol were measured using cardio-check examination equipment (Cardio check P.A. In vitro diagnostic medical devices for use with PTS panels test strips; Manufacturer: Polymer Technology Systems, INC, Indianapolis, IN USA CE 0197)²³. The response rate for STEP 1 and 2 was 95%, and for STEP 3 88%²³.

Measures

Outcome variables: NCD risk factors were included based on previous studies 16-19, as follows: Behavioural NCD risk behaviour variables included inadequate fruit and vegetable intake (<5 servings/day), low physical activity based on the "Global Physical Activity Questionnaire", current tobacco use (smoking and/or smokeless tobacco), and episodic heavy alcohol use (six or more in one session) in the past months²³. Biological NCD risk factors. Fasting (≥ 10 hours) blood sugar measurements were conducted and diabetes was defined as "fasting plasma glucose levels ≥ 7.0 mmol/L, and/or currently taking insulin or oral hypoglycemic drugs."²³ Hypertension was assessed based on measured blood pressure (BP) (mean of the last two of three readings) defined as systolic BP ≥ 140 mm Hg and/or diastolic BP ≥ 90 mm Hg or currently on antihypertensive medication; raised total cholesterol (TC) ("fasting TC ≥ 5.0 mmol/L or currently on medication for raised cholesterol"); Body Mass Index (measured 25-29.9kg/m² overweight and ≥ 30 kg/m² obesity)²³. Exposure variables included, sex, age, work status, education, household income, residence status and marital status²³.

Data analysis

Statistical analyses were conducted with STATA software version 15.0²⁴. To produce representative data for the targeted population, the study sample was "weighted considering the probability of selection at three levels and accounted for participant weight/ individual weight), non-response weight and adjustment for participant's

age/sex group (population weight).”²³. The number of NCD risk factors (10) were classified as in previous studies^{18,22} into three groups, 1=0-1, 2=2 and 3=3-8 NCD risk factors, and described with frequency counts and bar graphs. Unadjusted and adjusted ordered logistic regression were used to assess predictors of one or more NCD risk factors. Covariates were selected based on previous literature review^{16,18-22}. Missing values were not included in the analysis. P<0.05 was accepted as significant. Taylor linearization methods were applied to all statistical procedures to account for sample weighting and complex study design.

Results

Sample and NCD risk factor characteristics

The sample included 7,722 adults (35.1% males and

64.9% females) aged 18 to 69 years, median age 31 years (IQR: 23-43). About one-third of the participants (34.0%) could not read and write, 51.7% had an household income of 1000 or less Sudanese pounds, and 62.9% were residing in rural areas.

The prevalence of individual NCD risk factors was 94.6% inadequate fruit and vegetable intake, followed by hypertension (31.6%), general overweight/obesity (28.0%), low physical activity (21.3%), current tobacco use (15.7%), raised total cholesterol (13.6%), diabetes (5.9%), and heavy episodic drinking (1.7%). The prevalence of tobacco use and heavy episodic drinking was significantly higher in men than in women, while low physical activity, general overweight/obesity, raised total cholesterol and diabetes was significantly higher in women than in men (Table 1).

Table 1: Sample and non-communicable diseases risk factors among 18-69 year-old persons in Sudan, 2016 (N=7722)

Variable	Sample Unweighted number	All %	Male %	Female %	Sex difference p-value
Socio-demographics					
Age in years					
18-34	3454	57.7	58.9	56.2	0.094
35-49	2474	26.5	25.3	28.0	
50-69	1794	15.8	15.9	15.8	
Education					
Cannot read or write	3272	34.0	24.2	45.7	<0.001
≤Primary	2481	34.2	39.7	27.6	
>Primary	1952	31.8	36.1	26.7	
Household income (Sudanese Pounds)					
≤500	1326	18.9	20.4	17.2	0.073
501 to ≤1000	2632	32.8	33.2	32.5	
1001 to ≤2000	1949	24.1	23.7	24.6	
>2000	727	10.5	10.5	10.5	
Do not know	1025	13.6	12.2	15.3	
Marital status					
Never married	1205	30.3	40.0	18.5	<0.001
Married	5871	64.8	58.4	72.4	
Separated/divorced/widowed	634	4.9	1.5	9.1	
Employment status					
Self-employed/non-paid/student/unemployed (able to work)	558	7.9	9.6	5.9	<0.001
Government employee	858	15.0	23.1	5.3	
Non-government employee	2389	43.4	62.7	20.0	
Homemaker	3677	31.4	1.9	67.0	
Retired/unemployed (unable to work)	218	2.2	2.6	1.7	
Residence					
Rural	5129	62.9	62.4	63.5	0.563
Urban	2593	37.1	37.6	36.5	
Non-communicable diseases risk factors					
Fruit and vegetable intake (<5 servings/day)	410	94.6	95.2	93.9	0.101
Low physical activity	1827	21.3	17.8	25.5	<0.001
Current tobacco use	830	15.7	28.1	0.7	<0.001
Heavy episodic drinking	78	1.7	3.0	0.2	<0.001
Diabetes	515	5.9	5.0	6.8	0.014
Hypertension	2710	31.6	31.1	32.1	0.495
Raised total cholesterol	1229	13.6	8.8	19.5	<0.001
General overweight/obesity	2455	28.0	22.5	35.2	<0.001

Frequency distribution of multiple NCD risk factors

The prevalence of having zero NCD risk factors was 1.5%, 1 risk factor 32.6%, 2 risk factors 33.5%, 3 risk

factors 19.9%, 4 risk factors 9.3%, 5 risk factors 2.8%, 6 risk factors 0.3%, 7 risk factors 0.1% and 8 risk factors 0% (Figure 1).

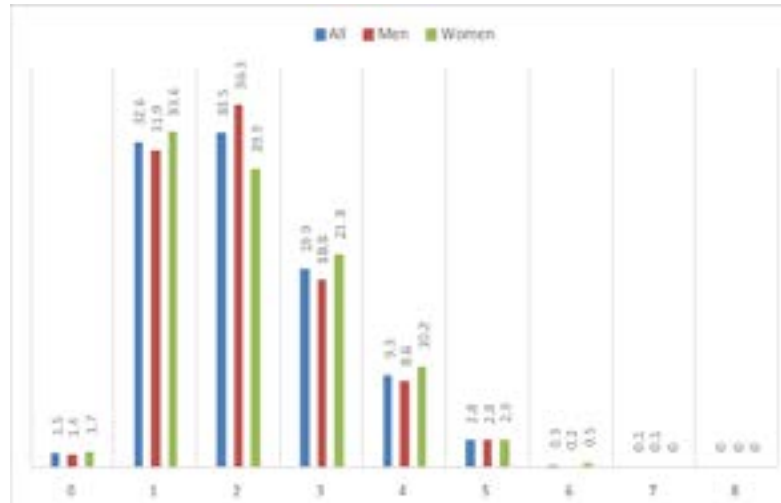


Figure 1: Frequency of non-communicable diseases risk factors among adults in Sudan

Overall, 34.2% had 0-1 NCD risk factor, 33.5% 2 risk factors, 32.4% 3-8 NCD risk factors. Having multiple NCD

risk factors increased with age, urban residence, higher education, higher household income, marital and employment status and sex (Table 2).

Table 2: Proportion of multiple non-communicable diseases risk factors (NCDs) among 18-69 year-old persons in Sudan, 2016

Variable	All			Men			Women		
	Number of NCD risk factors			Number of NCD risk factors			Number of NCD risk factors		
	0-1	2	3-8	0-1	2	3-8	0-1	2	3-8
	%	%	%	%	%	%	%	%	%
All	34.2	33.5	32.4	33.3	36.3	30.4	35.3	29.9	34.8
Age (years)									
18-34	43.8	35.7	20.4	40.8	38.2	21.0	48.1	32.3	19.6
35-49	25.2	32.8	42.0	25.5	36.7	37.8	24.8	28.5	46.7
50-69	15.7	26.8	57.5	17.9	28.6	53.5	13.1	24.5	62.4
p-value	<0.001			<0.001			<0.001		
Education									
Cannot read or write	32.8	36.7	30.5	28.8	42.9	28.3	35.5	32.5	32.1
≤Primary	36.5	32.4	31.1	35.3	34.2	30.5	38.7	29.0	32.3
>Primary	33.2	31.3	35.5	34.2	34.0	31.8	31.6	26.5	41.9
p-value	0.041			0.103			<0.001		
Marital status									
Never married	45.7	34.0	20.3	44.7	35.7	19.6	48.4	29.6	22.0
Married	29.1	34.0	36.9	25.8	36.6	37.6	32.8	31.1	36.1
Separated/divorced/widowed	25.8	24.0	50.2	23.7	39.1	37.2	26.3	20.8	52.9
p-value	<0.001			<0.001			<0.001		
Employment status									
Self-employed/non-paid/student/unemployed (able to work)	24.5	30.8	44.7	22.9	30.6	46.5	27.8	31.3	41.0
Government employee	27.0	36.0	37.0	25.0	37.5	37.5	37.6	28.3	34.2
Non-government employee	40.2	35.5	24.3	38.9	37.0	24.1	44.9	29.7	25.4
Homemaker	33.2	29.8	37.0	38.6	26.8	34.5	33.0	29.9	37.1
Retired/unemployed (unable to work)	11.5	30.9	57.6	4.1	31.0	64.8	25.7	30.5	43.8
p-value	<0.001			<0.001			<0.001		
Residence									
Rural	38.2	35.6	26.1	36.0	38.5	25.5	41.1	32.0	27.0
Urban	27.4	29.9	42.7	28.7	32.6	38.8	25.8	26.4	47.8
p-value	<0.001			<0.001			<0.001		
Household income (Sudanese Pounds)									
≤500	40.6	33.8	25.6	42.0	35.6	22.3	38.5	31.0	30.5
501 to ≤1000	36.8	31.8	31.3	36.5	34.4	29.1	37.3	28.5	34.2
1001 to ≤2000	28.0	34.6	37.4	25.2	37.5	37.3	31.5	31.0	49.9
>2000	25.2	31.4	43.4	26.5	35.4	38.1	23.6	26.6	25.2
Do not know	37.8	35.6	26.6	32.7	39.5	27.9	43.4	31.4	34.9
p-value	<0.001			<0.001			<0.001		

Associations with multiple NCD risk factors

In adjusted ordinal logistic regression analysis, the odds of having a higher count of NCD risk factors increased from 2.04 to 3.52 from the age group of 35-49 years to age group of 50-69 years when compared to the younger people aged 18-34 years. Men had higher odds (1.21) of higher NCD risk factor count than women. Individuals residing in urban areas had higher odds (1.86) of higher NCD risk factor count than individuals residing in rural areas. Married participants and persons separated, divorced or widowed were also associated with higher odds (1.51 and 1.74, respectively) of possessing higher counts of NCD risk factors. The odds of having a higher count

of NCD risk factors increased from 1.61 to 1.75 from the household income of 1001-2000 Sudanese Pounds to the household income of >2000 Sudanese Pounds when compared to those who had a household income of 500 or less Sudanese Pounds. Women who had more than primary education had higher odds (1.38) of higher NCD risk factor count than women who cannot read or write. Among men, the odds of having a higher count of NCD risk factors increased from 1.82 to 3.46 from the government employee group to the retired/unemployed (unable to work) group when compared to the self-employed, engaged in non-paid work, were students or unemployed (able to work) group (Table 3).

Table 3: Associations with multiple non-communicable diseases risk factors among 18-69 year-old persons in Sudan, 2016

Variable	All	Men	Women
	AOR (95% CI)	AOR (95% CI)	AOR (95% CI)
Age in years			
18-34	1 (Reference)	1 (Reference)	1 (Reference)
35-49	2.04 (1.72, 2.43)***	1.45 (1.09, 1.93)*	2.73 (2.29, 3.26)***
50-69	3.52 (2.88, 4.31)***	2.26 (1.66, 3.09)***	5.45 (4.29, 6.94)***
Education			
Cannot read or write	1 (Reference)	1 (Reference)	1 (Reference)
≤Primary	1.02 (0.85, 1.22)	0.97 (0.74, 1.28)	1.07 (0.88, 1.30)
>Primary	1.01 (0.81, 1.26)	0.84 (0.60, 1.15)	1.38 (1.06, 1.80)*
Marital status			
Never married	1 (Reference)	1 (Reference)	1 (Reference)
Married	1.51 (1.22, 1.87)***	1.84 (1.34, 2.52)***	1.43 (1.11, 1.84)**
Separated/divorced/widowed	1.74 (1.22, 2.47)**	1.67 (0.86, 3.26)	1.55 (1.04, 2.29)*
Household income (Sudanese Pounds)			
≤500	1 (Reference)	1 (Reference)	1 (Reference)
501 to ≤1000	1.19 (0.95, 1.48)	1.30 (0.95, 1.78)	1.01 (0.79, 1.28)
1001 to ≤2000	1.61 (1.26, 2.06)***	2.00 (1.41, 2.84)***	1.19 (0.91, 1.56)
>2000	1.75 (1.28, 2.38)***	2.01 (1.27, 3.19)**	1.36 (1.01, 1.82)*
Do not know	1.28 (0.96, 1.71)	1.78 (1.24, 2.57)**	0.88 (0.62, 1.24)
Employment status			
Self-employed/non-paid/student/unemployed (able to work)	1 (Reference)	1 (Reference)	1 (Reference)
Government employee	1.43 (1.06, 1.93)*	1.82 (1.20, 2.77)**	0.93 (0.62, 1.42)
Non-government employee	1.46 (1.16, 1.83)***	1.59 (1.22, 2.07)***	1.20 (0.80, 1.80)
Homemaker	1.32 (1.08, 1.63)**	1.16 (0.50, 2.73)	1.22 (0.97, 1.54)
Retired/unemployed (unable to work)	2.13 (1.47, 3.07)***	3.46 (2.06, 5.83)***	1.25 (0.74, 2.11)
Residence			
Rural	1 (Reference)	1 (Reference)	1 (Reference)
Urban	1.86 (1.49, 2.32)***	1.79 (1.32, 3.41)***	1.90 (1.52, 2.37)***

AOR=Adjusted Odds Ratio; CI=Confidence Interval; ***p<0.001; **p<0.01; *p<0.05

Discussion

The present study aimed to assess the prevalence and correlates of multiple NCD risk factors in a national community-based survey among 18-69 year-old individuals in Sudan. In comparison to other low- middle-income countries, the prevalence of 3-8 NCD risk factors (32.4%) in

this study (18-69 years) was higher than in the 2009 Malawi STEPS survey (24-64 years) (16.5% 3-7 NCD risk factors) 17, the 2014 Uganda STEPS survey (18-69 years) (17.3% 3-5 NCD risk factors) 18, the 2013 Nepal STEPS survey (15-69 years) (27.7% 3-8 NCD risk factors) 19, and lower than in the 2015 Kenya STEPS survey (18-69 years)

(75.8% 4-12 NCD risk factors 16. The clustering of three or more NCD risk factors was common in this survey predisposing the adult population in Sudan to a greater risk of NCDs.

In agreement with some studies^{16,19-22}, this study shows for the first time in a national study in Sudan that older age, male sex, being married, urban residence, higher household income, being in salaried employment, and among women higher education increased the odds for multiple NCD risk factors. Regarding increasing age, early screening, in particular among males, those with higher income, higher education and residing in urban areas, should be propagated to prevent an accumulation of NCD risk factors in Sudan.

The prevalence of hypertension was higher than in previous three local surveys, in four states (Khartoum, Gezira, Blue Nile, and Kassala) (16.6%) 7, in the 2005-2006 Khartoum State SEPS survey (23.6%) 10, and in Khartoum State in Sudan (27.6%) 11, but lower than in two other local surveys in Gadarif, Eastern Sudan (40.8%) 8, and in four main cities of the River Nile State, north Sudan (35.7%) 9. The prevalence of overweight/obesity (28.0%) was lower than in four states (Khartoum, Gezira, Blue Nile, and Kassala) (56.1%) 5, and in Gadarif, Eastern Sudan (59.0%) 6. The high prevalence of inadequate fruit and vegetable intake (94.6%) in this survey was also found in a community in Kassala State, Sudan (72.8% and 36.2% rarely or did not consume fruit and vegetables, respectively) 15. The 2016 Sudan STEPS survey team recommend to “strengthen health literacy and capacity of individuals to make healthy choices e.g. by making fruits and vegetable more affordable”²³.

The prevalence of current tobacco use (15.7%) and heavy episodic alcohol use (1.7%) in this study was in terms of tobacco use similar to the 2005-2006 Khartoum State STEPS survey (current smoking 12.0%) 10, the Kenya STEPS survey (smoking: 10.2%) 16 and the Malawi STEPS survey (tobacco smokers: 14.1%) 17 but lower in terms of heavy drinking in the Kenya STEPS survey (harmful alcohol use: 13.8%) 16 and the Malawi STEPS survey (excessive alcohol drinkers: 7.7%) 17. Increasing exercise taxes and prices on tobacco products may be recommended in Sudan²⁵.

The prevalence of low physical activity (21.3%) in this survey was lower than in a study in Khartoum state, Sudan, (53.8%) 14. The proportion of raised total cholesterol (13.6%), and diabetes (5.9%) in this study was lower than in the 2005-2006 Khartoum State STEPS survey (raised total cholesterol 19.8% and diabetes 19.8%) 10 in four main cities of the River Nile State, north Sudan (diabetes 19.1%) 12, in the Northern State and River Nile State (diabetes 18.7%) 13, but higher than in the Malawi STEPS survey (raised cholesterol: 8.7% and raised fasting blood glucose: 5.6%) 17 and the Kenya STEPS survey (high blood total cholesterol: 10.1% and diabetes: 2.6%) 16.

Some of the found NCD risk factors differed by sex. Current tobacco use and heavy episodic drinking was significantly higher in men than in women, while low physical activity, general overweight/obesity, raised total cholesterol and diabetes was significantly higher in women than in men. In the Kenya STEPS survey daily tobacco and harmful alcohol use was also more prevalent in men than in women, obesity and raised total cholesterol was more common among women than men were 16. Similarly, in the Malawi STEPS survey, the prevalence of alcohol use and tobacco smoking was higher in men than women, and overweight/obesity and raised cholesterol were higher in women than men were 17. The higher prevalence of overweight/obesity in women may be attributed to “in Sudan, obesity is associated with beauty. Furthermore, some young women in Sudan use steroids to gain weight and refuse to take metformin because it is associated with weight loss.”²⁶.

This study was limited because of the self-report of the interview data as well as its cross-sectional design. Further, the public use dataset of the Sudan 2016 STEPS survey did not include some of the variables, such as region and state, which could therefore not be included in the analysis.

Conclusion

The study found among a nationally representative population of 18 to 69 years in Sudan that almost one in three participants had three or more NCD risk factors. Several factors associated with an increase in NCD risk count were identified, including older age, male sex, urban residence, higher household income and among women

higher level of education, which can assist in guiding interventions to prevent multiple NCD risk factors in the Sudanese population. Considering the clustered nature of NCD risk factors, interventions are needed that target multiple, in particular modifiable, NCD risk factors.

Abbreviations

BMI: Body Mass Index; BP: Blood Pressure; HDL: High-density lipoprotein; NCD: Non-communicable diseases; STEPS: STEPwise approach to surveillance; STATA: Statistics and data

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“The data source, the World Health Organization NCD Microdata Repository (URL: <https://extranet.who.int/ncdsmicrodata/index.php/catalog>), is hereby acknowledged.”

Authors' contributions

“All authors fulfill the criteria for authorship. SP and KP conceived and designed the research, performed statistical analysis, drafted the manuscript and made critical revision of the manuscript for key intellectual content. All authors read and approved the final version of the manuscript and have agreed to authorship and order of authorship for this manuscript.”

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Availability of data and materials

The data on which this analysis were based are publicly available at the World Health Organization NCD Microdata Repository: URL: <https://extranet.who.int/ncdsmicrodata/index.php/catalog>.

Ethics approval and consent to participate

This study was approved by the national ethical committee at Federal Ministry of Health, Sudan²³. Verbal informed consent was obtained from all participants²³.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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