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Metabolic Disorders and Metabolically Obese Normal-Weight in Burkinabe Adults: Increasing Prevalences Across Normal BMI Quartiles, Using the 2013 STEPS Database

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Abstract: *Background:* Majority of Burkinabè adults were normal-weight by body mass index (BMI). This study explored by gender, the metabolic abnormalities and "metabolic obesity with body weight" (MONW) throughout the normal BMI quartiles (Q) of Burkinabè adults. *Methods:* We performed a secondary-analysis of data from the first WHO Stepwise approach to surveillance survey conducted in 2013 in Burkina Faso, and only adults with BMI between 18.5 – 24.9 kg/m² were included. Metabolic disorders (individual abnormal metabolic syndrome component, having at least two abnormalities and MONW) were described in BMI' quartiles, for each gender, and the risk of occurrence of having at least two abnormalities or MONW was analysed using quartiles as dependent variables, after adjustment on sociodemographic and lifestyle factors. *Results: I*n the 3112 adults with normal BMI and despite their gender, low high-density lipoprotein cholesterol was widespread (>75%) and its distribution did not differ across quartiles, as for raised fasting blood glucose (its prevalence was low ≈ 8%). Elevated blood pressure was the predominant abnormality in overall men (35.3%) with a significant increment starting at Q3 and reached 42.8% in Q4, while abdominal obesity was predominant in overall women (27.2%) with a significant increase starting at Q2, and reached 53.8% in Q4. In men, MONW was low (2.3%), while 30.6% had at least two abnormalities with an increasing pick starting at Q3, and prevalence was 38.0% in Q4. In women, the prevalence of MONW and those with at least two abnormalities was 8% and 39% respectively, with a common significant elevation beginning at Q3 and respectively reached 16% and 56% in Q4. Independently of sociodemographic and lifestyle factors, the number of metabolic abnormalities started to increase at Q3 in both sexes. *Conclusion:* Prevalence of adults with at least two metabolic abnormalities was considerable, and the number of abnormalities increased with normal BMI, and more severely in female gender in whom the prevalence of MONW was alarming. Abnormalities should also be early screened in normal-weight Burkinabè adults, more especially when their BMI reaches the Q3 cut-offs, i.e., 21.5 and 21.1 kg/m² respectively for men and women.

Keywords: Normal-Weight, BMI, Metabolic Disorders, Metabolically Obese Normal-Weight, 2013 Burkina Faso STEPS

1. Introduction

In low- and middle-income countries (LMICs), the nutrition and epidemiological transitions are matched with an increase in weight gain and the metabolic diseases, such as cardiovascular diseases and diabetes mellitus [1–3]. The prevention of metabolic diseases usually involves that of weight gain or overweight/obesity, the main target for

different prevention policies. Overweight/obese status was associated with a lower risk of remaining undiagnosed for cardiovascular or metabolic diseases (hypertension or diabetes) [4, 5] in LMICs. In people with normal-weight by the body mass index (BMI) i.e.; between 18.5–24.9 kg/m², clinicians, Public Health workers or National Health Systems might wrongly show very limited interest regarding metabolic diseases. Despite normal BMI, high body fat percentage was correlate with a high degree of metabolic dysregulation [6]. For four decades, metabolic disorders were found in subjects with normal BMI and those with metabolic syndrome (MetS) are known as metabolically obese with normal-weight (MONW) subjects [7], although the non-uniform criteria defining a MONW phenotype [8]. In MONW individuals, an increase in visceral adipose tissue mass, fasting blood glucose, lower insulin sensitivity of target tissues, hyperinsulinemia, atherogenic dyslipidaemia and high arterial pressure are usually diagnosed [7, 9, 10] with increased the risk for cardiometabolic disease [11].

In Sub-Saharan African (SSA), the comparative studies usually report a low prevalence of overweight and obesity in Burkina Faso where the majority of adult people was normal-weight by BMI [2, 12]. Furthermore, in-hospital Burkinabè study among patients with cardiovascular events, and population-based study in apparently healthy people reported a comparable mean weight in samples [13, 14].

This study explored by gender, the metabolic abnormalities and MONW across the quartiles of normal BMI, among adults in Burkina Faso. It should serve as a baseline report to the overcoming national surveys.

2. Methods

2.1. Study Design

We used data from the first Burkina Faso national survey conducted in 2013, which was based on the WHO STEPS methodology. 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.

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 nationally representative survey covered all the 13 administrative regions of Burkina Faso and involved all three components – behavioural or lifestyle factors, physical (anthropometric and BP) and biological measurements [15]. 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).

2.2. Variables of Interest

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 and physical activity. 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. Serum triglycerides were not measured.

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 [16]. Data on self-reported physical activity were collected using the validated Global Physical Activity Questionnaire [17]. 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, and values between 18.5 – 24.9 kg/m²) defined normal weight [18].

Each MetS abnormal component counts as one metabolic disorder and using the International Diabetes Federation criteria [19], 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 [19]. Since consistent data supported that the increased number of MetS abnormal components showed a significant increased value in predicting cardiovascular impairment or events [20], the outcome variables we considered were having at least two on the one hand; and at least three metabolic disorders (i.e., MONW) 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 [21]. BP (in mmHg) was measured three times using an electronic BP device, and the mean value used in the analysis. The biochemical tests were done on fasting capillary blood samples.

2.3. 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 (%). The chi-squared test was used to compare categorical variables. 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, i.e., MONW (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). The Hosmer-Lemeshow test was performed to determine the goodness-of-fit of the logistic regression models. Except for the Hosmer-Lemeshow test, for all analyses, a p-value below 0.05 was considered statistically significant.

3. Results

Of the sample of 4800 individuals enrolled in the primary study, 105 were not eligible. After excluding all individuals with incomplete data with regard to the variables of interest, and underweight, overweight and obese individuals, the remaining 3112 participants with normal BMI were included in our secondary analysis. Figure 1 reports the process of participants' inclusion. The number of men was 1647 (52.9%) and Table 1 describes the sociodemographic and lifestyle factors practices.

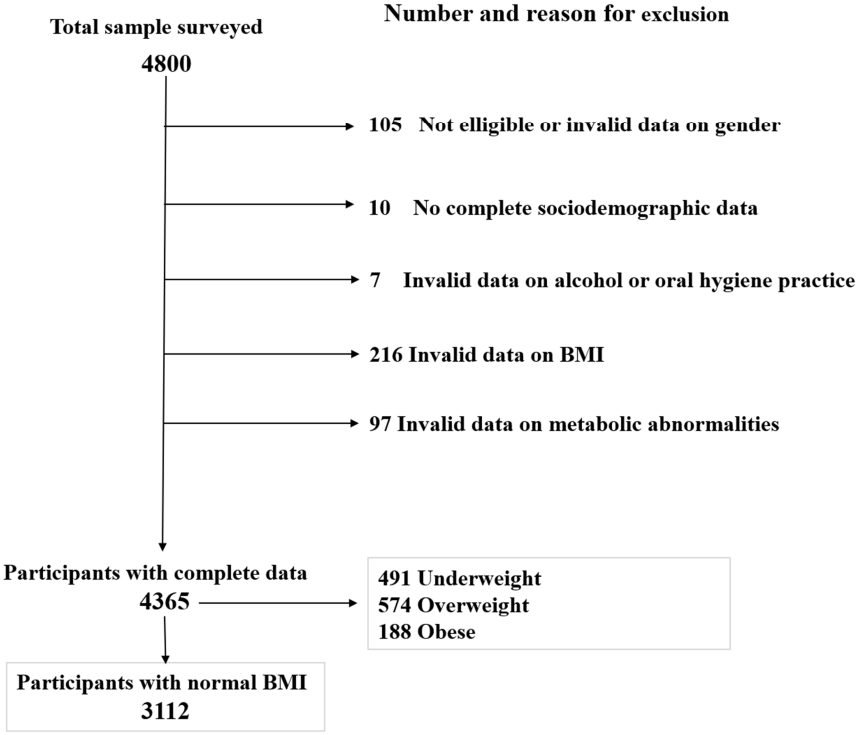

Figure 1. *Flow diagram of normal-weight participants' inclusion.*

Derived from the BMI, the quartile values or cut-offs were 20.22303; 21.504; and 22.78183 kg/m² in men; while in women, they were 19.86555; 21.10959 and 22.67574 kg/m². Table 2 summarizes the median, mean (standard deviation) in anthropometric (WC, weight, BMI), BP and biological (glycemia, serum lipids) parameters by quartile for each gender, while Table 3 reports the prevalence of individual metabolic abnormality, MONW and those with at least two abnormalities, by quartile for each gender.

In normal weight participants, despite the gender, the prevalence of low HDL-C was high (>75%), and its distribution did not differ with the quartiles of BMI, as for the raised FBG (even its prevalence was low, ≈ 8%). Elevated BP was the specific predominant abnormality in overall men (35.3%) with a significant increment starting at Q3 and reached 42.8% in Q4, while abdominal obesity was particularly predominant in overall women (27.2%) with a significant increase starting at Q2, and reached 53.8% in Q4. In men, MONW was low (2.3%), while 30.6% had at least two abnormalities with an increasing pick starting at Q3, and prevalence was 38.0% in Q4. In women, the prevalence of MONW and those with at least two abnormalities was 8% and 39% respectively, with a common significant elevation beginning at Q3 and reached respectively 16% and 56% in Q4 (Table 3). Table 4 reports the associations with MONW or having at least two metabolic abnormalities in the logistic regressions that included quartile categories as independent variable, for each gender. Independently of sociodemographic and lifestyle factors, the number of metabolic abnormalities started to increase at Q3 in both sexes (Table 4). Regarding the goodness-of-fit test for all logistic regression models, the Hosmer-Lemeshow chi-square test yielded a p-value over 0.05.

Table 1. *Sociodemographic characteristics and lifestyle practices by gender of the normal-weight participants.*

	Overall normal-weight (N= 3112)	**Normal-weight men (N = 1647)**	**Normal-weight women (N= 1465)**
	n (%)	**n (%)**	**n (%)**
Age (years)			
< 40 years	2008 (64.5)	1014 (61.6)	994 (67.9)
≥40 years	1104 (35.5)	633 (38.4)	471 (32.1)
Residency			
Rural area	2632 (84.6)	1397 (84.8)	1235 (84.3)
Urban area	480 (15.4)	250 (15.2)	230 (15.7)
Instruction			
Not formal education	2770 (89.0)	1428 (86.7)	1342 (91.6)
Educated	342 (11.0)	219 (13.3)	123 (8.4)
Marital status			
Singles (divorced/widows)	420 (13.5)	246 (14.9)	174 (11.9)
Married/cohabiting	2692 (86.5)	1401 (85.1)	1291 (88.1)
Occupation			
Job without regular or formal income	2419 (77.7)	1583 (96.1)	836 (57.1)
Job providing regular and formal income	693 (22.3)	64 (3.9)	629 (42.9)
Cleaning teeth at least twice a day			
No	2155 (69.2)	1147 (69.6)	1008 (68.8)
Yes	957 (30.8)	500 (30.4)	457 (31.2)
Substance use			
Did not use any substance	1881 (60.4)	868 (52.7)	1013 (69.1)
Used alcohol or tobacco	936 (30.1)	558 (33.9)	378 (25.8)
Used alcohol and tobacco	295 (9.5)	221 (13.4)	74 (5.1)
Physical Activity			
Physically Inactive	2927 (94.1)	1552 (94.2)	1375 (93.9)
Physically active	185 (5.9)	95 (5.8)	90 (6.1)

Table 2. *Median, mean (standard deviation) in anthropometric (waist circumference [WC], weight, body mass index [BMI]), blood pressure (BP) and biological (glycemia, blood lipids) parameters by gender of the normal weight participants.*

	Normal-weight men (N= 1647)								
	Q1 (412)		**Q2 (n=410)**		**Q3 (n=414)**		**Q4 (n=411)**		**P-value †**
	Me	**X̄ (σ)**	**Me**	**X̄ (σ)**	**Me**	**X̄ (σ)**	**Me**	**X̄ (σ)**	
WC	72.0	73.5 (11.7)	75.0	75.2 (6.8)	75.5	76.7 (8.7)	79.0	79.6 (9.3)	0.0001
Weight	56.6	56.6 (4.9)	61.1	61.1 (4.8)	64.3	64.3 (5.3)	68.7	69.0 (6.2)	0.0001
BMI	19.5	19.5 (0.5)	20.9	20.9 (0.4)	22.1	22.1 (0.4)	23.7	23.8 (0.6)	0.0001
SBP	120.7	122.1 (15.0)	121.0	123.0 (15.6)	123.3	125.6 (14.8)	125.0	127.7 (15.6)	0.0001
DBP	77.0	77.0 (10.7)	76.7	76.8 (10.5)	76.7	77.5 (10.0)	77.7	79.0 (11.1)	0.010
FBG	3.8	3.8 (1.4)	3.8	3.8 (1.6)	3.9	3.8 (1.6)	3.9	3.9 (1.5)	0.22
HDL-C	0.7	0.8 (0.5)	0.7	0.8 (0.4)	0.7	0.8 (0.4)	0.8	0.8 (0.4)	0.77
TC	2.6	2.9 (0.7)	2.6	3.0 (0.7)	2.6	3.0 (0.7)	2.7	3.1 (1.0)	0.032

Table 2. *Continued.*

	Normal-weight women (1465)								
	Q1 (n=377)		**Q2 (n=366)**		**Q3 (n=366)**		**Q4 (n=366)**		**P-value †**
	Me	**X̄ (σ)**	**Me**	**X̄ (σ)**	**Me**	**X̄ (σ)**	**Me**	**X̄ (σ)**	
WC	71.0	71.8 (7.8)	72.6	74.0 (9.8)	76.0	76.7 (9.4)	80.0	80.8 (10.1)	0.0001
Weight	50.1	50.8 (4.6)	53.0	53.6 (5.0)	57.0	57.3 (5.3)	61.9	62.3 (5.9)	0.0001
BMI	19.2	19.2 (0.4)	20.5	20.5 (0.4)	21.8	21.8 (0.4)	23.7	23.7 (0.7)	0.0001
SBP	115.7	118.8 (18.4)	115.7	118.2 (16.2)	116.7	118.9 (15.7)	118.8	122.1 (16.9)	0.006
DBP	75.3	75.9 (10.3)	75.5	75.8 (9.8)	76.7	76.6 (9.3)	77.3	78.1 (10.6)	0.006
FBG	3.9	3.9 (1.5)	4.0	3.9 (1.4)	3.8	3.8 (1.4)	4.1	3.9 (1.8)	0.56
HDL-C	0.9	0.9 (0.5)	0.9	1.0 (0.5)	0.9	0.9 (0.5)	0.9	1.0 (0.5)	0.78
TC	2.7	3.1 (0.8)	2.8	3.1 (0.7)	2.7	3.0 (0.8)	2.9	3.2 (0.9)	0.008

†P-value from the anova test, between the four variances of quartiles, for each gender. WC: waist circumference (in cm); BMI: body mass index (in kg/m²); SBP: Systolic blood pressure (in mmHg), DBP: Diastolic blood pressure (in mmHg), FBG: Fasting blood glucose (in mmol/l); HDL-C: High-density

lipoprotein cholesterol (in mmol/l); TC: Total cholesterol (in mmol/l). Weight is given in kg.

Table 3. *Prevalence of individual metabolic abnormalities and having at least two abnormalities, and MONW in each gender of the normal weight participants.*

	Normal-weight men, N = 1647						**Normal-weight women, N = 1465**					
	High WC	**Elevated BP**	**Raised FBG**	**Low HDL-C**	**At least two**	**MONW**	**High WC**	**Elevated BP**	**Raised FBG**	**Low HDL-C**	**At least two**	**MONW**
Q1	5 (1.2)	126 (30.6)	24 (5.8)	313 (76.0)	108 (26.2)	4 (1.0)	32 (8.7)	86 (23.4)	33 (9.0)	289 (78.8)	101 (27.5)	19 (5.2)
Q2	1 (0.2)	125 (30.5)	31 (7.6)	320 (78.1)	104 (25.4)	7 (1.7)	62 (16.9)	86 (23.5)	25 (6.8)	283 (77.3)	114 (31.2)	17 (4.6)
Q3	6 (1.5)	154 (37.2)	32 (7.7)	318 (76.8)	136 (32.9)	12 (2.9)	108 (29.5)	95 (26.0)	21 (5.7)	299 (81.7)	152 (41.5)	29 (7.9)
Q4	11 (2.7)	176 (42.8)	42 (10.2)	314 (76.4)	156 (38.0)	15 (3.7)	197 (53.8)	115 (31.4)	27 (7.4)	273 (74.6)	204 (55.7)	58 (16.0)
p-value†	0.023	0.0001	0.13	0.91	0.0001	0.043	0.0001	0.046	0.40	0.13	0.0001	0.0001
Overall	23 (1.4)	581 (35.3)	12 (97.8)	1265 (76.8)	504 (30.6)	38 (2.3)	399 (27.3)	382 (26.1)	106 (7.2)	1144 (78.1)	571 (39.0)	123 (8.4)

†: Comparison between the four prevalences of quartiles, for each gender.
Comparison in overall prevalence of abnormalities in men versus women: for high WC: (1.4 vs 27.3%), p=0.0001; Elevated BP: (35.3 vs 26.1%), p=0.0001; Raised FBG: (7.8 vs 7.2%), p= 0.40; Low HDL-C: (76.8 vs 78.1%), p= 0.50; At least two abnormalities (30.6 vs 39.0%); p=0.0001 and MONW: (2.3 vs 8.4%), p=0.0001.

Table 4. *Associated factors with having at least two metabolic abnormalities and MONW (only in female) in each gender of the normal weight participants, in logistic regressions.*

	Normal-weight men (1647)			**Normal-weight women (1465)**					
	Associations with having at least two metabolic abnormalities			**Associations with having at least two metabolic abnormalities**			**Associations with MONW**		
	aOR	**CI 95%**	**P-value**	**aOR**	**CI 95%**	**P-value**	**aOR**	**CI 95%**	**P-value**
Quartiles (Q) of normal BMI									
Q1 (Reference)	1			1			1		
Q2	0.9	0.7-1.3	0.90	1.3	0.9-1.8	0.11	0.9	0.5-2.0	0.98
Q3	1.4	1.1-1.9	0.02	2.1	1.5-2.8	0.0001	1.8	0.9-3.3	0.06
Q4	1.7	1.3-2.4	0.0001	3.5	2.5-4.8	0.0001	3.8	2.2-6.5	0.0001

Adjustment was performed on the five sociodemographic (age, marital status, living area, education, occupation) factors and the lifestyle behaviours (substance use, physical activity and teeth cleaning frequency). aOR: adjusted Odds-ratio.
Nonetheless, it is worth noting the protective effect of a factor not usually explored, the frequency of cleaning the teeth at least twice a day. In women especially, our multivariable analysis showed a negative association between cleaning the teeth at least twice a day and having at least two metabolic abnormalities and [aOR=0.7, (95% CI: 0.6-0.9), p = 0.04].

4. Discussion

4.1. Main Findings

In both men and women with normal BMI, those with at least two metabolic abnormalities were prevalent, and increased with the quartiles of their normal BMI, and prevalence of MONW was particularly high among women in the Q4 of normal BMI.

4.2. Widespread of Low HDL-C, While Low Raised FBG Among Men and Women with Normal Weight

In both gender groups and regardless of the quartile normal BMI, low HDL-c was widespread (nearly four-fifths of normal-weight population) and large international reported that men and women with NWO also had higher prevalence of dyslipidaemia [22]**.** Moreover, our finding may be underlined by economic poverty (Ref) with the low quality of diet [23], and the relationships between the micronutrient deficiency and low HDL-C it has been reported in the SSA people [24]. Low HDL-c reduction should be ranked among key health issues by the national Public Health system, and normal-weight individuals should also be advised and be involved in the public health interventions. Even the HDL-c concentration in blood was low (mean of 0.7 – 1.0 mmol/L, Table 2), it should be considered and encouraged by the mixed evidence (in vitro, randomized analyses) that regular aerobic exercise improves cholesterol efflux capacity, with beneficial effects [25]. It found that 10 weeks of walk/run training increased the ability of isolated HDL-C to protect endothelial cells from injury by decreasing monocyte adhesion [26]. Thus, public health interventions should be vulgarized because in the absence of sound advice, people with normal weight may believe that engagement in regular physical activity practice is irrelevant for them. In addition, there is no local or specific food composition table in Burkina Faso, nor is there a specific healthy food pyramid. The national-specific healthy dietary guidelines should be developed and extended to the entire population to control the widespread of low HDL-C.

Prevalence of raised FBG (≈ 8%) for both genders reflected its overall level in Burkina Faso (8.4%) [27]. Conventional guidelines state that dietary interventions combined with increased physical activity remain the first-line approaches to treatment of the pre-diabetic state [28, 29],

and thus raised glycemia and low HDL-C should be addressed using the similar policies in Burkina Faso.

4.3. Raised BP Specifically Predominant in Normal Weight Men, While Abdominal Obesity in Normal Weight Women

Raised BP was predominant in overall men (35.3% whereas 26.1% in women) with a significant increment starting at Q3; and from Q3 to Q4, the coefficient of the increase in the frequency of raised BP (42.8/37.2) and that of MONW (3.7/2.3) were comparable. The similar observation was done in the international study, reporting that male subjects with NWO also had higher prevalence of hypertension [22]**.** For men, BP seemed crucial for metabolic disorders occurrence, and Chinese male subjects with normal BP, or prehypertension, more frequently developed MetS, even those with normal BMI [30]. High-normal BP was a crucial status for MONW prevention and these physical variables (BP and BMI) are simple to be measured routinely, and national health surveillance system should focus on these parameters in men. Clinicians in routine care should early raise awareness in men even with a normal BMI, particularly when reaching 21.5 kg/m².

Abdominal obesity was predominant abnormality in overall women (27.4% whereas 1.4% in men) with a significant increase starting at Q2. Sex is an additional modulator of adipose tissue, there is a sexual dimorphism in body fat distribution, and sex-specific differences in adipocyte size and metabolic function may contribute to the frequent development of MetS in women [31]. A SSA study reported a strong association between abdominal obesity and MetS [32]; and from Q3 to Q4, the coefficient of increase in the prevalence of abdominal obesity (53.8/29.5) and that of MONW (15.9/7.9) were similar. These anthropometric parameters (WC and BMI) are simple to be measured routinely, and national health surveillance system should focus on these parameters in women. Clinicians in routine care should early raise awareness in women even with a normal BMI, particularly when reaching 19.8 kg/m².

4.4. Normal Weight Adults with at Least Two Abnormalities and MONW

Accumulation of metabolic abnormalities in individuals occurred over time, and because it was closely related to abnormal brachial ankle pulse wave velocity, it was considered as an early indicator of arteriosclerosis [33, 34]. From three large cohort studies, having 1-2 MetS components was associated with a significantly increased risk of cardiovascular diseases (hazard ratio (HR): 2.1; CI95%: 1.8 - 2.5) [35]. About 30% and 40% of our normal weight men and women respectively, had at least two metabolic abnormalities, with significant increase starting at Q3 (Table 3). The protective effect of tooth cleaning regularly (at least twice a day) was not sufficiently promoted [36, 27] and should be emphasized in public health interventions.

In women specifically, the overall prevalence of MNOW (8.4%) was not trivial, and doubled from Q3 (8%) to Q4 (16%). There is a lifelong change in the percentage of body fat, and in the level of practice of physical activity. Even among individuals remaining normal weight lifelong, an increase in adiposity from childhood to adulthood was detrimental to cardiometabolic health [37]. Despite our study did not include the body fat percentage, the evidence from an international large study found that women with NWO and high body fat also had higher prevalence of cardiovascular disease and showed a significant 2.2-fold increased risk for cardiovascular mortality (HR = 2.2; 95% CI: 1.03–4.67) [22]. Evidence stated adults with MONW had significantly lower BMI in childhood and young adulthood, but their BMI increased more than in other adults after this age. Unfortunately, physical activity decreased relatively more since youth in individuals with adult MONW [38] while the moderate weight loss improves body composition and metabolic function in metabolically unhealthy lean subjects [11].

5. Limitations

Database does not include triglyceride values and thus, the cumulative number of components could not be specifically calculated and MetS could not be entirely defined. Our analysis did not include the relevant modifiable lifestyle behaviours such as diet or fruits and vegetables consumption, psychological stress, sleep quality, etc. Besides, uricemia was not analysed while hyperuricemia was significantly associated with MONW [39], and triglyceride glucose index, the novel surrogate marker should have specified the cardiovascular disease risk in our MONW [40] was not calculated The level of metabolic abnormalities in 2013 may not reflect the current situation although it provides a relevant baseline against which future national surveys may be compared. A second national STEPS survey in Burkina Faso has recently been completed with analysis pending.

6. Conclusion

Prevalence of adults with at least two metabolic abnormalities was considerable, and the number of abnormalities increased with normal BMI, and more severely in female gender in whom the prevalence of MONW was alarming. Nevertheless, a potential number of individuals may not be advised, and not be involved or not encouraged to undergo for abnormalities screening, because the majority of Burkinabè was normal-weight. Abnormalities should be early screened in normal-weight Burkinabè adults, more especially when their BMI reaches the Q3 cut-offs, i.e., 21.5 and 21.1 kg/m² respectively for men and women. To control the low HDL-C widespread with raised glycemia, the appropriate national dietary guidelines based on local healthy food pyramid should be developed and vulgarized and coupled with the physical activity promotion. For the purposes of epidemiological surveillance of metabolic disorders, the simple physical measurement of the BMI for both genders,

and the BP specifically for men, while the waist circumference for women is crucial, and should be a priority.

Disclosure of Interest

The authors declare that they have no competing interest.

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References

[1] Abrahams Z, McHiza Z, Steyn NP. Diet and mortality rates in Sub-Saharan Africa: stages in the nutrition transition. BMC Public Health. 2011; 11: 801.

[2] Bosu WK. An overview of the nutrition transition in West Africa: implications for non-communicable diseases. Proc Nutr Soc. 2015; 74: 466–77.

[3] Macia E, Cohen E, Boetsch G, Boetsch L, Cohen E, Duboz P. Prevalence of obesity and body size perceptions in urban and rural Senegal: new insight on the epidemiological transition in West Africa. Cardiovasc J Afr. 2017; 28: 324–30.

[4] Haider MR, Das Gupta R. Inequalities in undiagnosed hypertension among adult Nepalese population: Evidence from a nationally representative survey. Int J Cardiol Hypertens. 2020; 5: 100026.

[5] Bjerggaard M, Philipsen A, Jørgensen ME, Charles M, Witte DR, Sandbæk A, et al. Association of self-perceived body image with body mass index and type 2 diabetes—The ADDITION-PRO study. Prev Med. 2015; 75: 64–9.

[6] Oliveros E, Somers VK, Sochor O, Goel K, Lopez-Jimenez F. The concept of normal weight obesity. Prog Cardiovasc Dis. 2014; 56: 426–33.

[7] Ruderman N, Chisholm D, Pi-Sunyer X, Schneider S. The metabolically obese, normal-weight individual revisited. Diabetes. 1998; 47: 699–713.

[8] Pluta W, Dudzińska W, Lubkowska A. Metabolic Obesity in People with Normal Body Weight (MONW)-Review of Diagnostic Criteria. Int J Environ Res Public Health. 2022; 19: 624.

[9] Meigs JB, Wilson PWF, Fox CS, Vasan RS, Nathan DM, Sullivan LM, et al. Body mass index, metabolic syndrome, and risk of type 2 diabetes or cardiovascular disease. J Clin Endocrinol Metab. 2006; 91: 2906–12.

[10] Hyun YJ, Koh SJ, Chae JS, Kim JY, Kim OY, Lim HH, et al. Atherogenecity of LDL and unfavorable adipokine profile in metabolically obese, normal-weight woman. Obes Silver Spring Md. 2008; 16: 784–9.

[11] Chooi YC, Ding C, Chan Z, Choo J, Sadananthan SA, Michael N, et al. Moderate Weight Loss Improves Body Composition and Metabolic Function in Metabolically Unhealthy Lean Subjects. Obes Silver Spring Md. 2018; 26: 1000–7.

[12] Yaya S, Ekholuenetale M, Bishwajit G. Differentials in prevalence and correlates of metabolic risk factors of non-communicable diseases among women in sub-Saharan Africa: evidence from 33 countries. BMC Public Health. 2018; 18: 1168.

[13] Diendéré J, Millogo A, Philippe F, Kaboré J, Napon C, Dabilgou A, et al. Post-stroke Complications and Mortality in Burkinabè Hospitals: Relationships with Deglutition Disorders and Nutritional Status. Dysphagia. 2020; 36: 85–95.

[14] Diendéré J, Kaboré J, Somé JW, Tougri G, Zeba AN, Tinto H. Prevalence and factors associated with overweight and obesity among rural and urban women in Burkina Faso. Pan Afr Med J. 2019; 34.

[15] World Health Organization. WHO steps surveillance manual: the WHO stepwise approach to chronic disease risk factor surveillance. Geneva: World Health Organization; 2005.

[16] Claydon NC. Current concepts in toothbrushing and interdental cleaning. Periodontol 2000. 2008; 48: 10–22.

[17] Bull FC, Maslin TS, Armstrong T. Global physical activity questionnaire (GPAQ): nine country reliability and validity study. J Phys Act Health. 2009; 6: 790–804.

[18] World Health Organization. Obesity: Preventing and Managing the Global Epidemic. Technical Report 894. Geneva: World Health Organization; 2000.

[19] Alberti KGMM, Zimmet P, Shaw J. Metabolic syndrome--a new world-wide definition. A Consensus Statement from the International Diabetes Federation. Diabet Med J Br Diabet Assoc. 2006; 23: 469–80.

[20] Gami AS, Witt BJ, Howard DE, Erwin PJ, Gami LA, Somers VK, et al. Metabolic syndrome and risk of incident cardiovascular events and death: a systematic review and meta-analysis of longitudinal studies. J Am Coll Cardiol. 2007; 49: 403–14.

[21] Després JP, Lemieux I, Prud'homme D. Treatment of obesity: need to focus on high risk abdominally obese patients. BMJ. 2001; 322: 716–20.

[22] Romero-Corral A, Somers VK, Sierra-Johnson J, Korenfeld Y, Boarin S, Korinek J, et al. Normal weight obesity: a risk factor for cardiometabolic dysregulation and cardiovascular mortality. Eur Heart J. 2010; 31: 737–46.

[23] Frongillo EA, Nanama S. Development and validation of an experience-based measure of household food insecurity within and across seasons in northern Burkina Faso. J Nutr. 2006; 136: 1409S-1419S.

[24] Delisle H, Ntandou G, Sodjinou R, Couillard C, Després J-P. At-risk serum cholesterol profile at both ends of the nutrition spectrum in West African adults? The Benin study. Nutrients. 2013; 5: 1366–83.

[25] Ruiz-Ramie JJ, Barber JL, Sarzynski MA. Effects of exercise on HDL functionality. Curr Opin Lipidol. 2019; 30: 16–23.

[26] Sang H, Yao S, Zhang L, Li X, Yang N, Zhao J, et al. Walk-run training improves the anti-inflammation properties of high-density lipoprotein in patients with metabolic syndrome. J Clin Endocrinol Metab. 2015; 100: 870–9.

[27] Diendéré J, Bosu WK, Ouédraogo W-LR, Ouattara S, Konsem T, Zeba AN, et al. How alcohol and/or tobacco use and raised glycemia are associated with oral hygiene practices among Burkinabè adults: Evidence from the first national non-communicable disease risk factors survey. Prev Med Rep. 2022; 28: 101854.

[28] American Diabetes Association. 4. Lifestyle Management: Standards of Medical Care in Diabetes-2018. Diabetes Care. 2018; 41 Suppl 1: S38–50.

[29] American Diabetes Association. 5. Prevention or Delay of Type 2 Diabetes: Standards of Medical Care in Diabetes-2018. Diabetes Care. 2018; 41 Suppl 1: S51–4.

[30] Huo D, Tao L, Li X, Wang W, Wang Z, Chen D, et al. Association of blood pressure with development of metabolic syndrome components: a five-year Retrospective Cohort study in Beijing. BMC Public Health. 2013; 13: 912.

[31] Pradhan AD. Sex differences in the metabolic syndrome: implications for cardiovascular health in women. Clin Chem. 2014; 60: 44–52.

[32] Marbou WJT, Kuete V. Prevalence of Metabolic Syndrome and Its Components in Bamboutos Division's Adults, West Region of Cameroon. BioMed Res Int. 2019; 2019: 9676984.

[33] Zhu WH, Chen LY, Lu CR, Su L, Fang LZ. [Association between the accumulation of metabolic syndrome abnormal components and arterial pulse wave velocity among adult individuals undergoing routine health examination]. Zhonghua Xin Xue Guan Bing Za Zhi. 2018; 46: 810–7.

[34] Chen L, Zhu W, Mai L, Fang L, Ying K. The association of metabolic syndrome and its components with brachial-ankle pulse wave velocity in south China. Atherosclerosis. 2015; 240: 345–50.

[35] Wildman RP, McGinn AP, Lin J, Wang D, Muntner P, Cohen HW, et al. Cardiovascular disease risk of abdominal obesity vs. metabolic abnormalities. Obes Silver Spring Md. 2011; 19: 853–60.

[36] Tanaka A, Takeuchi K, Furuta M, Takeshita T, Suma S, Shinagawa T, et al. Relationship of toothbrushing to metabolic syndrome in middle-aged adults. J Clin Periodontol. 2018; 45: 538–47.

[37] Viitasalo A, Pitkänen N, Pahkala K, Lehtimäki T, Viikari JSA, Raitakari O, et al. Increase in adiposity from childhood to adulthood predicts a metabolically obese phenotype in normal-weight adults. Int J Obes 2005. 2020; 44: 848–51.

[38] Viitasalo A, Pahkala K, Lehtimäki T, Viikari J, Tammelin TH, Raitakari O, et al. Changes in BMI and physical activity from youth to adulthood distinguish normal-weight, metabolically obese adults from those who remain healthy. Front Endocrinol. 2022; 13: 923327.

[39] Guerrero-Romero F, Simental-Mendía LE. Hyperuricemia is Associated with the Presence of Metabolically Obese Normal-Weight and Metabolically Healthy Obese Phenotypes. Endocr Res. 2022; 47: 124–9.

[40] Morales-Gurrola G, Simental-Mendía LE, Castellanos-Juárez FX, Salas-Pacheco JM, Guerrero-Romero F. The triglycerides and glucose index is associated with cardiovascular risk factors in metabolically obese normal-weight subjects. J Endocrinol Invest. 2020; 43: 995–1000.