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Title of the manuscript: *Modifiable Lifestyle Factors and their Relationships with Metabolic Disorders among Adults in Burkina Faso: Findings from the First National Survey*

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Abstract

This study aimed to report the magnitude of modifiable lifestyle factors, their relationships with metabolic disorders in Burkinabè adults by using nationally representative data. This cross-sectional study included 4100 adults selected through multistage cluster sampling performed during the first national survey conducted in 2013 in Burkina Faso. The modifiable factors we considered were tooth cleaning, fruit and/or vegetable (FV) intake, substances' use, physical activity and overweight/obesity, while metabolic syndrome abnormal components defined metabolic disorders. We performed logistic regressions. 31.1% cleaned the teeth at least twice a day, 14.7% consumed five or more FV, 39.7% used alcohol and/or tobacco, the prevalence of physical inactivity and overweight/obesity was respectively 6.6% and 17.7%. About 41.0% had at least two metabolic disorders and 9.5% had at least three. Lifestyle factors associated with having at least two metabolic disorders were overweight/obesity, more FV intake (when five or more aOR=1.5, $p<0.001$), physical inactivity (aOR=1.3, $p<0.05$), tooth cleaning (aOR=0.8, $p<0.01$). Except for consuming five or more FV (aOR=1.4, $p=0.09$), the same trend of relationships was observed with having at least three metabolic disorders. Excluding overweight/obesity and physical inactivity, unhealthy modifiable lifestyle factors were common and tooth cleaning was found as a protective practice for metabolic disorders.

Key-words: Modifiable lifestyle factors; Metabolic disorders; Prevalence; Relationships; Burkina Faso.

Introduction

Non-communicable diseases (NCDs) are emerging as significant contributors to disease burden in the low- and middle-income countries (LMICs) [1, 2]. Modifiable risk factors such as unhealthy lifestyle behaviour contribute to the shifting disease burden and so should primarily targeted [3], particularly for cardiovascular diseases' prevention [4, 5]. Systematic reviews and

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meta-analyses have assessed the relationships between the modifiable lifestyle factors such as the alcohol consumption [6], tobacco use [7, 8], oral hygiene practices [9], fruit and/or vegetable (FV) consumption [10, 11], physical inactivity [12] excess weight [13–15] and the metabolic disorders. The World Health Organization (WHO) recommends the implementation of a national surveillance system for the risk factors for the NCDs (stepwise approach to surveillance [*STEPS]*) including those for cardiovascular diseases [16] and while the US Centre for Disease Control and Prevention recommends the Behavioural Risk Factor Surveillance System [17]. The WHO STEPS surveys uses a standardized tool for data collection which includes specific sections on behavioural risk factors (the alcohol and tobacco use, oral hygiene practices, fruit and vegetable intake, physical activity), anthropometry (measurement of the body mass index [BMI]) and the measurement of some biological parameters [18] which may help identify metabolic disorders. Observational studies [19–21] including cohort studies [22] and meta-analyses [23] have supported that presence of only two metabolic syndrome (MetS) abnormal components increased the risk for subclinical/clinical cardiovascular dysfunctions or events, alongside having the MetS (i.e., having at least three abnormal components). Thus, highlighting the associated factors with the presence of at least two or at least three abnormal components may lead to the relevant awareness with regard to those who may receive particular benefit from lifestyle measures in Preventive Medicine. Moreover, among the modifiable lifestyle factors, the most easily achievable at lower intervention costs should be known and prioritised as policy fields in LMICs. The survey using the STEPS method in Burkina Faso provided the first national lifestyle variables which have not yet been analysed and especially in relation to metabolic disorders. Our study aimed to report the modifiable lifestyle factors and their relationships metabolic disorders among adults in Burkina Faso, by using the first nationally representative data.

Methods

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Description of the Burkina STEPS Survey

The nationally representative survey covered all the 13 administrative regions of Burkina Faso and involved all three components – behavioural or lifestyle factors, anthropometric and biological measurements [18]. The survey enrolled 4800 adults aged 25–64 years, based on a calculated sample size considered to achieve sufficient accuracy by weighting the numbers of age groups for each sex. It was also weighted to ensure representativeness with regard to the living environment (rural or urban areas).

Data were collected from 3 September to 24 October 2013 through face-to-face interviews in the language spoken by the participant. The data were collected using personal digital assistants with standardized WHO STEPS questionnaires loaded with eSTEPS software. Blood samples were collected for biological measurements.

The protocol of the STEPS survey was approved by the Ethics Committee for Health Research of the Ministry of Health of Burkina Faso (deliberation No: 2012-12092; December 05, 2012). Written informed consent was systematically obtained from each participant in the STEPS survey.

Study variables

Sociodemographic data collected included living environment, sex, age, marital status, education level and occupation. Self-reported data on the modifiable lifestyle factors were also collected: alcohol and/or tobacco use, oral hygiene practices, FV consumption, and physical inactivity. The anthropometric measurements of weight, height, waist circumference (WC) as well as blood pressure (BP) were taken. These physical measurements and the biological measurements of fasting blood glucose (FBG) and high-density lipoprotein cholesterol (HDL-C) were used to determine the presence of metabolic disorders.

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The current alcohol consumption was defined as alcohol intake in the past one month while current tobacco use was defined as use of smoked or smokeless tobacco in the past 12 months. The oral hygiene practices were categorized based on the frequency of cleaning teeth per day, with, at least, twice daily cleaning being recommended [24]. Daily FV intake was derived from the number of servings of FV consumed per day during a typical week. Five or more daily FV servings is recommended [25]. Data on self-reported physical activity were collected using the validated Global Physical Activity Questionnaire [26]. Physical activity was determined from the amount of time being physically active in three domains; transport, at work and during leisure time. Participants were asked about the frequency, intensity and duration of their work-, travel- and leisure-related physical activity (vigorous or moderate), in a typical week. BMI, calculated as a subject's weight divided by height², in kg/m², was characterized as underweight (BMI<18.5 kg/m²), normal (BMI=18.5 – 24.9 kg/m²) overweight (BMI=25 – 29.9 kg/m²) and obesity (BMI ≥30 kg/m²) states [27].

Each MetS abnormal component counts as one metabolic disorder and using the International Diabetes Federation criteria [28], the metabolic disorders were: (i) elevated BP with systolic BP ≥ 130 or diastolic BP ≥ 85 mmHg, or currently taking anti-hypertensive medication; (ii) raised FBG ≥ 5.6 mmol/l or previously diagnosed type 2 diabetes; (iii) reduced HDL-C of < 1.03 mmol/l in men and <1.29 mmol/l in women; (iv) and central obesity defined a WC ≥ 94 in men and 80 cm ≥ in women [28]. Since consistent data supported that the increased number of MetS abnormal components showed a significant increased value in predicting cardiovascular impairment or events [23], the outcome variables we considered were having at least two on the one hand ; and at least three metabolic disorders on the other hand.

WC was measured, to the nearest 0.1 cm, using a flexible measuring tape placed at midpoint between the last rib and the iliac crest, with the subjects in light clothing, standing upright and breathing normally [29]. BP (in mmHg) was measured three times using an electronic BP

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device, and the mean value used in the analysis. The biochemical tests were done on fasting capillary blood samples.

Of the sample of 4800 individuals surveyed, 105 were not eligible; 10; 493 and 92 subjects had missing or invalid data on sociodemographic variables, lifestyle factors and MetS components respectively. The number of missing or invalid lifestyle factors was as follows: 1 for tobacco, 6 for oral hygiene practice, 279 for FV intake, 2 for physical activity and 205 for BMI. Thus, we included 4100 participants who had complete data in our secondary data analyses.

Statistical analyses

We used StataCorp Stata Statistical Software for Windows (Version 14.0, College Station, Texas, US) to analyse the data. The continuous variables were expressed as the means ± standard deviations, and categorical variables expressed as percentages (%). In the stepwise logistic regression models, we dichotomized the outcome variable as presence of at least two (yes/no), or at least three metabolic disorders (yes/no), while the lifestyle factors were the explanatory variables, with adjustment on sociodemographic factors (sex, age, urban-rural residence, marital status, education and occupation). For all analyses, a p-value below 0.05 was considered significant.

Results

The sample was made up of 2087 (50.9%) females and the mean age was 38.6 ± 11.1 years. The participants were predominantly aged 25-29 years (44.2%), rural residents (79.7%), illiterates (77.3%), currently married or cohabiting (86.7%) or engaged in an occupation earning regular income (74.7%) (Table 1).

Of the sample studied, 31.1% cleaned the teeth at least twice a day, only 14.7% consumed five or more FV servings, 39.7% were current alcohol and/or tobacco users, 6.6% were physically

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inactive and 17.7% were overweight/obese. About 40.7% and 9.5% of participants had at least (any) two or three metabolic disorders respectively.

Table 2 summarizes results from stepwise logistic regressions and sociodemographic factors associated with having at least two metabolic disorders were living in urban area (aOR=1.4, p<0.001), being woman (aOR=1,9, p<0.001) and older age (aOR = 1.2 to 2.3; p<0.01). Concerning modifiable lifestyle factors, consuming more FV (when the number was three or four aOR=1.3, p<0.01; for five or more aOR=1.5, p<0.001) and physical inactivity (aOR=1,3; p<0.05) and increased BMI (for overweight aOR=3.7, p<0.001 and for obesity aOR=9.6, p<0.001) were unfavourable factors for having at least two metabolic disorders, while cleaning the teeth at least twice a day was a protective factor (aOR=0.8, p<0.01).

Furthermore, when the binary variable “having at least three metabolic disorders” was considered as the outcome in the logistic regression model, the significant factors remained identical, except only for the variable "five or more FV intake" (aOR=1.4; p=0.09) and professions without regular income (aOR=1.4; p=0.02).

Discussion

Findings suggested that (except for overweight/obesity and physical inactivity) unhealthy lifestyle practices were common among adults in Burkina Faso and the adequate oral hygiene practice should be included among the protective behaviours of metabolic disorders.

Prevalence of lifestyle factors and metabolic disorders among adults in Burkina Faso:

Only 14.7% consumed five or more FV: The low rainfall in the wide area of Burkina Faso (the Sahelian and Sudano-Sahelian areas) may support the low availability of FV, despite these products are not sustainable over all seasons because of the issue of their storage and processing remains a major challenge for the country. Moreover, the value of the FV consumption did not

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be well known by the general population and thus, the nutrition education should be undertaken [30]. There was an insufficient prevention for the licit psychoactive substances' use such as alcohol and tobacco in Burkina Faso (respective prevalence of the use was 28.1% and 20.4%). The WHO reported in 2014 as in 2018, the absence of a national monitoring system regarding alcohol consumption, alcohol-related health disorders, and alcohol policy response in Burkina Faso. There were no restrictions for on- or off-premise sales concerning the hours, days, density, specific events and intoxicated persons [31, 32]. By the time of our study, the WHO also noticed the low level of achievement with regards to the tobacco control policy i.e.; the "***MPOWER***" guidelines: Monitoring (epidemiological data collecting on tobacco use), Protect (smoke-free policies), Offer (cessation programs), Warnings (health warnings, mass media), Enforce (advertising bans) and Raise (taxation). As the report of STEPS survey in Indian adults (prevalence of 29%) [33], less than a third of Burkinabè adults cleaned the teeth at least twice a day (31.1%, table 1). The prevalence of overweight/obesity (17.7%) was among the low levels in sub-Saharan Africa [34] but it should be read in conjunction with the higher rate of underweight [35], especially in rural areas [36] with the lower food availability. The prevalence of the physical inactivity (6.6%) was also low and identical to the previous rate (6.7%) described in the study including sub-Saharan African countries [37] or to the level founded in a Kenyan STEPS survey (7.7%) [38].

Evidence from the literature suggests that triglycerides may be normal among West Africans with MetS [39] and the absence of this parameter in our study would at least affect our results. The prevalence of MetS may be perceived as low (9.5% had at least three abnormal components), however, a significant part of Burkinabè adults (about 41% who had at least two abnormal components) showed warning alarming indicators for cardiovascular concerns [22, 23] and authors recommended that these individuals should be considered as being in an early step of the arteriosclerosis process [40, 41].

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Associations with increased number of metabolic disorders: Consuming more FV was an unfavourable factor for having at least two abnormal components (Table 2). This finding did not corroborate with the results from the meta-analysis including international studies [42] underlighting that FV intake was inversely associated with risk of MetS. Our finding may reflect the practice in close line with a secondary prevention attitude and suggests that the individuals who applied to the consumption of FV already had a medical history such as hypertension, diabetes, cardiovascular events and thus, they may benefit from medical advices. The similar pattern (concerning vegetable servings and overweight/obesity) was observed among adolescents whom the parents were highly aware of their weight status and also advised to change their children's health behaviours [43], suggesting actually the therapeutic lifestyle change process [30]. The increased metabolic risk in physically inactive individuals we reported (Table 2) was consistent with the literature [44–46]. Number of abnormal components usually increases in tobacco or alcohol users [47] while our analysis did not found a significant relationship (Table 2). Tobacco and alcohol are the psychoactive substances and their contents (nicotine and ethanol from tobacco and alcoholic beverages respectively) can decrease the appetite [48] via the ghrelin hormone pathway (these substances have an acute inhibitory effect on human ghrelin secretion [49], lower the hunger rate [50] with anorectic effects) [51, 52], that may result into insufficient food intake [53], particularly in the context of low food availability [54]. Burkina Faso usually has a low food availability (particularly in rural area with 77.3% of the population), and subjects may adjust to hunger through tobacco consumption. Such behaviour was noted in a supplemental qualitative study (interview) in three Ethiopian pastoral communities with a long tradition of tobacco use [55]. Thus, the decrease of anthropometric (including WC) values was plausible [48] and combined to the diastolic BP decreasing due to the potential effect of nicotine included in tobacco [36], the number of abnormal components could be lowered. The similar observations may be reported in alcohol users [49, 50].

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Overweight or obesity increased the risk for having at least two abnormal components (Table 2) or having at least three abnormal components as the finding of Omuse et al concerning relationships with MetS in Kenya (aOR=5.01, p<0.001 and 5.23, p<0.001 for overweight and obesity, respectively [56] and this is consistent with international data (Brazil [57], China [58], Iran [59]).

Cleaning the teeth at least twice a day was a protective factor (aOR=0.8, p<0.01). Indeed, having demonstrated that more frequent toothbrushing was related to a lower prevalence and incidence of MetS and its components, Kobayashi et al suggested that more frequent toothbrushing may contribute to the prevention of MetS due to the inflammation/triglyceride pathway [60]. Moreover, the finding of the link between the poor oral hygiene and the high levels of inflammatory cytokines with the risk of excess of weight resulted authors concluding that the early proper dental prophylaxis and treatment could lead to the better prevention of metabolic disorders [61]. The 5-year follow-up retrospective study (of 3722 participants aged 35-64 years) reported that the participants with more frequent daily toothbrushing tended to have significantly lower odds of developing the increased number of components or MetS (p for trend = 0.01) [62]. It also specified that the risk of development of MetS was significantly lower in participants brushing teeth ≥3 times/day than in those brushing teeth ≤1 time/day (aOR=0.64, CI:0.45-0.92). The efficiency of the healthy oral hygiene practice in the secondary prevention of cardiovascular events was also described: Authors reported that patients with coronary heart disease who reported practicing interdental cleaning reduced tobacco exposure and had a significant decreased adjusted risk for new cardiovascular events (HR=0.2, CI:0.06-0.6) than those who did not report practicing interdental cleaning [63]. Other authors noted the significant relationship between oral health behaviour and stroke (odds for stroke even was of 2.15, CI:1.01–4.58 for those who daily did not clean the teeth) [64]. Although the consistent

data reported benefits (with regards to the MetS prevention) from the adequate/healthy oral practice, this fundamental public health issue is still neglected by the healthcare workers [65].

Limitations: The non-assessment of the psychological stress [66], sleep quality [67] did not allow to test most number of the potential modifiable explicative variables. Triglycerides were not measured and so our estimate of the prevalence of MetS may be an underestimate. However, we based our definition of MetS the most common components. Evidence from the literature suggests that triglycerides may be normal among West Africans with MetS [39].

Conclusion: Except for overweight/obesity and physical inactivity, unhealthy modifiable lifestyle factors were common in Burkinabè adults and those with a warning alarming number of metabolic disorders were also significant. The unfavourable and unexpected effect of more FV intake with increased number of abnormal components may be understood as the therapeutic lifestyle change effect. The tooth cleaning at least twice a day has been revealed as a protective practice and should be promoted in the general population and included in the therapeutic lifestyle change policy for the potentially risky individuals.

Declarations

Ethics approval and consent to participate: The protocol of the STEPS survey was approved by the Ethics Committee for Health Research of the Ministry of Health (deliberation No: 2012-12092; December 05, 2012). Written informed consent was systematically obtained from each participant in the STEPS survey.

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Authors' contributions: JD, JK, ANZ and WBS contributed to drafting the manuscript, JD and WBS performed the statistical analysis, SWJ, PVO, AAS, FG and AM, provided the first

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interpretation of the results, JD and WBS reviewed the last version. All authors read and approved the final manuscript.

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Data Availability Statement: The database of the STEPS survey used for this secondary analysis is available at the Ministry of Health of Burkina Faso and can be requested to bicababrico78@gmail.com.

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Table 1: Description of the socio-demographic characteristic, lifestyle factors and metabolic disorders.

	n (%)
Socio-demographic characteristics	
Age ranges (in years, y)	
- 25 – 29 y	1814 (44.2)
- 30 – 44 y	1036 (25.3)
- 45 – 54 y	757 (18.5)
- 55 – 64 y	493 (12.0)
Sex	
- Men	2013 (49.1)
- Women	2087 (50.9)
Residence area	
- Rural	3267 (79.7)
- Urban	833 (20.3)
Education level	
- No formal/no education	3171 (77.3)
- Primary achieved	634 (15.5)
- Secondary or more	295 (7.2)
Occupation	
- Professions providing regular income	3064 (74.7)
- Professions with no regular income	1036 (25.3)
Marital status	
- Never or previously married	547 (13.3)
- Currently married/cohabiting	3553 (86.7)
Lifestyle factors	
Oral hygiene Practices	
Tooth cleaning frequencies	
- Never cleaned the teeth	233 (5.7)
- Less than once a day	512 (11.5)

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- Cleaning the teeth once a day	2079 (50.7)
- Cleaning the teeth at least twice a day	1276 (31.1)
Use of alcohol or tobacco	
Current alcohol consumption	
- Not consumers	2948 (71.9)
- Consumers	1152 (28.1)
Current tobacco use	
- Not users	3262 (79.6)
- Users	838 (20.4)
Current alcohol and/or tobacco use	
- Non-user of alcohol or tobacco	2472 (60.3)
- User of alcohol and/or tobacco	1628 (39.7)
Physical lifestyle (number of the practice of physical activities per week)	
- Physically inactive	271 (6.6)
- Physically active	3829 (93.4)
Consumption of fruits and vegetables (number of servings consumed per day)	
- 0	1007 (24.6)
- 1 – 2	1504 (36.7)
- 3 – 4	985 (24.0)
- ≥5	604 (14.7)
Body mass index status	
- Underweight	456 (11.1)
- Normal weight	2919 (71.2)
- Overweight	547 (13.4)
- Obese	178 (4.3)
Metabolic disorders	
Presence of abnormal metabolic components	
Raised waist circumference: yes	889 (21.7)
Raised blood pressure: yes	1381 (33.7)

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Raised fasting blood sugar: yes	359 (8.8)
Reduced high-density lipoprotein cholesterol (HDL-C): yes	3162 (77.1)
Metabolic disorders' accumulation	
- No abnormal metabolic components	402 (9.8)
- With one abnormal metabolic component	2030 (49.5)
- With two abnormal metabolic components	1278 (31.2)
- With three abnormal metabolic components	355 (8.7)
- With four abnormal metabolic components	35 (0.8)

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Table 3: Factors associated with the presence of "at least two metabolic disorders" and "at least two metabolic disorders" in the multivariable analyses

	Relationships with having at least two abnormal components						Relationships with having at least three abnormal components					
	Univariable analysis			Multivariable analysis			Univariable analysis			Multivariable analysis		
	cOR	95% CI	p-value	aOR	95% CI	p-value	cOR	95% CI	p-value	aOR	95% CI	p-value
Residence: Urban vs rural (Ref)	2.1	1.8-2.4	0.0001	1.4	1.2-1.7	0.0001	3.1	2.5-3.8	0.0001	1.6	1.2-2.1	0.001
Sex: Female vs male (Ref)	1.8	1.6-2.0	0.0001	1.9	1.6-2.1	0.0001	3.2	2.5-4.1	0.0001	3.1	2.3-4.1	0.001
Age range (in years)												
- **25 – 34 (Ref)**	1			1						1		
- **35 – 44**	1.3	1.1-1.5	0.001	1.2	1.1-1.5	0.015	1.6	1.2-2.1	0.001	1.5	1.1-2.1	0.007
- **45 – 54**	1.6	1.4-1.9	0.0001	1.7	1.4-2.0	0.0001	2.2	1.6-2.9	0.0001	2.3	1.7-3.2	0.0001
- **55 – 64**	2.0	1.7-2.5	0.0001	2.3	1.9-2.9	0.0001	2.6	1.9-3.5	0.0001	3.6	2.6-5.2	0.0001
Marital status: Married/cohabiting vs no (Ref)	0.9	0.7-1.1	0.084	>0.9	0.8-1.2	0.73	0.7	0.6->0.9	0.03	0.9	0.6-1.2	0.44
Education levels												
- **No formal/no education (Ref)**	1			1			1			1		
- **Primary achieved**	1.2	0.9-1.4	0.073	1.1	0.9-1.4	0.31	1.2	0.9-1.6	0.24	>0.9	0.7-1.4	0.81
- **Secondary or more**	1.5	1.2-1.9	0.001	>1.0	0.7-1.3	0.89	2.3	1.6-3.1	0.0001	1.4	0.9-2.1	0.17
Professions with no regular income vs Professions providing regular income (Ref)	1.6	1.4-1.8	0.0001	1.1	0.9-1.3	0.18	2.3	1.8-2.8	0.0001	1.4	1.1-1.8	0.02
Physical activity: Yes vs No (ref)	1.8	1.4-2.3	0.0001	1.3	1.1-1.8	0.04	2.3	1.6-3.1	0.0001	1.5	1.1-2.2	0.038
Current use of alcohol &/or tobacco: Yes vs no (Ref)	0.8	0.7-0.9	0.002	0.9	0.8-1.1	0.14	0.8	0.6-0.9	0.013	>0.9	0.7-1.2	0.75

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Cleaning the teeth at least twice a day: Yes vs no (Ref)	0.9	0.8-1.1	0.15	0.8	0.7-0.9	0.005	0.9	0.7-1.2	0.61	0.7	0.5-0.9	0.017
Number of fruits/vegetables Consumed												
- **0**	1			1			1			1		
- **1 – 2**	1.2	1.1-1.4	0.031	1.1	0.9-1.3	0.30	1.4	1.1-1.8	0.04	1.1	0.8-1.6	0.49
- **3 – 4**	1.4	1.2-1.7	0.0001	1.3	1.1-1.6	0.003	1.8	1.3-2.4	0.0001	1.5	1.1-2.1	0.036
- **≥5**	1.4	1.2-1.8	0.0001	1.5	1.2-1.9	0.0001	1.5	1.1-2.1	0.04	1.4	0.9-2.1	0.09
BMI categories												
- **Normal BMI**	1			1			1			1		
- **Underweight**	0.9	0.8-1.2	0.54	0.8	0.6-0.9	0.03	0.6	0.4-1.01	0.07	0.4	0.3-0.8	0.003
- **Overweight**	3.9	3.2-4.8	0.0001	3.7	3.0-4.5	0.0001	5.9	4.5-7.5	0.0001	5.4	4.1-7.1	0.0001
- **Obese**	13.0	8.3-20.3	0.0001	9.6	6.1-15.1	0.0001	16.3	11.7-22.8	0.0001	11.2	7.7-16.2	0.0001