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Research Article

Metabolic Syndrome according to Three Definitions in Hammam-Sousse Sahloul Heart Study: A City Based Tunisian Study

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Objectives. Metabolic syndrome (MetS) is a major risk factor of CVD. The aim of the present study is to determine the prevalence of the MetS, its components, and its different profiles according to NCEP-ATP III 2001, IDF 2005, and JIS 2009 definitions in Hammam-Sousse Sahloul Heart Study (HSHS). *Study Design*. The study involved 1121 participants (364 men and 757 women; sex-ratio = 0.48; mean age = 47.49 ± 16.24 years) living in Hammam Sousse city, located in the east of Tunisia. *Methods*. Anthropometric parameters, blood pressure, lipids levels, glycemia, insulinemia, and body mass index were measured. Statistical analyses were performed by SPSS16.0. *Results*. The percentage of participants who had MetS defined according to NCEP ATP III, IDF 2005, and JIS 2009 definitions was respectively, 29.5%, 38.4%, and 39.6%. With regard to gender, the prevalence of MetS is higher in men than in women according to IDF 2005 definition (38.5% men versus 38.3% women, $P = 0.961$) and according to JIS 2009 definition (41.8% men versus 38.6% women, $P = 0.307$), whereas, according to NCEP ATP III definition, the prevalence of MetS is higher in women than in men (30% versus 28.6%, $P = 0.627$). The prevalence of MetS increased with increasing age according to the three definitions ($P < 0.001$) and peaked in the oldest age group (≥70 years) according to IDF 2005 and JIS 2009. Furthermore, a significant difference in the prevalence of MetS components according to gender was observed. Indeed, the abdominal obesity is the most frequent MetS compound in women group, but hypertension and low HDL-C are the most frequent in men. In addition, according to the three definitions, the most frequent MetS profile in our study is "higher waist circumference, hypertension, and low HDL-C." *Conclusion*. The high prevalence of MetS is a serious public health problem in Hammam-Sousse Sahloul community. Higher waist circumference, hypertension, and low HDL-C were the most frequent profile in our study.

1. Introduction

Several risk factors of cardiovascular diseases (CVD), including abdominal obesity, elevated fasting blood glucose, elevated triglycerides, elevated blood pressure, and low high-density lipoprotein (HDL) cholesterol, tend to cluster in individuals [1]. The simultaneous presence of three or more of these factors has been termed the metabolic syndrome (MetS) and is known to promote the development of CVD and type 2 diabetes [2–4]. MetS has become a major worldwide public health problem [5].

Several sets of criteria have been established for the detection of MetS, where many of them have been continually updated. The set of criteria, most commonly used in the past, was published in the Third Report of National Cholesterol Education Program Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults Treatment Panel III (NCEP-ATP III 2001) and they have proposed diagnostic criteria for MetS and cut-off points for its components (abdominal obesity, hypertension, increased level of triglycerides and fasting blood glucose, and low level of HDL-C) [6]. In 2005, the International Diabetes Federation

recommended a new definition of metabolic syndrome, the IDF definition [7]. Recently, A joint interim statement (JIS 2009) of the International Diabetes Federation Task Force on Epidemiology and Prevention (National Heart, Lung, and Blood Institute; American Heart Association; World Heart Federation; International Atherosclerosis Society; and International Association for the Study of Obesity) collaborated to release a unified set of criteria [8].

The estimated prevalence of MetS has varied due to the variability of the evaluated population, such as the ethnic group, the gender, and the age, and due to the diagnostic criteria [9].

Among 8,608 noninstitutionalized civilian population of the US aged ≥20 years, the age-adjusted prevalence was 23.9% using the ATP III definition and 25.1% using the WHO definition. Among all participants, 86.2% were classified as either having or not having the MetS under both definitions [5]. According to NCEP ATP III 2001 definition, the prevalence of MetS is 32.3% in the Americans [10], 31.6% in the Indians [11], and 33.1% in the Iranians [12].

In Europe, numerous small studies suggest significant geographical variations, with the prevalence among the nondiabetic population which was estimated at 25.9% in men and 23.4% in women (DECODE Study Group) [13] and the French DESIR study reported that the prevalence of MetS was 10% [14]. The prevalence of MetS in United States, according to the National Health and Nutrition Examination Survey (NHANES) in 2003–2006, was 34% [15].

In Tunisia and as a result of economic growth and its associated sociodemographic changes, the burden of CVD and risk factors has been increased [16]. At present, only three studies have investigated the prevalence of MetS, [17–19]. Bouguerra et al. reported that the prevalence of MetS, by using the definition of the NCEP ATPIII [18], was 16.3% and Allal-Elasmi et al. reported that the prevalence of MetS, according to NCEP ATPIII definition [19], was 31.2%. Harzallah et al. reported that, using the IDF criteria, the prevalence was found to be 45.5%, 28.7% according to WHO 1999 definition, and 24.3% according to NECP ATPIII2001 definition [17]. The studies reported by Harzallah et al. [17] and Bouguerra et al. [18] were now out of date. The study of Bouguerra et al. [18] has important limitations; the principal one is the nonmeasurement of HDL-C and the second one is the poor response rate of men.

The results of the different studies change according to the adopted definition. The objective of the present report is to estimate the prevalence of the MetS and its compounds by age and by sex in Hammam-Sousse Sahloul Heart Study (HSHS), a city based Tunisian study, according to NCEP-ATP III 2001, IDF 2005 definition, and JIS 2009 definitions.

2. Materials and Methods

2.1. Study Population. The HSHS is an epidemiological population study type "community based" in cardiovascular risks with very broad research aims. Hammam Sousse city (the governorate of Sousse, Tunisia), located in the east of Tunisia, included a population of 35 000 people. The HSHS was led with a sample of 1000 households (33 clusters ∗ 33 households) of the city of Hammam Sousse, from February to June 2009, and drawn lots by the technique of sampling in clusters in two degrees and in proportional probability. All people present at home the day of the investigation, aged 20 years or more, were included in the study.

The main purpose of the HSHS is to study the impact of lifestyle factors and metabolic perturbations on aspects of health, such as the quality of life, the prevalence of MetS, obesity, hypertension, and type 2 diabetes, and the incidence of chronic diseases.

A structured questionnaire was completed to the all members of the household. Anthropometric, demographic, and socioeconomic data were obtained for each subject including age, gender and marital status, level of education, occupation, household income, reproductive history in women, and family and personal history of obesity, diabetes, hypertension, and CVD. Also data on lifestyle, including physical exercise, dietary intake, smoking habits, and frequency of alcohol consumption, were collected.

We calculated the size of the sample by reference to the following hypothesis:

(i) a confidence level of 95%,

(ii) an estimated prevalence of 50%,

(iii) a precision of 3%.

So, an optimal sample size of 1111 subjects using the following equation [20] $n = [z^2(pq/\Delta^2)k]$ has been determined (z = reduced gap; p = prevalence; $q = 1 - p$; Δ = precision; k = cluster coefficient).

2.2. Anthropometric Parameters and Blood Pressure Measurements. Weight and height were measured on the subjects barefooted and lightly clothed. Waist circumference (WC) was measured by trained examiner from the narrowest point between the lower borders of the rib cage and the iliac crest.

Blood pressure was read three times from the left arm of seated subjects with a blood pressure monitor after 20 minutes of rest. The average of the two last measurements was recorded for each subject.

2.3. Biochemical Measurements. Blood samples were collected from subjects after 12 hours of overnight fast. Serum total cholesterol (TC) and triglycerides (TG) were determined by standard assays. HDL-C was measured by direct assay. Low density lipoprotein-cholesterol (LDL-C) concentrations were calculated with the Friedewald formula [21] if TG < 4 mmol/L. If not, LDL-C concentrations were measured by direct assay. Fasting glucose was measured by the glucose oxidase method. All biochemical parameters were performed on the Synchron CX7 Clinical System using the Beckman reagents (Beckman Coulter, Fullerton, CA, USA).

2.4. Definitions of Risk Factors. Diabetes mellitus was defined as fasting glucose more than 7 mmol/L or currently receiving antidiabetic medication [22]. Hypertension was defined as greater than 140/90 mmHg or currently of antihypertensive

medication [23]. Dyslipidemia was defined as LDL-C concentration more than or equal to 4.1 mmoL/L and/or HDL-C concentration less than or equal to 1 mmoL/L and/or triglyceride concentration more than or equal to 1.71 mmoL/L [24]. MetS was defined according to NCEP-ATP III 2001 definition [6], IDF 2005 definition [7], and JIS 2009 definition [8] (Table 7).

2.5. Statistical Analysis. Statistical analyses were performed by SPSS version 16. The quantitative results were reported as means ± SD and were compared by Student's t-test to equal variance if the distribution is Gaussian; if the distribution is not Gaussian, the quantitative results were reported as median [min–max] and comparedby the nonparametric test; Mann-Whitney U test is used. The qualitative variables have been compared by the test of Chi deux and were expressed in effective (n) and in percentage (%). The MetS prevalence, according to the three used definitions, has been measured after adjustment according to the class of age and sex and the weights of these different strata in the structure of the population, according to the population census in 2004 (http://www.tunisie-statistiques.tn). A P value of <0.05 was considered statistically significant for all tests.

3. Results

3.1. Sociodemographic and Clinical Characteristics. 1441 subjects completed the interview. We excluded 320 people who did not complete physical examination and/or biologic specimen collection. We thus included 1121 participants with complete data in this analysis. The study was approved by the Medical Hospital Ethic Committee and informed consent was obtained from all study subjects.

The sociodemographic and clinical characteristics of the study population are presented in Table 1.

Our study included 1121 subjects recruited in HSHS. This group was composed of 364 men and 757 women, the sex-ratio was 0.48 and the mean age was 47.5 ± 16.25 years. The most frequent pathologies in our population were hypertension (20.7%), type 2 diabetes (12.9%), CVD (10.9%), and dyslipidemia (8.9%).

3.2. Prevalence of MetS. Table 2 shows the prevalence of MetS in general population and by age group and gender, according to the three definitions.

With regard to gender, the prevalence of MetS is higher in men than in women according to IDF 2005 definition (38.5% men versus 38.3% women) and according to JIS 2009 definition (41.8% men versus 38.6% women), whereas, according to NCEP ATP III definition, the prevalence of MetS is higher in women than in men (30% versus 28.6%). After an adjustment to age brackets, according to the population census in 2004, this prevalence does not significantly change.

The prevalence of MetS increased with the increasing age according to the three definitions ($P < 0.001$). The prevalence of MetS peaked in the oldest age group (≥70 years) according to IDF 2005 and JIS 2009 definitions, but we noted a light regression of the MetS prevalence from 70 years according to NCEP ATP III definition. Indeed we pass from 57.4% of MetS subjects within the elderly of 60–69 years to 55.8% among the elderly ≥70 years.

The percentage of participants who had MetS defined according to NCEP ATP III definition was 29.5%, according to IDF 2005 definition was 38.4%, and according to JIS 2009

Table 1: Sociodemographic and clinical characteristics of the study subjects n (%).

Variables	Results
Age tranches	
20–29	174 (15.5)
30–39	198 (17.7)
40–49	272 (24.3)
50–59	211 (18.8)
60–69	137 (12.2)
≥70	129 (11.5)
Sex-ratio M/W and Tabac	0.48
Men	364 (32.5)
Women	757 (67.5)
Tabac	139 (12.4)
Civil status	
Married	785 (70)
Single	211 (18.8)
Divorcee	21 (1.9)
Widower	102 (9.1)
Imprecise	2 (0.2)
Academic level	
Illiterate	199 (17.8)
Primary school	404 (36)
Middle school (college)	73 (6.5)
High school	257 (22.9)
Superior (higher education)	147 (13.1)
Diploma after universities	41 (3.7)
Professional activity	
Senior official of the state	18 (1.6)
Employee of the state	85 (7.6)
High executive in the private	27 (2.4)
Employee on the private	147 (13.1)
Independent	63 (5.6)
Worker	83 (7.4)
Student/high school student	63 (5.6)
Retired man	89 (7.9)
Housewife	486 (43.4)
Unemployed person	36 (3.2)
Disabled person	18 (1.6)
Imprecise	6 (0.5)
Known diseases	
Diabetes	145 (12.9)
Hypertension	232 (20.7)
Dyslipidemia	100 (8.9)
Dysthyroidia	50 (4.5)
CVD	122 (10.9)

Table 2: Prevalence of MetS in general population and by age group and gender according to NCEP ATP III 2001 [6], IDF 2005 [7], and JIS 2009 [8] definitions.

	NCEP ATP III 2001 [6] *n* (%)	IDF 2005 [7] *n* (%)	JIS 2009 [8] *n* (%)
Gender			
Men (n = 364)	104 (28.6%)	140 (38.5%)	152 (41.8%)
	103 (28.20%)**	113 (31.19%)**	111 (30.68%)**
Women (n = 757)	227 (30%)	290 (38.3%)	292 (38.6%)
	190 (25.13%)**	203 (26.79%)**	202 (26.75%)**
P	*0.627*	*0.961*	*0.307*
Age groups			
20–29 (n = 174)	12 (6.9%)	22 (12.7%)	22 (12.7%)
30–39 (n = 198)	25 (12.6%)	40 (20.2%)	41 (20.7%)
40–49 (n = 272)	55 (20.3%)	88 (32.5%)	91 (33.6%)
50–59 (n = 211)	88 (41.9%)	114 (54.3%)	118 (56.2%)
60–69 (n = 137)	78 (57.4%)	83 (60.3%)	86 (63.2%)
≥70 (n = 129)	72 (55.8%)	83 (64.3%)	85 (65.9%)
P	***<0.001***	***<0.001***	***<0.001***
General population (n = 1121)	331 (29.5%)	430 (38.4%)	444 (39.6%)
	314 (28.01%)*	398 (35.5%)*	391 (34.87%)*

*Adjusted to human gender and the class of age according to the census of the population in 2004.
**Adjusted to class of age according to the census of the population in 2004.

definition was 39.6%. After an adjustment to human gender and age brackets, according to the population census in 2004, this prevalence does not significantly change.

3.3. Prevalence of Various MetS Components. Limits are the same as IDF 2005 and JIS 2009, so all their results are reported together in further analyses.

3.3.1. Prevalence of Various MetS Components in General Population and by Gender according to the Three Definitions. Table 3 shows, according to the three definitions, the prevalence of various components of MetS in the general population and by gender. Subjects presented a high waist circumference were 74.4% according to IDF 2005 and JIS 2009 definitions and 54% according to NCEP ATP III definition. So, high waist circumference is the most frequent component of MetS according to IDF 2005 and JIS 2009 definitions, whereas, according to NCEP ATP III definition, low HDL-C represented the most frequent component of MetS (62.5%). Whatever the adopted definition, hypertension, hypertriglyceridemia, and hyperglycemia prevalence were significantly higher in men, but in women the prevalence of abdominal obesity was higher.

3.3.2. Prevalence of Various MetS Components in Men and by Age Group according to the Three Definitions. Table 4 shows the prevalence of various MetS components in men and by age group, according to the three definitions. In MetS group, as defined by the three definitions, all components of MetS increased significantly with age except low HDL-C and hypertriglyceridemia.

3.3.3. Prevalence of Various MetS Components in Women and by Age Group according to Three Definitions. Table 5 shows the prevalence of various components of MetS in women and by age group, according to the three definitions. All components of MetS except low HDL-C increased, according to age.

3.4. Repartition of MetS Subjects according to the Number of Associated Criteria. We noted that the majority of the subjects with MetS had an association of 3 criteria (62.3%, 60.5%, and 62%, resp., according to the definitions of the NCEP ATP III 2001, IDF 2005, and JIS 2009) followed by an association of 4 criteria (29.6%, 30.4%, and 29.4%) and finally an association of 5 criteria (8.2%, 9.1%, and 8.7%) (Figure 1).

3.5. Prevalence of Various Profiles of MetS by Age according to the Three Definitions. We noted that "high waist circumference, hypertension, and low HDL-C" were the most frequent profile according to NCEP ATP III definition (28.9%), IDF 2005 definition (45.5%), and JIS 2009 definition (44.1%) in the group aged between 20 and 59 years. In the group aged ≥60 years, the most abundant profile combined "high waist circumference, hyperglycemia, hypertension, and low HDL-C" according to IDF 2005 definition (33.9%), NCEP ATP III definition (28%), and JIS 2009 definition (32.7%) (Table 6).

Whatever the adopted definition is, the most frequent profile in the studied population was "high waist circumference, hypertension, and low HDL-C" (38.1%, 36.9%, and 25.4%, resp., according to IDF 2005, JIS 2009, and NCEP ATP III definitions) followed by "high waist circumference, hyperglycemia, hypertension, and low HDL-C" (22.1%, 21.4%, and

Table 3: Prevalence of various components of MetS in general population and by gender according to NCEP ATP III 2001 [6], IDF 2005 [7], and JIS 2009 [8] definitions.

	Higher WC *n* (%)	Hypertension *n* (%)	Hypertriglyceridemia *n* (%)	Low HDL-C *n* (%)	Hyperglycemia *n* (%)
IDF 2005 [7] and JIS 2009** [8]					
General population (n = 1121)	834 (74.4)	614 (54.8)	114 (10.2)	695 (62)	265 (23.7)
Men (n = 364)	204 (56)	238 (65.4)	56 (15.3)	232 (63.7)	101 (27.7)
Women (n = 757)	628 (83)	374 (49.4)	58 (7.7)	462 (61.1)	164 (21.7)
P^*	***<0.0001***	***<0.0001***	***0.0001***	*0.380*	***0.028***
NCEP ATP III 2001 [6]					
General population (n = 1121)	605 (54)	443 (39.5)	114 (10.2)	701 (62.5)	266 (23.7)
Men (n = 364)	101 (27.9)	163 (44.8)	56 (15.3)	239 (65.6)	101 (27.7)
Women (n = 757)	506 (66.9)	278 (36.8)	58 (7.7)	462 (61.1)	164 (21.7)
P^*	***<0.0001***	***0.003***	***0.0001***	*0.135*	***0.028***

*Comparison of prevalence of studied component according to gender.
**Limits are the same as from IDF 2005 [7] and JIS 2009 [8] so their results are reported together.

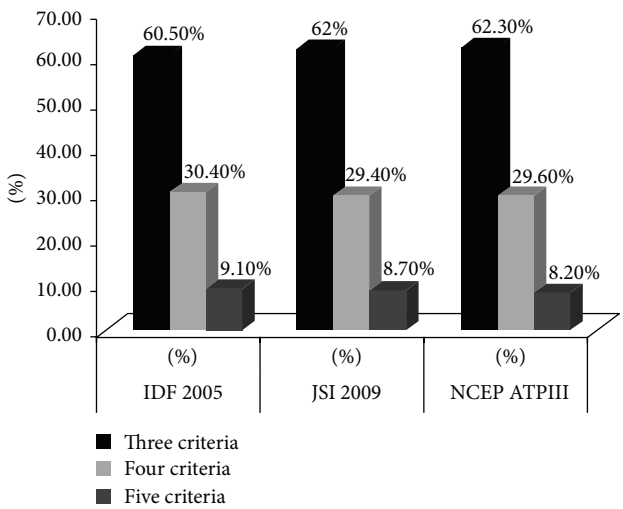

Figure 1: Repartition of MetS subjects according the number of associated criteria and according to IDF 2005, JIS 2009, and NCEP ATP III 2001 definitions.

19.6%, resp., according to IDF 2005, JIS 2009, and NCEP ATP III definitions).

4. Discussion

4.1. Prevalence of MetS. In our study, the prevalence of MetS was 29.5% (NCEP ATPIII), 38.4% (IDF 2005), and 39.6% (JIS 2009). Prevalence of MetS is higher considering the definitions of the IDF 2005 and JIS 2009 compared to NCEP ATP III 2001 definition. This can be explained by decreased waist circumference thresholds measurement and decreased blood glucose limits in the definitions of IDF2005 and JIS 2009. The JIS 2009 definition includes more patients than the IDF 2005 definition, because, contrary to this last one, it does not impose "the increased waist circumference measurement" as indispensable criteria to the diagnosis of MetS. Moreover, numerous studies showed that the prevalence of MetS was more important with the definition of IDF 2005 in comparison with NCEP ATPIII 2001 definition [25–27].

Previous realized studies, in 1996 and between 2004 and 2005, on a population of Tunis [18, 19], including, respectively, 2927 adults of 20 and more years old and 2712 individuals from 35 to 70 years old, reported that the prevalence of MetS is 16.3%, using the definition of the NCEP ATPIII [18] and 31.2%, according to NCEP ATPIII definition [19]. Harzallah et al. reported, in Arab men and women aged > or = 40 years living in Tunis, that the prevalence of the MetS using the IDF criteria was found to be 45.5% and 28.7% according to WHO 1999 definition and 24.3% according to NECP ATPIII2001 definition; thus, the MetS prevalence increased using IDF 2005 criteria compared to WHO 1999 and NCEP ATP III 2001 definitions [17].

A recent analysis, of the transverse data of almost 10000 subjects of Greek general population by comparing 4 definitions, showed that the prevalence of MetS was much more raised with the definitions of IDF 2005 and JIS 2009 with regard to NCEP ATPIII and AHA/NHLBI [26].

The prevalence of MetS in our study is similar to those reported in the other populations according to the same definition NCEP ATP III 2001 definition: Tunis (31.2%) [19], United States (32.3%) [10], India (31.6%) [28], and Iran (33.1%) [29].

Concerning the prevalence of MetS according to the gender, we did not observe significant difference. This absence of association was reported in other studies made in United States [30, 31], in Greece [32], and in Korea [33]. Moreover, the increased prevalence of MetS in the women group was found in two Tunisian studies cited previously [18, 19]. However the increased prevalence in the men group was found in the French study DESIRE [14].

As regards the study of the MetS prevalence and according to the age brackets, we noted that the prevalence of MetS increased with increasing age according to the three definitions. Following the NCEP ATPIII 2001 definition, the MetS prevalence passes from 6.9%, within subjects between

Table 4: Prevalence of various components of MetS in men and by age group according to NCEP ATP III 2001 [6], IDF 2005 [7], and JIS 2009 [8] definitions.

	Age groups	Higher WC %	Hypertension %	Hypertriglyceridemia %	Low HDL-C %	Hyperglycemia %
IDF 2005 [7] and JIS 2009* [8]	20–29 years	37.9	43.5	7.1	70	7.3
	30–39 years	56.6	41.6	18.2	69.5	9.2
	40–49 years	53.4	61.5	17.2	60	24.1
	50–59 years	63.2	73	19.4	68.2	33.7
	60–69 years	57.6	84.7	8.7	50	45.7
	≥70 years	62.1	90.3	14	62.3	49.1
	Total	56	64	15.3	63.9	27.7
	P	***0.046***	***<0.0001***	*0.262*	*0.254*	***<0.0001***
NCEP ATP III 2001 [6]	20–29 years	20.7	17.7	7.1	74	7.3
	30–39 years	18.4	18.2	18.2	69.5	9.2
	40–49 years	27.2	37.5	17.2	61.3	24.1
	50–59 years	31.6	56.5	19.4	71.6	33.7
	60–69 years	33.9	69.5	8.7	50	45.7
	≥70 years	36.2	71	14	64.2	49.1
	Total	28.6	44.7	15.3	65.8	27.7
	P	0.121	***<0.0001***	*0.262*	*0.116*	***<0.0001***

*Limits are the same as from IDF 2005 [7] and JIS 2009 [8] so their results are reported together.

Table 5: Prevalence of various components of MetS in women and by age group according to NCEP ATP III 2001 [6], IDF 2005 [7], and JIS 2009 [8] definitions.

	Age groups	Higher WC %	Hypertension %	Hypertriglyceridemia %	Low HDL-C %	Hyperglycemia %
IDF 2005 [7] and JIS 2009* [8]	20–29 years	53.2	14.2	2.8	56.6	6.3
	30–39 years	78.3	17.5	3.1	66.9	7.5
	40–49 years	87.6	44.8	5.2	61.3	15
	50–59 years	94.7	75.8	12.8	64.6	30.3
	60–69 years	99.1	85.1	16	57	46.5
	≥70 years	94.9	94.1	13.3	59	46.1
	Total	83.5	50.6	7.7	61.3	21.7
	P	***<0.0001***	***<0.0001***	***<0.0001***	*0.460*	***<0.0001***
NCEP ATP III 2001 [6]	20–29 years	28.2	11.7	2.8	56.6	6.3
	30–39 years	55.6	12	3.1	66.9	7.5
	40–49 years	66.4	24.9	5.2	61.3	15
	50–59 years	85.5	54.2	12.8	64.6	30.3
	60–69 years	93	71.1	16	57	46.5
	≥70 years	88.9	84.2	13.3	59	46.1
	Total	66.6	36.7	7.7	61.3	21.7
	P	***<0.0001***	***<0.0001***	***<0.0001***	*0.460*	***<0.0001***

*Limits are the same as from IDF 2005 [7] and JIS 2009 [8] so their results are reported together.

20 and 29 years old, to 55.8%, within subjects aged more than 70 years old. Similar results were reported in the NHANES study, where the MetS prevalence passes from 6.7%, in the group of participants between 20 and 29 years old, to 42%, in the group of participants aged more than 70 years old [34]. Other studies found this increased prevalence of the MetS, according to stratification by age [18, 19, 35, 36].

4.2. Prevalence of Various Components of MetS. In the present study, the abdominal obesity constitutes the most frequent anomaly in the women group while in the men group the most observed anomaly is the low HDL-C, according to NCEP ATPIII 2001 definition, and hypertension, according to IDF 2005 and JIS 2009. In other Tunisian studies based on NCEP ATPIII 2001 [18, 19] and according to Bouguerra et al. [18], the hypertension is the most frequently anomaly in men and women groups. Allal-Elasmi et al. [19] showed that abdominal obesity is the most frequent component of MetS in women group, but hypertension is the most frequent one in men group.

However, similar results were observed in a study made on 1121 Jordanians aged 25 years or more [37]. This study

Table 6: Prevalence of various profiles of MetS by age according to the 3 definitions.

Various profiles	IDF 2005 [7]		JIS 2009 [8]		NCEP ATP III 2001 [6]	
	20–59 years %	60 years %	20–59 years %	60 years %	20–59 years %	60 years %
1	6.8	13.3	6.6	12.9	7.2	10
2	—	—	0.4	0.6	1.1	4
3	—	—	1.8	2.3	6.1	7.3
4	14.8	**33.9**	14.3	**32.7**	12.8	**28**
5	7.2	3	7	2.9	3.9	1.3
6	0.4	1.8	0.4	1.8	0	1.3
7	1.9	0.6	1.8	0.6	3.3	2
8	0.4	0	0.4	0	0.6	0.7
9	5.3	0	8.5	1.8	15	6.7
10	8.7	1.8	5.1	0	7.2	1.3
11	1.5	1.2	1.5	1.2	1.1	1.3
12	—	—	0.4	0	2.2	0
13	**45.5**	26.7	**44.1**	25.7	**28.9**	21.3
14	7.6	17.6	7.4	17	6.7	14
15	—	—	0	0.6	0.6	0
16	—	—	0.4	0	3.3	0.7
P	***<0.0001***		***<0.0001***		***<0.0001***	

1: higher WC + hypertriglyceridemia + hyperglycemia + low HDL-C + hypertension; **2**: hypertriglyceridemia + hyperglycemia + low HDL-C + hypertension; **3**: hyperglycemia + low HDL-C + hypertension; **4**: higher WC + hyperglycemia + low HDL-C + hypertension; **5**: higher WC + hypertriglyceridemia + low HDL-C + hypertension; **6**: higher WC + hypertriglyceridemia + hyperglycemia + hypertension; **7**: higher WC + hypertriglyceridemia + hyperglycemia + low HDL-C; **8**: higher WC + hypertriglyceridemia + hyperglycemia; **9**: higher WC + hyperglycemia + low HDL-C; **10**: higher WC + hypertriglyceridemia + low HDL-C; **11**: higher WC + hypertriglyceridemia + hypertension; **12**: hypertriglyceridemia + hyperglycemia + low HDL-C; **13**: higher WC + low HDL-C + hypertension; **14**: higher WC + hyperglycemia + hypertension; **15**: hypertriglyceridemia + hyperglycemia + hypertension; **16**: hypertriglyceridemia + low HDL-C + hypertension.

Table 7: Definitions of MetS.

	NCEP ATP III [6]	IDF 2005 definition [7]	JIS 2009 [8]
Abnormalities	MetS was defined as having three or more of the following abnormalities	Participant was defined as having the MetS if he or she had central obesity plus two or more of following criteria. To define central obesity, we used the criteria of Europeans	Three of the following 5 criteria of IDF 2005 [7] should be met to qualify for metabolic syndrome although central obesity is not an obligatory component
Waist circumference	>102 cm in men and >88 cm in women	≥94 cm in men and ≥80 cm in women	≥94 cm in men and ≥80 cm in women
Serum triglycerides	≥150 mg/dL (1.69 mmoL/L)	>1.7 mmol/L (150 mg/dL)	>1.7 mmol/L (150 mg/dL)
HDL-cholesterol	<40 mg/dL (1.04 mmoL/L) in men and <50 mg/dL (1.29 mmoL/L) in women	<1.03 mmol/L (40 mg/dL) in men and <1.29 mmol/L (50 mg/dL) in women	<1.03 mmol/L (40 mg/dL) in men and <1.29 mmol/L (50 mg/dL) in women
Systolic and/or diastolic blood pressure	≥130 mmHg ≥85 mmHg or on treatment for hypertension	>130 mmHg >85 mmHg or previously diagnosed hypertension	>130 mmHg >85 mmHg or previously diagnosed hypertension
Fasting serum glucose	≥110 mg/dL (6.1 mmoL/L) or on treatment for diabetes	>5.6 mmol/L (100 mg/dL) or previously diagnosed type 2 diabetes mellitus	>5.6 mmol/L (100 mg/dL) or previously diagnosed type 2 diabetes mellitus

revealed that the abdominal obesity was the most component found in women with 60.7% and low HDL-C represented the most frequent anomaly in men (61.5 %) [37]. In addition, a strong prevalence of low HDL-C in men is coherent with those reported in American Arabic population [38] and in Oman [39].

Thus, we noted that the abdominal obesity is much more present in women than in men; this is in agreement with the previous studies made on the Tunisian population [18, 19]. This importance of the abdominal obesity frequency in women could be explained by the repeated pregnancies and the changes of the lifestyle such as food habits and lack of

physical and sports activities in Tunisian women [16]. In fact, in Tunisia, there is a passage from the traditional food habits with a food rich in cereal, fruits, and vegetables to food rich in animal products with high quantities of saturated fatty acids [40].

Furthermore, studies made in the other Arabic populations showed an increased frequency of the abdominal obesity in women. Indeed, a study made on Moroccan women showed that 75% of those women presented an abdominal obesity [41]. Al-Lawati et al., in the Omani population, reported that prevalence of abdominal obesity was more raised in woman (44.3%) than in men (4.7%) [36]. In France, according to the DESIRE study, abdominal obesity is not the frequent compound, but it stays all the same, higher in women (13.3%) than in men (7.9%) [14].

By stratification according to gender and age group, we also noted that the prevalence of abdominal obesity, hypertension, and hyperglycemia increased significantly with the age in men, while in women all MetS components, except low HDL-C, increased significantly with the age.

Khader et al. [37] also observed in Jordanian men that abdominal obesity, hypertension, and hyperglycemia were the only components which increased significantly with the age. In addition, many studies suggested that all the components of MetS were significantly more frequent in the group aged more than 40 years compared to the group aged <40 years, independently of the sex [14, 18, 30, 34, 40].

4.3. Prevalence of the Metabolic Syndrome according to the Number of Associated Criteria. In our study and according to the three definitions, the MetS subjects were mainly represented by an association with 3 criteria, followed by 4 criteria, and finally by an association of 5 criteria. Our results concurred to the study of Hanefeld et al., in a diabetic type 2 population, who showed that 35.3%, 27.2%, and 4.4% of the subjects had an association of 3, 4, and 5 criteria of MetS, defined by AHA/NHBLI definition [42]. The study GEMCAS realized in Germany showed that 66%, 27.6%, and 6% in men and 64%, 28%, and 8% in women present, respectively, 3, 4, and 5 criteria of MetS [43]. In Tunisia, a study, concerning 90 diabetic patients aged more than 40 years old, showed that 46.7% of those with MetS had an association of 4 criteria and only 8% of the patients presented all the criteria of MetS, according to IDF 2005 definition [44].

4.4. Prevalence of Various Profiles of MetS. According to the three definitions of MetS, the most frequent profile in our study is "higher WC, hypertension, and low HDL-C" After stratification our population according to gender, we noted the same results, whereas the most frequent profile change by stratification according to age and becomes "higher WC, hyperglycemia, hypertension, and low HDL-C" in group aged ≥60 years.

This difference can be explained by the decrease of the insulin secretion and the increase of insulin resistance in the skeletal muscle of the elderly [45], so higher frequency of the hyperglycemia was observed in subjects aged more than 60 years.

A recent study, realized on a German population using the AHA/NHLBI definition, found that the most frequent profile of MetS was "higher WC, hypertension, and low HDL-C" (28%). They also demonstrated that the profiles varied according to age and gender. In fact, the most frequent profile in young men was "higher WC, hypertension, and hypertriglyceridemia," while in young women it was "higher WC, hypertension, and low HDL-C." Within the elderly and among both genders the most frequent profile was "higher WC, hypertension, and hyperglycemia" [43]. In addition, Thanopoulou et al. showed that the most frequent profile of MetS in 5 populations living in different countries (Algeria, Bulgaria, Egypt, Italy, and Greece) was "higher WC, hypertension, and low HDL-C" [46]. Furthermore, Van Den Hooven et al. contradicted our results; they reported that the most frequent profile of MetS was "higher WC, hypertension, and hypertriglyceridemia" (43.7 %) in 500 patients between 40 and 60 years old [47].

Our study has several limitations, including the small sample size, because we have many absent subjects in the day of the collects. The study was led in an urban area which made it difficult to compare the MetS prevalence with those found in rural areas and consequently the extrapolation of our results to populations living in rural areas. The call for a random sample of the households ends in the composition of a population of study, with feminine ascendancy and essentially old persons. We may have underestimated the MetS prevalence because we excluded, from analysis, people with incomplete data; those were more likely to be low income or overweight.

5. Conclusion

We noted a higher prevalence of MetS in our population, where it passes from 29.5% (NCEP ATPII) to 39.6% (JIS 2009). This prevalence increases with age and does not seem to depend on the gender. Moreover, a significant difference in the prevalence of MetS components, according to gender, was observed. Indeed, the abdominal obesity is the most frequent MetS compound in women but hypertension and low HDL-C are the most frequent one in men. In addition, according to the three definitions of MetS, the most frequent profile in our study is "higher WC, hypertension, and low HDL-C."

Conflict of Interests

The authors declare that there is no conflict of interests regarding the publication of this paper.

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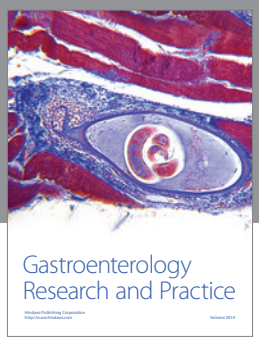

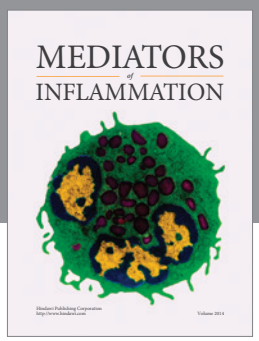

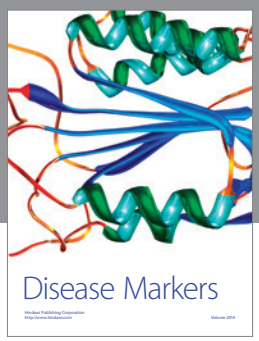

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