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Sex-Specific Prevalence of Metabolic Abnormalities by Trend of Urbanization and Age, Among Adults in Burkina Faso: Analysis Using the National Baseline Data

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Abstract: *Introduction*: Metabolic abnormalities increase with the epidemiological transition in Sub-Saharan African area. *Objective:* To report the sex-specific prevalence of metabolic abnormalities in Burkinabè adults by the trend of urbanization and age, using the national baseline data. *Methods*: Data of 4365 male/female participants to the 2013 Burkina Faso Stepwise approach to surveillance survey were analysed, including sociodemographic parameters (with four age-groups of 25-34; 35-44; 45-54 and 55-64 years). The urbanization trend was the four categories derived from the quartiles of the urbanization rates of the 13 Burkinabè regions. The metabolic abnormalities were defined using the International Diabetes Federation criteria (raised waist circumference [WC], blood pressure [BP], fasting blood glucose [FBG] and low high-density lipoprotein cholesterol [HDL-C]). *Results*: Between quartiles, the sex-specific prevalences (%) of abnormalities significantly differed and the extremes were: 71.1-81.2 in men(♂), 75.9-81.2 in women(♀) for low HDL-C; 32.8-48.2(♂), 21.5-51.6(♀) for elevated BP; 3.4-7.3(♂), 30.8-45.5(♀) for high WC; 6.2-11.0(♂), 6.7-14.2(♀) for high FBG; 2.8-7.3(♂), 9.6-24.0(♀) for participants who cumulated at least three abnormalities; and the extreme means in cumulative number of abnormalities were 1.3-1.5(♂), 1.4-1.9(♀). Between the four age-groups, sex-specific prevalences significantly differed and the extremes were: 71.9-81.6(♂), 71.8-83.1(♀) for low HDL-C; 32.3-49.1(♂), 23.8-30.3(♀) for elevated BP; 2.0-14.0(♂), 24.8-65.3(♀) for high WC; 6.4-13.0(♂), 5.5-10.4(♀) for high FBG; 2.5-12.0(♂), 8.5-25.8(♀) for individuals who cumulated at least three abnormalities; and the extreme means in number of abnormalities were 1.2-1.4(♂), 1.4-1.9(♀). *Conclusion*: The low HDL-C was very widespread in the general population in Burkina Faso, substantially increasing the risk of carrying several abnormalities, which worsened with the process of urbanization and older age, and women more severely affected.

Keywords: Sex-Specific Prevalence, Metabolic Syndrome Components, Abnormalities, Urbanization Trend, Age, Burkina Faso

1. Introduction

Epidemiological transition in low- and middle-income countries (LMICs) leads to new health challenges, such as the management of noncommunicable diseases (NCDs) [1, 2] such as cardiovascular diseases [3]. Concerns with this transition included the gradual growth in the number of units of blood sugar [4], blood pressure (BP) [5] and fat accumulation specifically in the sub abdominal area [6] with lipid profile impairment [7]. Metabolic syndrome (MetS) is defined by the International Diabetes Federation (IDF) using different metabolic abnormalities (raised waist circumference [WC], blood pressure [BP], fasting blood glucose [FBG] and blood triglyceride and low level of blood high-density lipoprotein [HDL-C] [8]) and is a main cardiovascular risk factor [9]. From Sub-Saharan African [SSA] studies, each individual metabolic abnormality can predict another (Beninese study) [10] or MetS (Ethiopian study) [11] or the cardiovascular events [12]. Accumulation of metabolic abnormalities occurred over time with increasing risk of cardiovascular diseases and events [13, 14] and thus, a public health programme based on the surveillance is required. For the SSA LMICs, demographic transition is relevant to population health patterns [1, 15] and the epidemiology of metabolic abnormalities in each gender [16] was influenced by the process of urbanization [17]. Burkina Faso is a SSA low-income country, and data collected during the first national survey in 2013, with the Stepwise approach to Surveillance (STEPS) method was the national baseline survey, and included WC, BP, FBG, HDL-C and sociodemographic parameters. The country is divided into thirteen administrative regions and when the first STEPS survey was conducted, the female gender represented 52.2% of the overall 14,017,262 inhabitants (estimate of the 2006 General Population and Housing Census); the national urbanisation rate was 23.3% while the regional rates of urbanisation were ranged from 6.6% to 85.4% [18]. Metabolic disorders have been described only in normal-weight individuals [19]. This study aimed to report the sex-specific prevalence of metabolic abnormalities by the trend of urbanization and age, among adults in Burkina Faso, by using the national baseline data.

2. Methods

2.1. Study Design

The baseline data from the Burkina Faso national survey conducted in 2013 based on the STEPS method [20] was used. The study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving human subjects/patients and 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 recorded from each participant to STEPS survey.

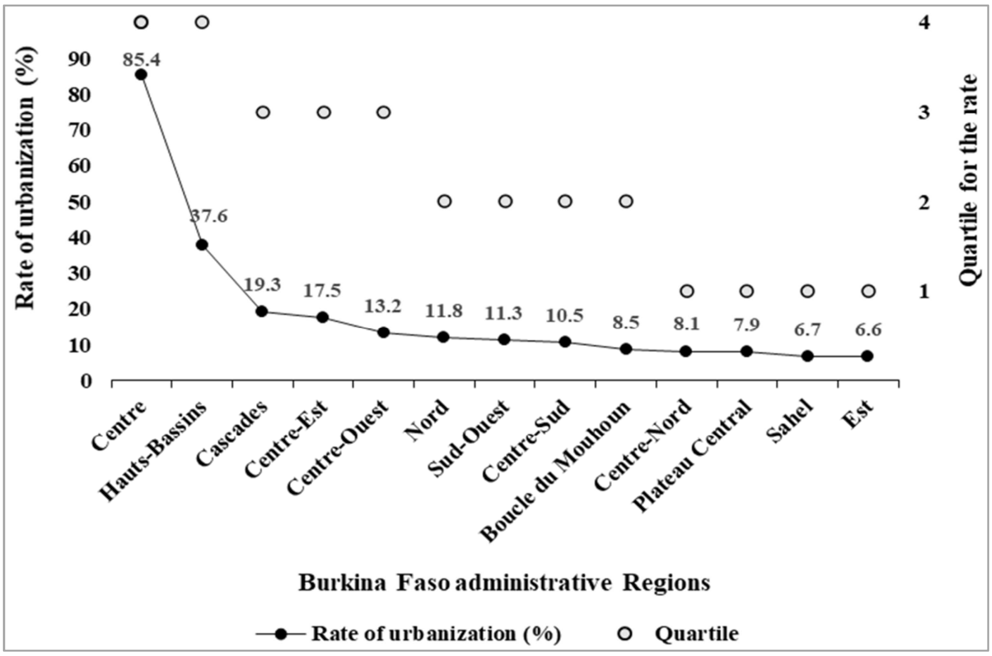

Figure 1. *Trend of urbanization derived using the quartiles of the specific rate of urbanization of the 13 Administrative Burkinabé Regions (thresholds for quartiles were 8.1, 11.8 and 19.3%) [23].*

2.2. Variables of Interest Extracted from the STEPS Database

The Participants' demographic variables included residence environment, gender, age, marital status, education level and occupation. The Anthropometric characteristics were WC (cm), body mass index ([BMI] = weight/height², in kg/m²) which was used to characterize 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. The BP (in mmHg, which included systolic blood pressure [SBP] and diastolic blood pressure [DBP] values) was measured three times, and we kept only the mean value for each indicator. The biological characteristics tested in blood were TC (mmol/l), HDL-C (mmol/l), and FBG (mmol/l). The IDF cut-offs were used to identity MetS abnormal components [8]: (i) high WC when WC ≥ 95/80 cm for men/women, (ii) elevated BP when SBP/DBP ≥ 130/85 mmHg, (iii) FBG ≥ 5.6 mmol/l indicated high FBG, and (iv) HDL-C < 1.04/1.29 mmol/l for men/women indicated the Low HDL-C. The blood triglyceride was not available.

2.3. Participants Included for Analyses

The nationwide representative sample size was calculated to be 4800 men and women aged 25 – 64 years. The sample size calculation and the data collection processes throughout the country have been described [21, 22]. We analysed variables for those with complete data for the sociodemographic, nutritional, biological and blood pressure parameters. Thus, 4365 individuals with compete data were included for analyses.

2.4. Trend of Urbanization

The geographical subdivision of the country population was carried out based on the level of urbanization for the 13 administrative regions (Figure 1) [23]. The trend of urbanization was characterized using the quartiles of the urbanization rates for regions provided by the "Institut National de la Statistique et de la Demographie INSD" in 2006 [18]. The urbanization rate of each region was calculated as the proportion of inhabitants living in urban areas in the region. The national mean rate of urbanization was 23.3% [minimum = 6.6%, maximum = 85.4%], and the quartile cut-offs were 8.1, 11.8 and 19.3. Thus, four administrative regions were included in the first quartile (Q1) or in the second quartile (Q2), three in the third quartile (Q3) and two (of the Regions of "Centre" and "Hauts-Bassins") in the fourth quartile (Q4) (Figure 1). The two Regions in Q4 included the political capital Ouagadougou ("Centre" Region) and the economic capital; Bobo-Dioulasso (in the Region of "Hauts-Bassins") and were the living areas for about 62% of the country urban dwellers (46.4% for Ouagadougou, 15.4% for Bobo-Dioulasso).

2.5. Statistical Analyses

StataCorp Stata Statistical Software for Windows (Version 12.0, College Station, Texas, U.S.) was used to analyse the data. Quantitative variables were expressed in means ± standard deviation, categorical variables as percentages (%) with a confidence interval (CI) of 95%. When appropriate, Student's t or ANOVA tests were used to compare quantitative variables, $\chi 2$ or Fishers tests for categorical variables and a *p*-value <0.05 was considered statistically significant.

3. Results

The sociodemographic factors are summarized in Table 1 and female represented 50.4% and rural residents 71.6% (Table 1).

Table 1. *Sociodemographic features in the study sample (n = 4365).*

Parameters	Gender						p-value
	Overall, n=4365		Male, n=2164		Female, n=2201		
	n	%	N	%	n	%	
Age range (in years)							***
25-34	1915	43.9	900	41.6	1015	46.1	
35-44	1110	25.4	549	25.4	561	25.5	
45-54	814	18.7	414	19.1	400	18.2	
55-64	526	12.0	301	13.9	225	10.2	
Residence area							NS
Rural area	3500	80.2	1761	81.4	1739	79.0	
Urban area	865	19.8	403	18.6	462	21.0	
Living area by urbanization gradient							NS
Q1 (first quartile)	870	19.9	435	20.1	435	19.8	
Q2 (second quartile)	1238	28.4	642	29.7	596	27.1	
Q3 (third quartile)	1276	29.2	610	28.2	666	30.2	
Q4 (fourth quartile)	981	22.5	477	22.0	504	22.9	
Marital status							*
Married or cohabitating	3752	86.0	1833	84.7	1919	87.2	
Singles	613	14.0	331	15.3	282	12.8	
Education level							***
No formal education	3386	77.6	1590	18.1	1796	81.6	
Primary school	671	15.4	391	73.5	280	12.7	
Secondary school and more	308	7.0	183	8.4	125	5.68	
Occupation							***
Self-employed/independent workers	3056	70.0	1894	87.5	1162	52.8	
Household-keepers	933	21.4	13	0.6	920	41.8	
Wage earner (in public or private field)	240	5.5	174	8.0	66	3.0	
Jobless	136	3.1	83	3.8	53	2.4	

NS: Not significant, *: indicates P<0•05, **: indicates P<0•01, ***: indicates P<0•001

Figures 2 & 3 report the sex-specific prevalence of metabolic abnormalities respectively with regard to the trend of urbanization and the four age-groups, while Figure 4 reports the sex-specific prevalence of having at least three abnormalities, and these figures can be read with the Table 3 for more understanding. Between quartiles, the sex-specific prevalences (%) of abnormal components significantly differed, and the extremes were: 71.1-81.2 in men(♂), 75.9-81.2 in women(♀) for the low HDL-C; 32.8-48.2(♂), 21.5-51.6(♀) for elevated BP; 3.4-7.3(♂) and 30.8-45.5(♀) for high WC; 6.2-11.0(♂), 6.7-14.2(♀) for high FBG; 2.8-7.3(♂), 9.6-24.0(♀) for those with at least three metabolic abnormalities. The change consisted in the gradually significant increase of the sex-specific prevalences from Q1 to Q4 concerning high WC in women, high FBG in both sexes and having at least three metabolic abnormalities in both sexes (Figures 2A, 2C, 4A & Table 3).

Table 2. *Sex-specific prevalence of cumulative number of metabolic abnormalities by age range and the category of urbanization (n = 4365).*

Number of abnormalities	**0**	**1**	**2**	**3**	**4**		**0**	**1**	**2**	**3**	**4**
	Sex-specific prevalence (%) of abnormalities by age range						**Sex-specific prevalence (%) of abnormalities by urbanization category**				
Age range (years)						**Urbanization categories**					
25-34						Q1					
Men	9.9	59.3	28.0	2.7	0.0		8.1	56.8	32.6	2.5	0.0
Women	8.9	52.4	29.1	8.8	0.8		9.9	48.3	33.3	8.3	0.2
P-value	NS	*	NS	***	**		NS	**	NS	***	NS
35-44						Q2					
Men	11.8	53.9	28.2	5.7	0.4		11.7	59.6	26.0	2.5	0.2
Women	9.4	42.1	34.9	12.5	1.1		8.1	52.5	29.7	8.4	1.3
P-value	NS	***	*	***	NS		**	**	NS	***	*
45-54						Q3					
Men	12.8	51.7	30.0	5.3	0.2		13.6	56.9	26.5	2.8	0.2
Women	6.5	36.0	38.2	16.8	2.5		8.4	45.8	33.9	11.4	0.5
P-value	**	***	*	***	**		**	***	**	***	NS
55-64						Q4					
Men	11.6	47.9	33.2	6.3	1.0		10.3	44.2	33.5	11.1	0.9
Women	4.0	29.8	42.2	20.9	3.1		6.1	30.0	38.1	22.0	3.8
P-value	**	***	*	***	NS		*	***	NS	***	**

Q1, Q2, Q3, Q4: first, second, third, fourth quartiles respectively; p-value: Comparison was performed between men and women for the corresponding number of abnormal components in column. NS: Not significant, *: indicates P<0•05, **: indicates P<0•01, ***: indicates P<0•001

Table 3. *Sex-specific prevalence and mean number (standard deviation) of metabolic abnormalities by age-group and the trend of urbanization (n = 4365).*

Abnormal component	**Age-groups**					**Urbanization gradient**				
	25-34	**35-44**	**45-54**	**55-64**		**Q1**	**Q2**	**Q3**	**Q4**	
	n = 1915	**n = 1110**	**n = 814**	**n = 526**		**n = 870**	**n = 1238**	**n = 1276**	**n = 981**	
	Prevalence % of abnormal components in men and women (with reference to the IDF cutoffs)									
	%	**%**	**%**	**%**	**‡P-value**	**%**	**%**	**%**	**%**	**‡P-value**
High waist circumference										
Male	3.4	7.3	6.0	7.0	**	4.6	2.0	2.8	14.0	***
Female	30.8	38.9	45.5	44.0	***	24.8	28.7	30.6	65.3	***
†P-value	***	***	***	***		***	***	***	***	
Elevated blood presure										
Male	32.8	37.7	39.4	48.2	***	37.0	34.0	32.3	49.1	***
Female	21.5	30.3	40.5	51.6	***	28.5	23.8	29.9	30.3	***
†P-value	***	**	NS	NS		**	***	NS	**	
High Fasting blood glucose										
Male	6.2	10.0	10.6	11.0	**	6.4	6.9	8.9	13.0	**
Female	6.7	8.6	9.5	14.2	**	5.5	6.9	10.4	10.3	**
†P-value	NS	NS	NS	NS		NS	NS	NS	NS	
Low high-density lipoprotein cholesterol										
Male	81.2	73.8	72.5	71.1	***	81.6	77.0	75.1	71.9	**
Female	81.2	75.9	77.2	79.6	NS	81.8	83.1	78.8	71.8	***
†P-value	NS	NS	NS	*		NS	**	NS	NS	
	Prevalence (%) of individuals who cumulated at least three abnormal components									
Having at least 3 abnormal components										
Male	2.8	6.0	5.6	7.3	**	2.5	2.7	3.0	12.0	***
Female	9.6	13.6	19.2	24.0	***	8.5	9.7	11.9	25.8	***
†p-value	***	***	***	***		NS	***	***	***	

	Mean and standard deviation of number of abnormal components in men and women																	
	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	‡p-value	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	‡p-value
Male	1.2	0.7	1.3	0.8	1.3	0.8	1.4	0.8	*	1.3	0.6	1.2	0.7	1.2	0.7	1.5	0.8	***
Female	1.4	0.8	1.5	0.8	1.7	0.9	1.9	0.9	***	1.4	0.8	1.4	0.8	1.5	0.8	1.9	0.9	***
†P-value	***		***		***		***			*		***		***		***		

Q1, Q2, Q3, Q4: first, second, third, fourth quartiles respectively; IDF: International Diabetes Federation; SD: standard deviation; $\bar{X}$: mean; †p-value: Comparison was performed between men and women in the corresponding age-group in column; ‡p-value: Comparison was performed between all the age-groups in only men, or in only women. NS: Not significant, *: indicates P<0•05, **: indicates P<0•01, ***: indicates P<0•001

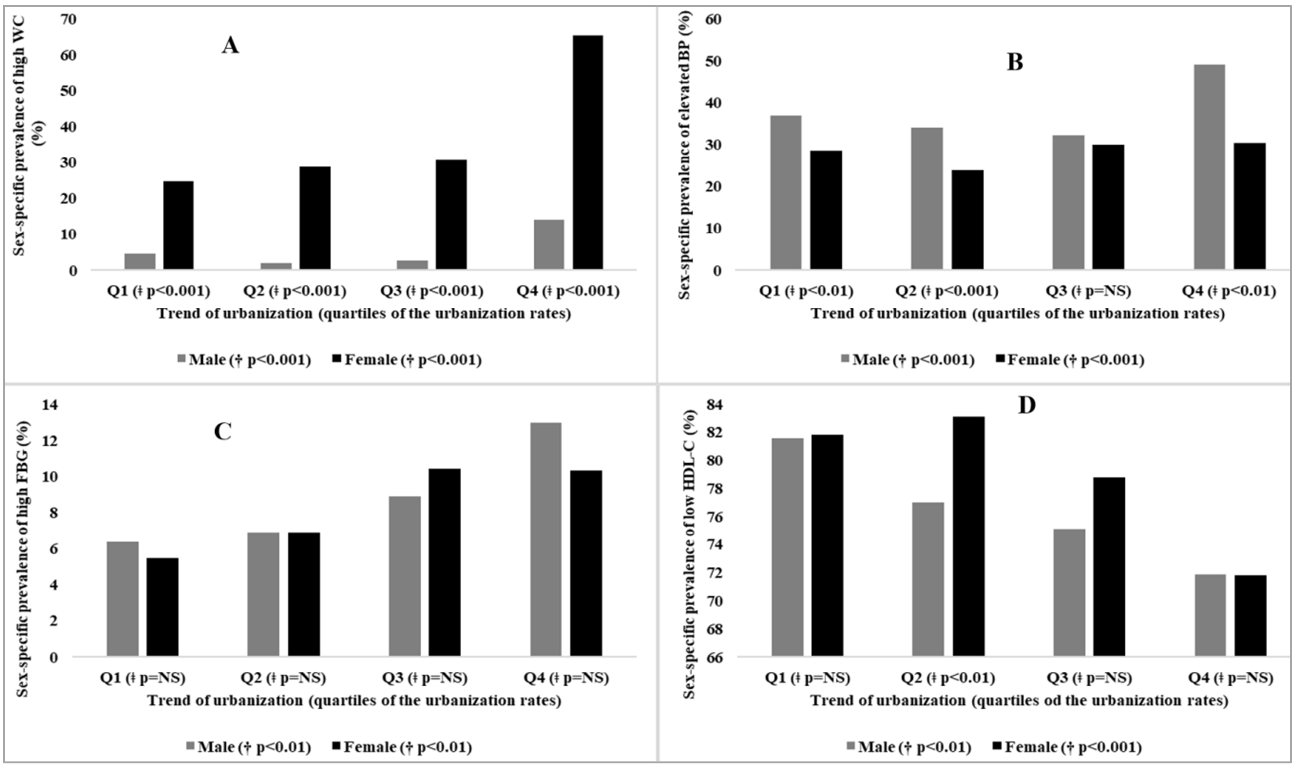

Figure 2. *Sex-specific prevalence of metabolic abnormalities (A: high waist circumference, B: elevated blood pressure, C: high fasting blood glucose, D: low high-density lipoprotein cholesterol) by the trend of urbanization.*

p: P-value, NS: Not Significant. ǂp: Comparison was performed between men and women within same quartile of the urbanization rate; †p-value: Comparison was performed between the four quartiles in only men, or in only women.

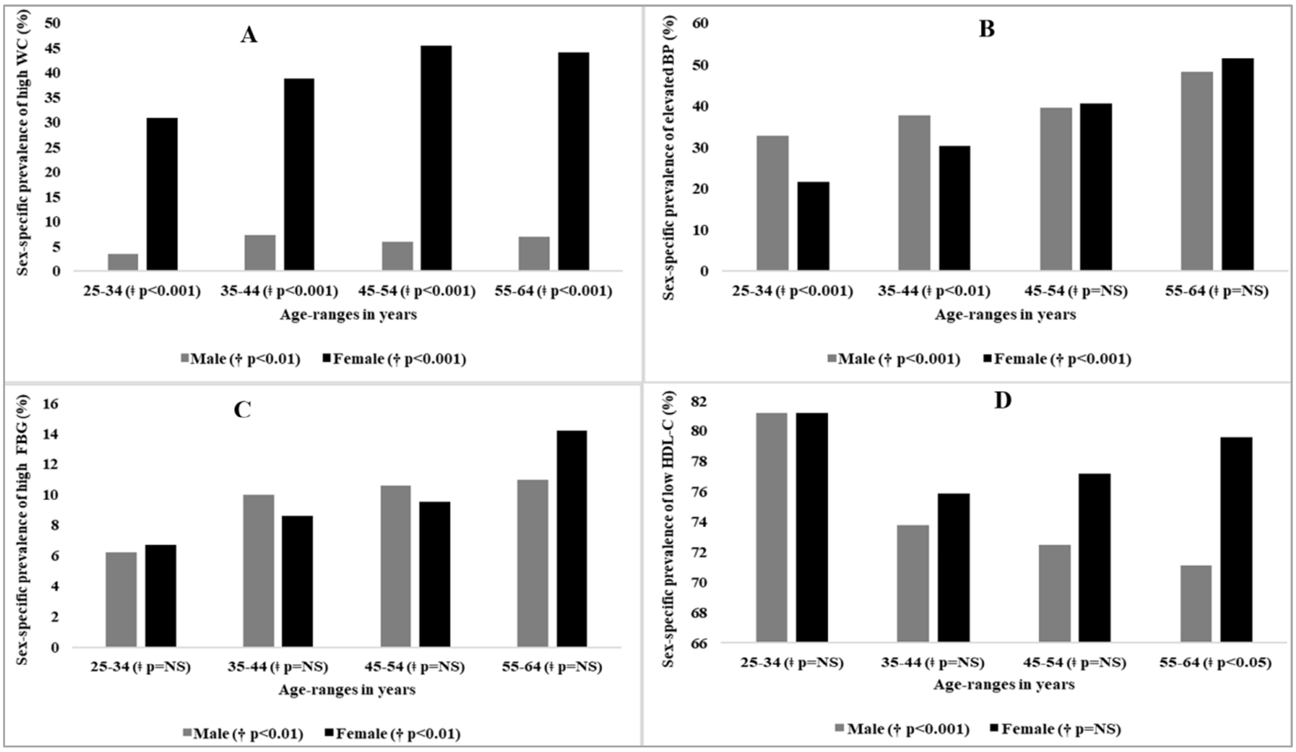

Figure 3. *Sex-specific prevalence of metabolic abnormalities (A: high waist circumference, B: elevated blood pressure, C: high fasting blood glucose, D: low high-density lipoprotein cholesterol) according to the four age-group.*

p: P-value, NS: Not Significant. ǂp: Comparison was performed between men and women in the same age-group; †p-value: Comparison was performed between the four age-groups in only men, or in only women.

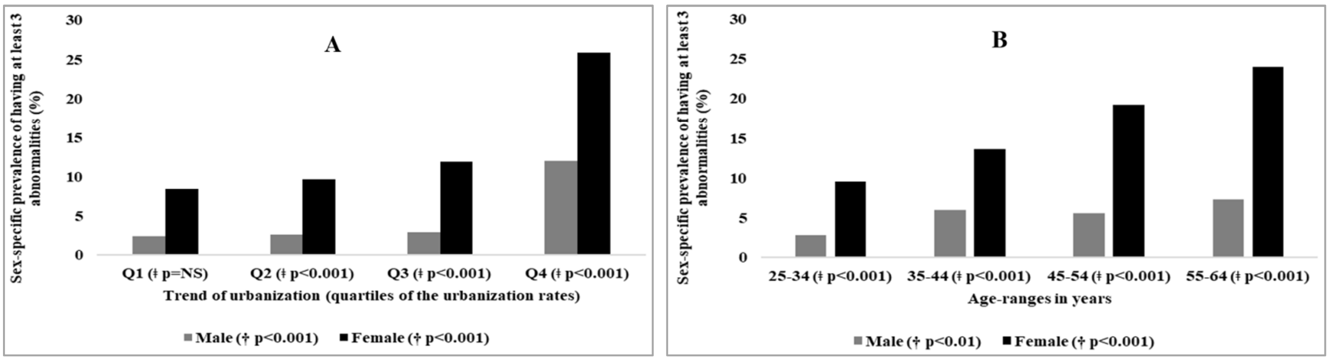

Figure 4. *Sex-specific prevalence of having at least three metabolic abnormalities, by the trend of urbanization (A); and age-group (B).*

ǂp: P-value when comparison was performed between men and women within the same age-group; †p: P-value when comparison was performed between the four age-groups in only men, or in only women.

Between the four age-groups, the sex-specific prevalences significantly differed, and the extreme values were: 71.9-81.6(♂), 71.8-83.1(♀) for the low HDL-C; 32.3-49.1(♂), 23.8-30.3(♀) for elevated BP; 2.0-14.0(♂), 24.8-65.3(♀) for high WC; 6.4-13.0 (♂), 5.5-10.4(♀) for high FBG; 2.5-12.0(♂), 8.5-25.8(♀) for those who cumulated at least three metabolic abnormalities. The change consisted in the gradually significant increase of the sex-specific prevalences from the youngest (25-34y) to oldest (55-64y) age-groups concerning high WC in both sexes, elevated BP in both sexes, high FBG in both sexes and having at least three abnormalities for only female gender (Figures 3A, 3B, 3C, 4B & Table 3).

However, the sex-specific prevalence of low HDL-C gradually decreased, especially in men, from Q1 to Q4, as from the youngest to oldest age-groups (Figures 2D, 3D & Table 3).

Table 2 describes the means number of metabolic abnormalities across quartiles and age-groups: In the quartiles, the extreme means in cumulative number of abnormalities were 1.3-1.5(♂) and 1.4-1.9(♀) while in age-groups, the means were 1.2-1.4(♂) and 1.4-1.9(♀) (Table 2). The change in the means number of abnormalities consisted in the gradually significant increase from Q1 to Q4, as well as the youngest to oldest age-groups in both sexes (Table 2).

4. Discussion

Low HDL-C was widespread in Burkina Faso. The means in number of abnormalities gradually increased from the lowest to highest urbanized settings, from the youngest to oldest age-groups, and the female gender frequently cumulated a great number of abnormalities.

4.1. Sex-Specific Prevalence of Low HDL-C

Low HDL cholesterol was widespread in Burkina Faso (Figure 2D, 3D), even in normal-weight individuals [19] and suggests a vulnerability to the accumulation of abnormal components for great number of people. Since low HDL-C was (after abdominal obesity) strongly associated with either MetS or cardiovascular events in SSA [24], its magnitude in Burkina Faso supports its ranking among key health issues by the national Public Health system. Furthermore, in rural area where food availability is more problematic [25], a lower mean in HDL-C has been described (0.9±0.5 vs. 1.1±0.5 mmol/l; p=0.0001) [23]. Public health interventions for low HDL-C reduction should consider both undernutrition especially in a low urbanized area and overweight/obesity in a high urbanized area.

4.2. Sex-Specific Prevalence of High WC

The pattern of high WC through the trend of urbanization (Figure 2A) also appears to be closely related to food availability in environment. Although food would be more available in a highly urbanized environment, this result suggests an inadequate use of food or the unhealthy consumption [26]. The environment of consumers influences global with abdominal obesity occurrence, as reported in Brazilian study [27]. The spectrum of the prevalence of Low HDL-C (gradual decrease inversely with the urbanization gradient especially in men) as that of high WC (especially in women), associated with its (high WC) overall pattern related to the BMI categories is compatible with the effect of the nutrition transition in LMICs, where accelerated urbanization induced change in lifestyle and dietary intake.

The wide gap in the prevalence of high WC between female and male gender at any age range (Figure 3A) seemed to be driven by the IDF cut-offs (94/80 cm for men/women) that may be nonoptimal for the SSA individuals [28]. The more shortened WC cut-offs of 81.2/81.0 cm for men/women were currently considered optimal in SSA [29], while 80/75 cm were recommended for Ghanaian [30]. The specific thresholds for the Burkinabé population are not available and should be highlighted.

4.3. Sex-Specific Prevalence of High FBG

In men as in women, the prevalence of high FBG increased with either urbanization gradient or age (Figures 2C, 3C) in accordance with the increase in glycemia with urbanization gradient among Peruvians (prevalence of diabetes was 0.8%, 3% and 6% for respectively rural, rural-to-urban migrants and urban Peruvians) [31] as in ascending age-groups (18-45, 46-55 and 56-65 years) of Chinese [32].

High FBG is a prediabetes state and reached 13.0/10.3% among men/women in Q4, and 11.0/14.2% in those aged 55-64y (Figures 2C, 3C) that indeed supports the need for epidemiological surveillance.

4.4. Sex-Specific Prevalence of Elevated BP

In both sexes, prevalence of elevated BP increased either with level of urbanization or age (Figures 2B & 3B). An increase in BP among urban residents (compared to rural or to semi-urban residents) was reported in Cameroonians [33], as an age dependency of peripheral and central BPs [34, 35]. In men, the pattern of the change in prevalence of the elevated BP with age (Figure 3B) was also closely to the spectrum reported in China [32]. The overall prevalence of hypertension (SBP/DBP≥140/90 mmHg or medication for hypertension) was considered to be low in Burkina Faso (18%) [21] but in Q4 and 55-64 age range, the respective prevalence of elevated BP in men/women reached 49.1/30.3% and 48.2/51.6%. The threshold we considered as elevated BP includes the prehypertension state, and measures to prevent hypertension development should be initiated in the context of urbanization and aging progress.

4.5. Cumulative Number of Metabolic Abnormalities

From Q1 to Q4 as from the youngest to oldest age-groups, the mean number of abnormal components significantly increased for both males (1.2 to 1.5) and females (1.4 to 1.9) (Table 2). In Nigerian communities, MetS (cumulating three among five components) progressively increased from rural (10%), semi-urban (18%) to urban (35.1%) areas [36, 37] and female was more affected [37]. This trend was similar to our description concerning change in sex-specific prevalence of having at least three abnormalities, according to the level of urbanization (Figure 4A & Table 3). In men/women, the change in the prevalence of participants with at least three abnormalities across age-groups (Figure 4B & Table 3) was closed to the spectrum of MetS prevalence described in men/women in Norway (basically urban) [38], in the city of Oran in Algeria [39], in urban Ethiopia [40], in the Black population of Cape town in South Africa [41] and in the city of North-Western Nigeria [37]. In men, the distribution of those with at least three abnormalities according to the age-groups mimicked the trend of raised BP and raised FGB (Figures 3B & 3C & 4B) in accordance with the finding in China [32]. In Q4 and 55-64y age-group respectively, the prevalence of those with at least three abnormalities in men/women reached 12.0/25.8% and 7.3/24.0% (Table 2) and targeting MetS reduction specially in older adult women or women living in high urbanized areas should be a priority.

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. Analysis should have included other relevant modifiable lifestyle behaviours such as oral hygiene practices, fruits and vegetables consumption, physical activity, psychological stress, sleep quality, etc. 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

The low HDL-C was very widespread in the general population in Burkina Faso, substantially increasing the risk of carrying several metabolic abnormalities, which worsened in high urbanized areas and in older adults, and women were more severely affected. The ongoing process of urbanization and demographic transition in Burkina Faso should alert on the increasing burden of cardiovascular diseases, and prompt to anticipate with preventive measures implementation, with women as the primary target.

Conflict of Interest Statement

The authors declare that they have no competing interest.

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