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Prevalence of metabolic syndrome and associated risk factors in the population of southern Benin

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Abstract

The metabolic syndrome is a set of abnormalities that increases the high risk in developing cardiovascular disease and type 2 diabetes. The objective of this study was to determine the prevalence of the metabolic syndrome in the population of southern Benin and associated risk factors. This was a prospective cross-sectional analytical study that ran from February 15, 2018 to May 15, 2018, including apparently healthy people aged 18 and over in four ethnic groups in southern Benin. Informed consent was obtained from each participant in the study. The metabolic syndrome has been defined according to the criteria of the International Diabetes Federation. The population consisted of 434 subjects. The average age was 40.62 ± 13.95 years old. 146 subjects or 33.64% were overweight with a female predominance (82.22% vs 17.78%, p = 0.0004). The prevalence of the metabolic syndrome was 17.1% with a female predominance (25.7% vs 6.6%, p = 0.000). Some ethnic groups are more affected than others (p = 0.031). Factors associated with the metabolic syndrome were: ethnic group, age, female sex, educational level, marital status, and physical inactivity, overweight, non-regular consumption of fruits and vegetables, and LDL hypercholesterolemia. The metabolic syndrome is a reality in the population of sub-Benin. Measures to handle the associated and predisposing factors will significantly reduce the prevalence of the metabolic syndrome and consequently, the risk of cardiovascular disease and the onset of type 2 diabetes.

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Introduction

Diet and lifestyle have a strong influence on the health of a population (Mbemba *et al.*, 2006). A diet high in fat and calories on the one hand and a sedentary lifestyle on the other hand favor the appearance of the metabolic syndrome (Procopiou and Philippe, 2005). A high carbohydrate diet is associated with an increased risk of metabolic syndrome (Park *et al*, 2003). The metabolic syndrome increases the high risk of developing cardiovascular disease and type 2 diabetes (Grundy *et al*, 2004; Gami *et al*, 2007) and exposes a significant number of other complications. It is recognized that having a metabolic syndrome increases the risk of T2D by a factor of 5 (Després *et al*, 2000; Grundy, 2006; Ford *et al*, 2008). According to the WHO (September 2011 report), more than 366 million people in the world are affected by diabetes, or about 8.3% of adults, and this number will reach more than 552 million by 2030. It is therefore considered as a major public health problem. The metabolic syndrome or insulin resistance syndrome (Alberti *et al*, 2009) is characterized by the presence of at least three of the following abnormalities: high blood pressure, low concentration of high density lipoprotein cholesterol (HDL-C) high triglycerides, hyperglycemia and abdominal obesity.

Its prevalence generally increases in both poor and developed countries (Lameira, Lejeune and Mourad, 2008). In the United States, a quarter of the population is affected by the metabolic syndrome (Ford, Giles and Mokdad, 2004).

In Europe, the metabolic syndrome is reported to affect one in four adults (Grundy, 2008). In Senegal, its prevalence is 15.7% (Pessinaba *et al*, 2013). In Burkina-Faso it is 10% and 12.3% according to the criteria of both the IDF and NCEP-ATP III respectively (Sawadogo *et al*, 2014).

In Benin, a study carried out in Porto-Novo revealed that the metabolic syndrome is common among HIV-infected patients on antiretroviral therapy (Adébayo *et al*, 2015). It suggests that prevention taking into account the associated and predisposing factors is necessary. It is in this context that a study of the prevalence of dyslipidemia based on biochemistry tests at Parakou University Hospital (Benin) revealed a very high prevalence of dyslipidemia and suggested that the general population should be carried out to identify the extent of these types of dyslipidemia in Benin (Gomina *et al*, 2016). Despite the scientific interest aroused by the metabolic syndrome due to the fact that it predisposes to type 2 diabetes and cardiovascular diseases, few studies have been devoted to this in Africa, particularly in Benin.

The objective of this work was to determine the prevalence of the metabolic syndrome in the population of southern Benin and associated risk factors.

Material and methods

Framework and period of study

Our study took place in Southern Benin in Ouémé and Plateau provinces from 15 February 2018 to 15 May 2018. The Avrankou municipality was selected in Ouémé and those of Ifangni and Sakété in Plateau province. The choice of municipalities was performed randomly. For each municipality selected, the survey took place in the public square of the central district.

Study population

The study population consisted of apparently healthy adults from Benin participating in the first study that is belonging to the target group on dietary habits (Sognigbé *et al*, 2019). The Goun, Tori, Nago and Yoruba ethnic groups were concerned.

Sampling

Of the 497 subjects initially included in the first study of dietary habits in southern Benin, a total of 434 subjects (237 women and 197 men) or 87.32% were found and were selected for this study. By setting a margin of error at 5% (standard value 0.05), a 95% confidence level (standard value 1.96) and a metabolic syndrome prevalence of 50%, a staff of 384 subjects was sufficient for this study as showed by SCHWARTZ formula:

$n = t^2 \times p\ (1 - p)\ /\ m^2$; where: n = sample size required; t = confidence level; p = estimated prevalence of the studied variable; m = margin of error.

These were participants included in the concerned study: all residents of the three municipalities, at least 18 years old, apparently healthy, who participated in the first survey of dietary habits. Not included were all subjects unable to provide sufficient information regarding the necessary data, pregnant women as well as subjects with a pathology leading to an increase in the abdominal perimeter (tumor, ascites, hernia) or who had not given their consent.

Variables of the study and their measurement

Dependent variable

The dependent variable in this study is the presence of metabolic syndrome and risk factors. The metabolic syndrome has been evaluated according to the criteria of the International Diabetes Federation (Zimmet *et al*, 2005; Alberti *et al*, 2009). These criteria are as follows: an abdominal perimeter ≥ 94 cm for men and ≥ 80 cm for women, this is the main criterion; blood pressure ≥130 / 85 mmHg or specific treatment for high blood pressure, fasting glycemia ≥1 g / L or specific treatment, fasting triglyceride ≥1.50 g / L or specific treatment and HDL cholesterol < 0.40 g / L for men and <0.50 g / L for women or specific treatment. The presence of the main criteria associated with two other ones defines the metabolic syndrome.

Independent variables

Independent variables: ethnicity, socio-demographic factors (age, sex, marital status and educational attainment), family history (diabetes, high blood pressure), clinical variables (weight, height, waist circumference, and blood pressure) and information on behavioral habits (alcohol, tobacco, physical activity ...), biochemical data related to the metabolic syndrome have been censused.

Data collection procedure

Blood pressure was taken with the seated person after 15 minutes of rest using an automatic digital sphygmomanometer with an armband (OMRON brand). It was taken to the naked right arm, placed on a table, palm facing upwards. Blood pressure is considered high when it is 130 / 85mmHg and more. Waist measurement was performed on participants in light clothing with a ribbon and assessed the anatomical distribution of body fat. Waist circumference was measured on the person standing midway between the anterior superior iliac spine and the last costal margin on the mid axillary line. Weight and height measurements were performed on people wearing light clothing and without shoes by a team of 3 people. The weight measurement was made on portable scales with a range of 120 kg (CAMRY brand). The measurement of the size was carried out by fences.

The BMI was calculated using Quetelet equation by the quotient Weight (in Kg) / Size squared (m^2). The breakdown of subjects by category of BMI was made according to the official classification accepted by the WHO: BMI <18.5 Undernutrition; 18.5 <BMI <24.9 Normal nutritional status; 25 <BMI <29.9 Excess weight and BMI ≥ 30 obesity (Yessoufou *et al*, 2015).

Paraclinical Variables: Blood samples were taken by superficial venipuncture at the elbow crease in fasted participants for 10 to 12 hours in tubes containing EDTA anticoagulant and in dry tubes.

The blood samples obtained (5 ml per tube) were stored in a cooler refrigerated at 4 ° C and then centrifuged in the next two hours. Plasma and serum were stored at -20 ° C at the Laboratory of Biochemistry and Molecular Biology at the Institute of Applied Biomedical Sciences (ISBA) in Cotonou, Benin. On the serum obtained, the enzymatic determination of biochemical parameters such as: total cholesterol, HDL-cholesterol, triglycerides, total proteins and glucose with reagent kits ELITECH Clinical Systems SAS (Cholesterol-Total (code: CHSL-0507), HDL cholesterol (code: HDLL-0380), triglycerides (code: TGML-0517) and glucose (code: GPSL-0507).

Total cholesterolemia more than 2 g/L is high; LDL cholesterol levels more than 1 g / L are high, HDL cholesterol levels below 0.5 g / L with women and lower than 0.4 g / L in humans are low, triglycerides greater than 1.5 g / L is high. Glycemia equal to equal to or more than 1.1 g / L was considered hyperglycemia.

Data analysis

The information collected was analyzed using Excel and R version 3.2.2 with the FactoMineR package. Quantitative data were presented by averages and their standard deviation (SD) and qualitative data by their size (n) and proportion (%). The Chi-square test was used for the comparison of the proportions and Fisher's exact test for that of averages. All statistical tests were considered significant when p is lower than 0.05.

Results

Sociodemographic, clinical and biological characteristics of the study population

A total of 434 subjects were included in this study in both departments. Among them 197 (45.39%) were male and 237 (54.61%) female with a sex ratio of 0.83. The average age of men was 39.3 ± 13.1 compared with 41.6 ± 14.6 for women. The average age of participants was 40.62 ± 13.95 with extremes of 18 to 80 years old (Table 1).

Table 1. Sociodemographic, clinical and biological characteristics of the population.

Settings	Male	Female	Total
Sociodemographic characteristics	(n= 197)	(n= 237)	(N= 434)
Average age (years)	39.3±13.1	41.6±14.6	40.6±13.9
Education level			
None	58 (29.44)	157 (66.24)	215 (49.54)
Primary	54 (27.41)	35 (14.77)	89 (20.51)
Secondary	60 (30.46)	43 (18.14)	103 (23.73)
Higher	25 (12.69)	2 (0.84)	27 (6.22)
Marital status			
Single	35 (17.77)	15 (6.33)	50 (11.52)
Married	159 (80.71)	192 (81.01)	351 (80.88)
Divorced or widowed	3 (1.52)	30 (12.66)	33 (7.60)
Ethnic group			
Goun	71 (36.04)	76 (32.07)	147 (33.87)
Tori	65 (32.99)	72 (30.38)	137 (31.57)
Nago	46 (23.35)	64 (27.00)	110 (25.35)
yoruba	15 (7.61)	25 (10.55)	40 (9.22)
Clinical features			
BMI (kg / m2)	22.8±3.8	24.7±5.3	23.9±4.8
WC (cm)	83.1±11.0	83.5±11.8	83.3±11.5
Biological characteristics			
Blood Sugar	0.9±0.2	0.8±0.2	0.8±0.2
Total cholesterol	1.5±0.4	1.6±0.4	1.6±0.4
HDL cholesterol	0.5±0.2	0.5±0.2	0.5±0.2
LDL cholesterol	0.8±0.4	0.9±0.4	0.9±0.4
Triglycerides	0.9±0.4	0.9±0.4	0.9±0.4

Data are indicated in Mean ± standard deviation and in number/percent (n(%)); Total cholesterol, HDL, LDL, triglycerides and glycaemia in g / l; BMI = Body Mass Index; WC = Waist circumference.

Distribution of subjects based upon BMI

The distribution of subjects according to BMI allowed to realize that 31 subjects (7.14%) were undernourished or malnourished, 257 subjects (59.22%) had a normal nutritional status, 101 (23.27%) were overweight and 45 subjects (10.37%) were obese (Fig. 1). So, overweight was found in 146 participants or 33.64%. The BMI average was 23.87 ± 4.79 kg / m2.

Table 2. Distribution of metabolic syndrome according ethnic group.

Ethnic group	Goun	Tori	Nago	Yoruba	Total
	n= 147	n= 137	n= 110	n= 40	n= 434
SMet +	21 (14.3)	19 (13.9)	21 (19.1)	13 (32.5)	74 (17.1)
SMet -	126 (85.7)	118 (86.1)	89 (80.9)	27 (67.5)	360 (82.9)

Data are indicated and inn (%); SMet + = presence of metabolic syndrome;
SMet - = absence of metabolic syndrome.

Individuals of both sexes have a statistically identical prevalence of overweight (58.42% and 41.58%, p = 0.380) while female individuals have a higher prevalence of obesity (82.22% vs. 17.78%). %; p = 0.0004) than men (Fig. 2). From the diagram of Fig. 3, it's found out that obesity is more obvious among Nago and Yoruba ethnic groups (p-value = 0.009).

Prevalence of metabolic syndrome according to IDF criteria

The prevalence of metabolic syndrome is 17.1% (74/434 subjects) in the population. Some ethnic groups are more affected than others, p = 0.031 (Table 2).

Environmental factors associated with metabolic syndrome

Table 3 summarizes the environmental factors associated with the metabolic syndrome in the population. Our results reveal that parameters such as age, sex, educational level, marital status, physical activity and BMI were risk factors associated with the occurrence of the metabolic syndrome with a very high statistically significant difference.

Table 3. Distribution of metabolic syndrome according to IDF criteria.

Parameters	Metabolic syndrome		
	Presence (n /%)	Absence (n /%)	p-value
Age < 40	18 (7.8)	212 (92.2)	0.000
Age ≥ 40	56 (27.5)	148 (72.5)	
Female	61 (25.7)	176 (74.3)	0.000
Male	13 (6.6)	184 (93.4)	
educated	23 (10.5)	196 (89.5)	0.000
Not educated	51 (23.7)	164 (76.3)	
married	67 (19.1)	284 (80.9)	0.020
Not married	7 (8.4)	76 (91.6)	
History of HBP	10 (14.5)	59 (85.5)	0.537
No history of HBP	64 (17.5)	301 (82.5)	
History of diabetes	1 (7.7)	12 (92.3)	0.362
No history of diabetes	73 (17.3)	348 (82.7)	
Regular physical activity	1 (2.3)	42 (97.7)	0.006
No regular physical activity	73 (18.7)	31 (81.3)	
BMI < 25 kg / m2	20 (6.9)	268 (93.1)	0.000
BMI ≥ 25 kg / m2	54 (37.0)	92 (63.0)	

Data are indicated in n (%); HBP = High Blood Pressure; BMI = Body Mass Index.

Nutritional factors associated with metabolic Syndrome

Table 4 summarizes the nutritional factors associated with the metabolic syndrome. The results from the table show a statistically significant difference in fruit and vegetable consumption and LDL hypercholesterolemia. These nutritional factors are therefore associated with the occurrence of the metabolic syndrome.

Table 4. Nutritional factors associated with metabolic syndrome.

Parameters	Metabolic syndrome		
	Presence (n /%)	Absence (n /%)	p-value
Alcohol consumption	37 (19.8)	150 (80.2)	0.187
No alcohol consumption	37 (15.0)	210 (85.0)	
Tobacco consumption	5 (19.2)	21 (80.8)	0.760
No smoking	69 (16.9)	33 (83.1)	
Regular consumption of fruits and vegetables	2 (4.6)	41 (95.4)	0.022
No regular consumption of fruits and vegetables	72 (18.4)	319 (81.6)	
Total hypercholesterolemia	15 (24.2)	47 (75.8)	0.106
No total hypercholesterolemia	59 (15.9)	313 (84.1)	
LDL hypercholesterolemia	41 (27.5)	108 (72.5)	0.000
No LDL hypercholesterolemia	33 (11.6)	252 (88.4)	

Predisposing factors to metabolic syndrome

Table 5 summarizes the predisposing factors for the metabolic syndrome. From the analysis of this table, it appears that all components of the metabolic syndrome predispose this study population.

Discussion

This study focuses on the metabolic syndrome and the associated risk factors in the population of southern Benin. It allowed to determine the prevalence of the metabolic syndrome according to the criteria of the International Federation of Diabetes as well as the risk and predisposition factors. To achieve this, we carried out a prospective study of transversal type for analytical purposes.

Females predominated (54.61%) with a sex ratio of 0.83. This female predominance had already been observed by Sognigbé *et al.*, (2019) who reported a prevalence of 53.92% with a sex ratio of 0.85 in the same population. Several other studies have reported a predominance of women in particular those of Dovonou *et al.* (2016) and Sawadogo *et al.* (2014) who indicated a prevalence of 55.17% and 71% respectively the study population was young with an average age of 40.62 ± 13.95. This youth of the study population was found in several studies. Indeed, in a study performed on subjects presumed healthy in Abidjan (Ivory Coast), Hauhouot-Attoungbre *et al.* reported an average age of 35 years (Hauhouot-Attoungbre *et al*, 2008). On the other hand, in Algeria, Zendjabil *et al* (2017) reported an average age of 52 ± 20 years, thus much higher than that of our study. Most participants were married (80.88%). This rate is similar to that reported by (Dovonou *et al*, 2016) (79.7%) but higher than that (53.7%) found by Janice *et al*, (2007) in California United States in 2007.

In our study 215 participants or 49.54% had no level of education. This rate is similar to that found by Sawadogo *et al*, (2014) in Burkina Faso, which reported a rate of 44.5%. The low level of education of our population could have an impact on the health of the population especially in the occurrence of the metabolic syndrome. Indeed, there is an inverse correlation between the level of education and the metabolic syndrome (Silventoinen *et al*, 2005).

Table 5. Predisposing factors for metabolic syndrome.

Parameters	Metabolic syndrome		
	Presence (n=74)	Absence (n= 360)	p-value
Abdominal obesity			
Man			
WC < 94 cm	0 (0.0)	154 (100.0)	1.662 10^{-12}
WC ≥ 94 cm	13(30.2)	30 (69.8)	
Women			
WC < 80 cm	0 (0.0)	86 (100.0)	7.93 10^{-12}
WC ≥ 80 cm	61(40.4)	90 (59.6)	
Hypertension			
Presence	63(37.1)	107 (62.9)	2.2 10^{-16}
Absence	11(4.2)	253 (95.8)	
hyperglycemia			
Presence	25(58.1)	18 (41.9)	4.417 10^{-14}
Absence	49(12.5)	342 (87.5)	
hypertriglyceridemia			
Presence	16 (51.6)	15 (48.2)	0.000
Absence	58 (14.4)	345 (85.6)	
HDL hypocholesterolemia			
Presence	60 (38.7)	95 (61.39	2.2 10^{-16}
Absence	14 (5.0)	265(95.0)	

Data are indicated in n (%); WC = waist circumference.

From the results of our study, overweight (BMI ≥25 kg / m2) and obese (BMI ≥ 30 kg / m2) subjects accounted for 23.27% and 10.37%, respectively. These frequencies of overweight are lower than those reported in the US and European series where the prevalence of overweight ranged from 30% to 62% and those of obesity from 18% to 32% (Pullinger *et al*, 2010). The sedentary lifestyle and high calorie diet explain this high prevalence of overweight in developed countries such as the United States, where obesity is a public health problem. Our study showed that females are more affected by obesity than men 8.76% vs. 1.61%, (p = 0.0004). The same observation was made by Bita Fouda *et al*, (2012) in Cameroon where obesity was present in 36.1% of women compared to 17.8% of men (p <0.05) and by Dugas *et al*, (2009) in South Africa where in semi-urban areas almost half of the women were overweight or obese whereas no man was. The increase in women's obesity may be due to their low level of education. Indeed, in 2000 in Cotonou, Acakpo *et al*, (2000) found the highest prevalence of obesity for people with a primary level (24.0%). Our results also showed a statistically significant difference in the prevalence of overweight and obesity across ethnic groups (p = 0.0004). This observation allows us to say that some ethnic groups are more affected than others.

The prevalence of metabolic syndrome in the population was 17.1%. This prevalence of metabolic syndrome according to the IDF is close to those of other authors using the same definition as Adébayo *et al.* (2015) and Tesfaye *et al.* (2014) who reported prevalences of 18.44% and 23.8%, respectively, but higher than those who respectively reported a prevalence of 10% and 12% (Zannou *et al*, 2009, Sawadogo *et al*, 2014). However, (Yessoufou *et al*, 2015) reported a higher prevalence of 79% with the same endpoints. This difference is explained by the fact that their study focused on obese patients, unlike ours, which focuses on apparently healthy people.

The distribution of this prevalence according to involve ethnic groups allowed us to note a disparity in the distribution (p = 0.031). This difference is explained by the inequality observed in the prevalence of overweight and obesity among ethnic groups, since obesity is considered as a key factor in the initiation and progression of the metabolic syndrome (Zimmet *et al*, 2005). Our study thus confirms several other studies that have reported that the metabolic syndrome varies by ethnicity (Ford, 2005; Kraja *et al*, 2005).

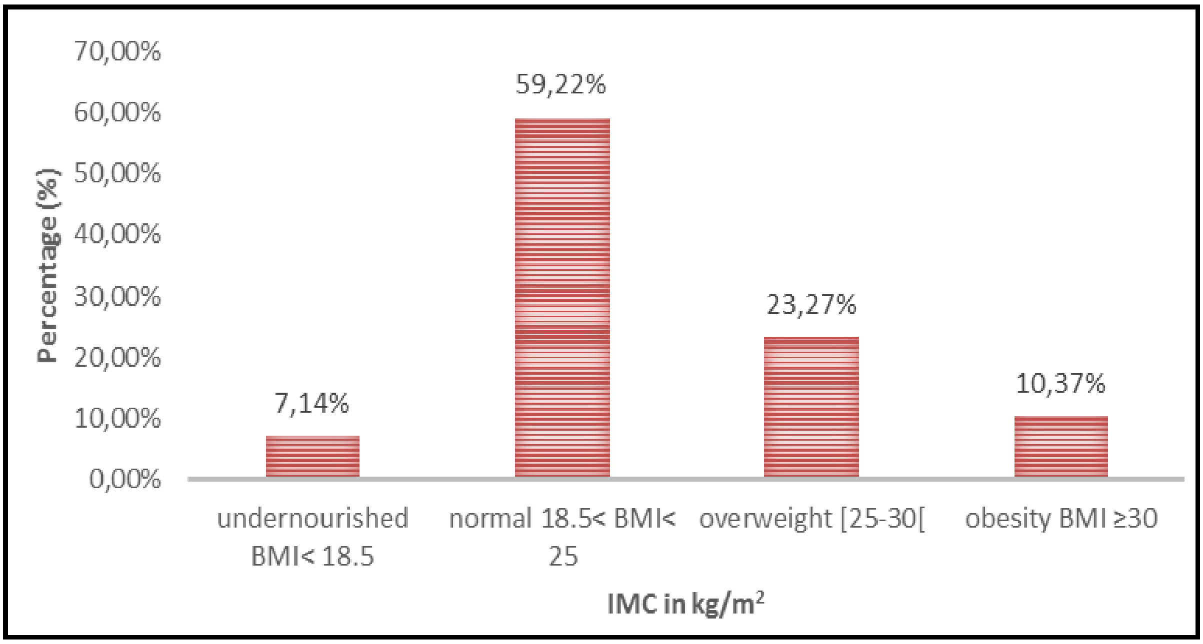

Fig. 1. BMI Distribution with Subjects.

The prevalence of the metabolic syndrome was high in subjects with an age of 40 years old or more, ie, 56/74 subjects (p = 0.000). This suggests that increasing age is a vulnerability of the metabolic syndrome. Numerous studies in the literature have shown the variability of the metabolic syndrome by age. Indeed, the frequency of occurrence of the metabolic syndrome is high in the advanced ages of life, which is probably related to the fact that these elderly people are sedentary and are exposed to complications related to diabetes and obesity.

This hypothesis is supported by several studies in the literature that have revealed that the prevalence of metabolic syndrome increases with age (Balkau *et al*, 2003, Cameron, Shaw and Zimmet, 2004; Eckel, Grundy and Zimmet, 2005). The metabolic syndrome is predominantly expressed in female subjects in our study (25.7% vs. 6.6%, p = 0.000).

This result is consistent with those who have shown a predominance of the female metabolic syndrome (Ford, 2005; Adébayo *et al*, 2015). On the other hand, it differs from those of Balkau *et al.* (2003) who showed a predominance of the metabolic syndrome with humans. The difference in prevalence of the metabolic syndrome between sexes can be explained by the difference in prevalence of each phenotype. In fact, high blood pressure, dyslipidemia and carbohydrate disorder are more common in men, while obesity seems more common in women (Hu *et al*, 2004). In addition, the different phenotypes of the metabolic syndrome may have a different impact on the appearance of the syndrome between men and women (Dallongeville *et al*, 2004).

The prevalence of metabolic syndrome was high among people with no education in our results (23.7% vs. 10.5%, p = 0.000).

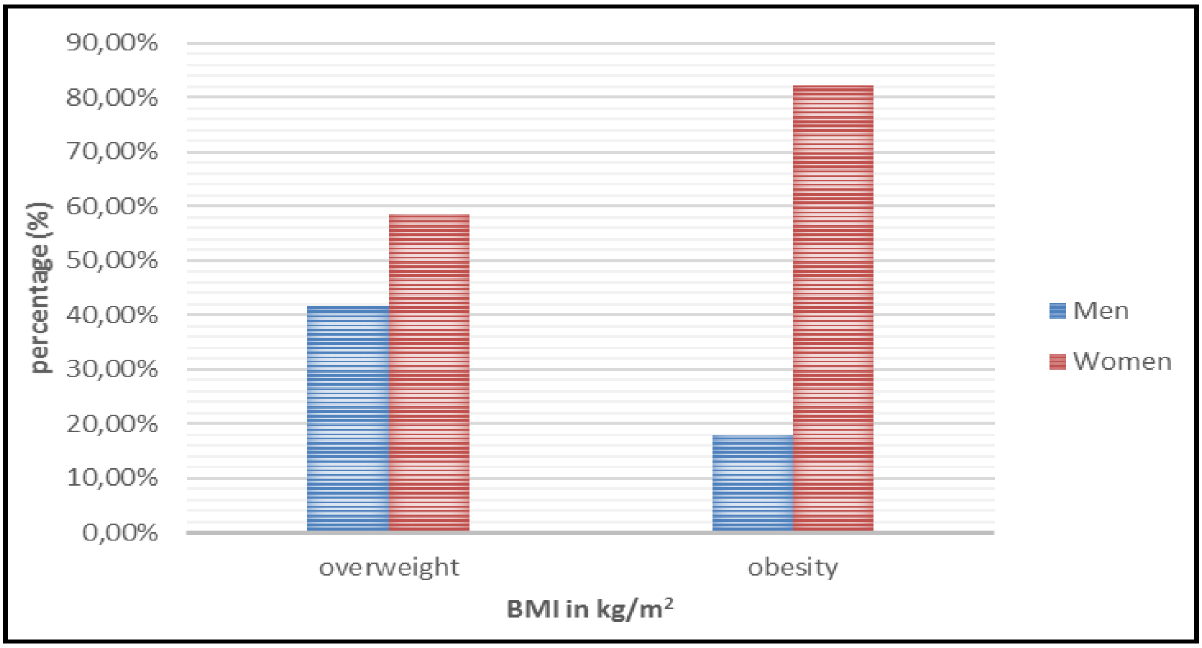

Fig. 2. BMI distribution among respondents by sex.

This result is consistent with that of Silventoinen *et al*, (2005) who reported in their work that there is an inverse correlation between education level and metabolic syndrome. Our study also reveals that married people and those not practicing regular physical activity are more affected by the metabolic syndrome. Lack of physical activity increases the risk of metabolic syndrome (Park *et al*, 2003; Dallongeville *et al*, 2004).

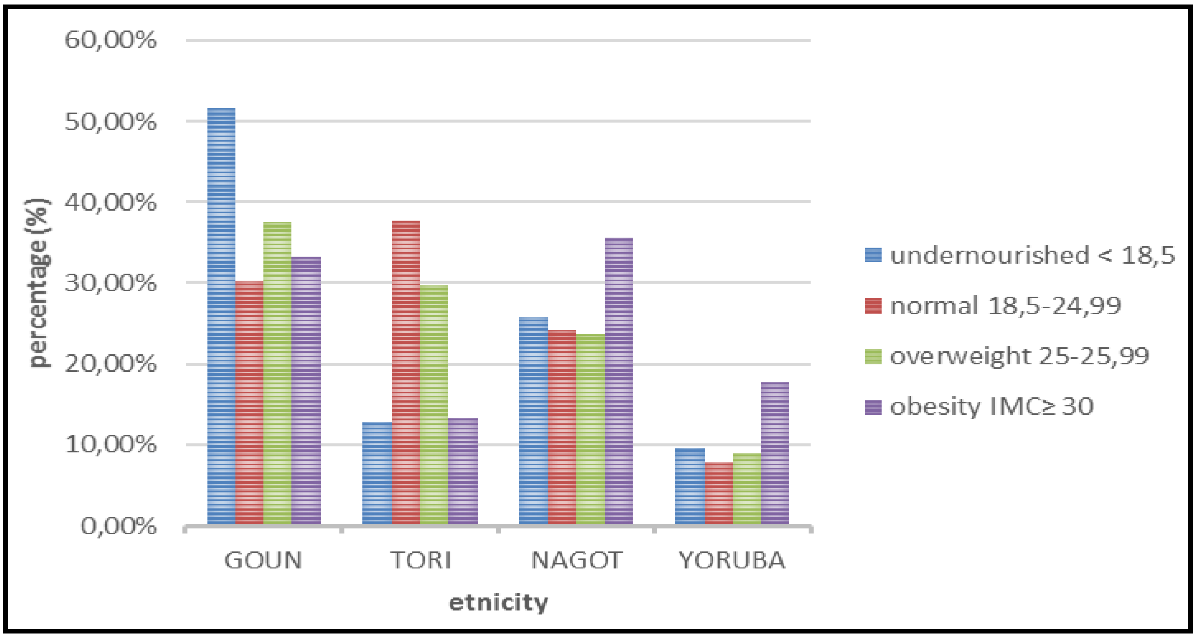

Fig. 3. BMI distribution among respondents by ethnicity**.**

BMI was higher with people with metabolic syndrome. The same observation was made by Ford *et al.* (2008). In fact, the adipose tissue of the obese produces pro inflammatory cytokines: TNFα, IL-1β and IL-6. The excessive production of TNFα observed in obese could play a central role in the development of the metabolic syndrome (Lyon, Law and Hsueh, 2003). The distribution of the metabolic syndrome according to the regular or non-regular consumption of fruits and vegetables per day shows a statistically significant difference (p = 0.02). Several studies had shown the influence of fruit consumption. Indeed, fruit consumption helps prevent obesity, improve glucose levels and lipid profile (Aleixandre and Miguel, 2008).

LDL hypercholesterolemia was associated with the metabolic syndrome in our study (p = 0.000). This result corroborates those studies which reported an association between LDL hypercholesterolemia and metabolic syndrome (Wu *et al*, 2012, Adébayo *et al*, 2015). Our results also reveal that all components of the metabolic syndrome were predisposing factors to the metabolic syndrome. This finding is consistent with those made by Adébayo *et al*, (2015).

Conclusion

The metabolic syndrome is a reality in the southern Benin study population; its prevalence was 17.1%. Factors associated with the metabolic syndrome were ethnicity, age, female sex, educational level, marital status, physical inactivity, overweight, non-regular consumption of fruits and vegetables and high cholesterol LDL. Predisposing factors for the metabolic syndrome were high blood pressure, elevated waist circumference, hyperglycemia, HDL hypocholesterolemia and hypertriglyceridemia. A study of the genetic susceptibility to the metabolic syndrome in this study population will better define the measures of management of various risk factors to significantly reduce the metabolic syndrome and consequently the risk of cardiovascular disease and the occurrence type 2 diabetes.

References

Acakpo A, Fayomi B, Djrolo F, Kolanowski J, Agueh V, Makoutode M. 2000. Prévalence et étude des facteurs déterminants de l'obésité à Cotonou. Louvain médical **119,** 276–81.

Adébayo A, Albert D. C, Ericie S, Angelo AC, Jules G, Armand W, Gabriel A. 2015. Prevalence, associated and predisposing factors of metabolic syndrome among people living with HIV on antiretroviral treatment in Porto Novo in 2014. The Pan African medical journal **22,** 296.
https://doi.org/10.11604/pamj.2015.22.296.7923

Alberti KG, MM, Eckel RH, Grundy SM, Zimmet PZ, Cleeman JI, Donato KA, Smith SC. 2009. Harmonizing the metabolic syndrome: A joint interim statement of the international diabetes federation task force on epidemiology and prevention; National heart, lung, and blood institute; American heart association; World heart federation; International. Circulation **120(16),** 1640–1645.
https://doi.org/10.1161/CIRCULATIONAHA.109.192644

Aleixandre A, Miguel M. 2008. Dietary fiber in the prevention and treatment of metabolic syndrome: A review. Critical Reviews in Food Science and Nutrition **48(10),** 905–912.
https://doi.org/10.1080/10408390701761886

Balkau B, Vernay M, Mhamdi L, Novak M, Arondel D, Vol S, Eschwège E. 2003. National Cholesterol Education Program (NCEP). Diabetes Metabolism, **S(29),** 526–532.
https://doi.org/10.4135/9781412963855.n821

Bita Fouda A, Lemogoum D, Owona Manga J, Dissongo J, Tobbit R, Ngounou Moyo D. 2012. Epidemiology of obesity in the work milieu, Douala, Cameroon. Revue Médicale Bruxelle **33,** 131–7.

Cameron AJ, Shaw JE, Zimmet PZ. 2004. The metabolic syndrome: Prevalence in worldwide populations. Endocrinology and Metabolism Clinics of North America **33(2),** 351–375.
https://doi.org/10.1016/j.ecl.2004.03.005

Dallongeville J, Cottel D, Arveiler D, Tauber J. P, Bingham A, Wagner A, Amouyel P. 2004. The Association of Metabolic Disorders with the Metabolic Syndrome Is Different in Men and Women. Annals of Nutrition and Metabolism **48(1),** 43–50.
https://doi.org/10.1159/000075304

Després J, Couillard C, Gagnon J, Bergeron J, Leon A, Rao DC, Bouchard C. 2000. Race, visceral adipose tissue, plasma lipids, and lipoprotein lipase activity in men and women: The health, risk factors, exercise training, and genetics (HERITAGE) family study. Arteriosclerosis, Thrombosis and Vascular Biology **20(8),** 1932–1938. https://doi.org/10.1161/01.ATV.20.8.1932

Dovonou C, Gounongbe F, Hinson A, Alassani C, Attinsounon C, Tognon F, Fayomi B. 2016. Etude Des Facteurs De Risque De L'obésité Chez Le Personnel Du CHUD/Borgou à Parakou (Bénin) en 2013. European Scientific Journal, ESJ **12(15),** 384. https://doi.org/10.19044/esj.2016.v12n15p384

Dugas LR, Carstens MA, Ebersole K, Schoeller DA, Durazo-Arvizu RA, Lambert EV, Luke A. 2009. Energy expenditure in young adult urban informal settlement dwellers in South Africa. European Journal of Clinical Nutrition **63(6),** 805–807. https://doi.org/10.1038/ejcn.2008.75

Eckel RH, Grundy SM, Zimmet PZ. 2005. The metabolic syndrome Robert. Lancet **365,** 1415–28. https://doi.org/10.1093/alcalc/agx075

Ford ES. 2005. Prevalence of the Metabolic Syndrome Defined by the International Diabetes. Diabetes Care, **28(11),** 2745–2749. Opgehaal van http://care.diabetesjournals.org/cgi/content/abstract/28/11/2745

Ford ES, Giles WH, Mokdad AH. 2004. Increasing prevalence of the metabolic syndrome among U.S. adults. Diabetes Care **27(10),** 2444–2449. https://doi.org/10.2337/diacare.27.10.2444

Ford ES, Li C, Sattar N, Glasgow B. 2008. Metabolic Syndrome and Incident Diabetes Current state of the evidence and the org/licenses/by-nc-nd/3.0/ for details. Diabetes Care **31(9).** https://doi.org/10.2337/dc08-0423

Gami AS, Witt BJ, Howard DE, Erwin PJ, Gami LA, Somers VK, Montori VM. 2007. Metabolic Syndrome and Risk of Incident Cardiovascular Events and Death. A Systematic Review and Meta-Analysis of Longitudinal Studies. Journal of the American College of Cardiology, **49(4),** 403–414. https://doi.org/10.1016/j.jacc.2006.09.032

Gomina M, Alassani A, Codjo L, Dovonou A, Akpona S. 2016. Prevalence of Dyslipidemia on the Basis of Biochemistry Tests in the Parakou University Teaching Hospital (Benin). British Biotechnology Journal, **16(2),** 1–8. https://doi.org/10.9734/bbj/2016/28362

Grundy SM. 2006. Metabolic syndrome: Connecting and reconciling cardiovascular and diabetes worlds. Journal of the American College of Cardiology **47(6),** 1093–1100. https://doi.org/10.1016/j.jacc.2005.11.046

Grundy SM. 2008. Metabolic syndrome pandemic. Arteriosclerosis, Thrombosis and Vascular Biology, **28(4),** 629–636. https://doi.org/10.1161/ATVBAHA.107.151092

Grundy SM, Brewer HB, Cleeman JI, Smith S. C, Lenfant C. 2004. Definition of Metabolic Syndrome: Report of the National Heart, Lung, and Blood Institute/American Heart Association Conference on Scientific Issues Related to Definition. Circulation, **109(3),** 433–438. https://doi.org/10.1161/01.CIR.0000111245.75752.C6

Hauhouot-Attoungbre ML, Yayo SE, Ake-Edjeme A, Yapi HF, Ahibo H, Monnet D. 2008. Le syndrome métabolique existe-t-il en Côte d'Ivoire ? Immuno-Analyse et Biologie Specialisee, **23(6),** 375–378. https://doi.org/10.1016/j.immbio.2008.10.002

Hu G, Qiao Q, Tuomilehto J, Balkau B, Borch-Johnsen K, Pyorala K. 2004. Prevalence of the metabolic syndrome and its relation to all-cause and cardiovascular mortality in nondiabetic European men and women. Archives of Internal Medicine, **164(10),** 1066–1076. https://doi.org/10.1001/archinte.164.10.1066

Janice BV, Hee-Soon J, Juhee C, Elisa RMM. 2007. Factors Associated With Overweight and Obesity Among Mexican Americans and Central Americans: Results From the 2001 California Health Interview Survey. Centers for Disease Control and Prevention. www.cdc.gov/pcd/issues/2007/jan/06_00.36.htm

Kraja AT, Rao DC, Weder AB, Cooper R, Curb JD, Hanis CL, Province MA. 2005. Two major QTLs and several others relate to factors of metabolic syndrome in the family blood pressure program. Hypertension **46(4),** 751–758. https://doi.org/10.1161/01.HYP.0000184249.20016.

Lameira D, Lejeune S, Mourad JJ. 2008. Le syndrome métabolique : son épidémiologie et ses risques. Annales de Dermatologie et de Venereologie, **135(4),** 249–253. https://doi.org/10.1016/S0151-9638(08)70543-X

Lyon CJ, Law RE, Hsueh WA. 2003. Minireview: Adiposity, inflammation, and atherogenesis. Endocrinology **144(6),** 2195–2200. https://doi.org/10.1210/en.2003-0285

Mbemba F, Mabiala-Babela JR, Massamba A, Senga P. 2006. Profil alimentaire de l'écolier à Brazzaville, Congo. Archives de Pediatrie, **13(7),** 1022–1028. https://doi.org/10.1016/j.arcped.2006.03.143

Park YW, Zhu S, Palaniappan L, Heshka S, Carnethon MR. 2003. The metabolic syndrome: prevalence and associated risk factors findings in the US population from the Third National Health and Nutrition Examination Survey, 1988-1994. Archive International.Medical **163,** 427–436.

Pessinaba S, Mbaye A, Yabéta GAD, Harouna H, Sib AE, Kane AD, Kane A. 2013. Prevalence survey of cardiovascular risk factors in the general population in St. Louis (Senegal). Annales de Cardiologie et d'Angeiologie **62(4),** 253–258. https://doi.org/10.1016/j.ancard.2013.02.005

Procopiou M, Philippe J. 2005. The metabolic syndrome and type 2 diabetes: Epidemiological figures and country specificities. Cerebrovascular Diseases **20(1),** 2–8. https://doi.org/10.1159/000088231

Pullinger CR, Aouizerat BE, Gay C, Coggins T, Movsesyan I, Davis H, Lee KA. 2010. Metabolic abnormalities and coronary heart disease risk in human immunodeficiency virus-infected adults. Metabolic Syndrome and Related Disorders **8(3),** 279–286. https://doi.org/10.1089/met.2009.0094

Sawadogo A, Sanou S, Hema A, Kamboule B. E, Kabore NF, Sore I, Sawadogo AB. 2014. Syndrome métabolique et risque cardiovasculaire chez des patients sous antirétroviraux à l'hôpital de jour de Bobo-Dioulasso (Burkina Faso). Bulletin de la Societe de Pathologie Exotique **107(3),** 151–158. https://doi.org/10.1007/s13149-014-0371-8

Silventoinen K, Pankow J, Jousilahti P, Hu G, Toumilehto J. 2005. Educational inequalities in the metabolic syndrome and coronary heart disease among middle-aged men and women. International Journal of Epidemiology **34(2),** 327–334. https://doi.org/10.1093/ije/dyi007

Sognigbé GB, Chabi Nicodème Worou, Avocèfohoun SA, Kohonou NA, Konfo TRC, Sina H, Noumavo AP, Dah Nouvlessounon D, Baba-Moussa L. 2019. Comparative study of the food habits of populations in southern Benin. International Journal of Current Research in Biosciences and Plant Biology **6(6),** 1–8. https://doi.org/https://doi.org/10.20546/ijcrbp.2019.606.001.

Tesfaye DY, Kinde S, Medhin G, Megerssa Y. C, Tadewos A, Tadesse E, Shimelis T. 2014. Burden of metabolic syndrome among HIV-infected patients in Southern Ethiopia. Diabetes and Metabolic Syndrome: Clinical Research and Reviews, **8(2),** 102–107. https://doi.org/10.1016/j.dsx.2014.04.008

Wu PY, Hung CC, Liu WC, Hsieh CY, Sun HY, Lu CL, Chien KL. 2012. Metabolic syndrome among HIV-infected Taiwanese patients in the era of highly active antiretroviral therapy: Prevalence and associated factors. Journal of Antimicrobial Chemotherapy **67(4),** 1001–1009. https://doi.org/10.1093/jac/dkr558

Yessoufou AG, Behanzin J, Djihoumeto E, Isstina ZA, Ahokpe M, Sezan A. 2015. Aspects épidémiologiques du syndrome métabolique au sein de la population obèse de la Commune Ouidah au Sud-ouest du Bénin Epidemiological aspects of metabolic syndrome in the obese population of the municipality of Ouidah in southwestern Benin. 111–116. Opgehaal van. www.didac.ehu.es/antropo

Zannou DM, Denoeud L, Lacombe K, Amoussou-Guenou D, Bashi J, Akakpo J. 2009. Incidence of lipodystrophy and metabolic disorders in patients starting non-nucleoside reverse transcriptase inhibitors in Benin. Antiviral Therapy, **14(3),** 371–380.

Zendjabil M, Abbou O, Chellouai Z. 2017. Association entre syndrome métabolique et hyperhomocystéinémie dans une population algérienne. Annales Pharmaceutiques Francaises, **75(1),** 54–58. https://doi.org/10.1016/j.pharma.2016.05.001

Zimmet PZ, Magliano D, Matsuzawa Y, Alberti G, Shaw J. 2005. The metabolic syndrome: a global public health problem and a new definition. Journal of atherosclerosis and thrombosis **12(6),** 295–300. https://doi.org/10.5551/jat.12.295