Hyperhomocysteinemia, coronary heart disease, and diabetes mellitus as predicted by various definitions for metabolic syndrome in a hypertensive Saudi population

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ABSTRACT

Objectives: From the emergence of different definitions of metabolic syndrome (MS) we aim to determine the prevalence of such a condition among hypertensive Saudi population and to identify which definition can best assess the risk of hyperhomocysteinemia, coronary heart disease (CHD), and diabetes mellitus.

Methods: In this cross-sectional study, we studied 581 hypertensive Saudis, aged 21-70, at the King Abdul-Aziz University Hospital, from June 2005 to December 2005 Each participant completed the questionnaire and underwent a complete physical examination. Metabolic parameters were measured using routine laboratory procedures and homocysteine using HPLC by the electrochemical detection method.

Results: According to the International Diabetes Federation (IDF) definition we diagnosed 222 males and 256 females. There is an increased risk for hyperhomocystenemia using the Adult Treatment Panel III (ATPIII) guidelines (odds ratio [OR] 3.30, 95% confidence interval [CI] 0.87-12.56; p=0.08) compared to IDF (OR 0.59, CI 0.17-2.10; p=0.41) and WHO (OR 0.45, CI 0.16-1.25; p=0.12); increased risk for probable CHD in patients with MS by WHO (OR 2.17, CI 1.11-4.25; p=0.02) compared to ATPIII (OR 2.14, CI 1.05-4.35; p=0.035) and IDF (OR 0.81, CI 0.37-1.78; p=0.6); risk of DM is highest with IDF (OR 13.07, CI 1.66-102.94; p=0.015).

Conclusion: There is a high prevalence of MS among hypertensive Saudis regardless of definition used; it is most prevalent using the IDF definition as well as the risk for diabetes Patients diagnosed with ATPIII guidelines have greater risk of hyperhomocysteinemia. We recommend the WHO definition for Arabs since it predicts increased risk for CHD.

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Five decades have passed since the late Dr. Jean Vague came up with an amazing observation that "upper obesity in men can predispose to diabetes, atherosclerosis, gout and calculi".[1] It was in 1977 however when the term "metabolic syndrome (MS)" was launched by Haller; defined as "associations of obesity, diabetes mellitus, hyperlipoproteinemia, hyperuricemia and steatosis hepatis.[2] Eleven years later, Dr. Gerald Reaven conceptualized insulin resistance as the underlying factor and named this constellation of abnormalities "Syndrome X".[3] Since then, MS has come a long way from a simple discovery of a group of symptoms to a global health threat. So far, major multi-national health organizations including the World Health Organization (WHO), National Cholesterol Education Program Adult Panel III (NCEP ATP III), and the International Diabetes Federation (IDF) have established distinct and sound criteria capable of detection and diagnosis of MS in 1998, 2001 and 2005 respectively.[4-6] With no uniform definition up to date, we can be more or less sure that the syndrome revolves around the central idea of a cluster of metabolic risk factors including central obesity, glucose intolerance, hyperinsulinemia, low HDL-cholesterol, high triglycerides, and hypertension. Turning to homocysteine, it is a sulfur-containing amino acid formed during the processing of methionine. In 1960s, Dr. Mc Cully hypothesized that elevated homocysteine levels can cause atherosclerosis in older individuals. But this theory, being somewhat over-ambitious, was rejected during their time. Ironic as it seems, homocysteine at present holds center stage in preventive cardiology.[7] With an

immense database to prove the claim of Dr. Mc Cully, the significance of homocysteine as an essential factor for the risk of coronary heart disease (CHD) and atherosclerosis is now an established fact.[8-13] Considered together, MS and homocysteine represent 2 of the better established risk factors for the development and progression of CHD. While there are few reports on the prevalence of MS using definitions of the 3 groups and none in the Kingdom of Saudi Arabia which has a very high incidence of MS 14, there has been no documentation of the capacity of 3 definitions by international authorities (WHO, ATPIII, and IDF) to identify hyperhomocysteinemia in patients who have MS. Given this premise, this study aims to determine and identify which of these definitions can predict the risk of hyperhomocysteinemia, CHD and DM as well as to compare the prevalence of MS in hypertensive Saudi population.

Methods. Five hundred and eighty-one hypertensive Saudi patients aged 21-70 years attending the Diabetic Center and primary care out-patient clinic at King Abdul-Aziz University Hospital, Riyadh, KSA, were included in this prospective and cross-sectional study (June 2005 to December 2005). All subjects submitted a self-reported questionnaire, which outlined their medical history including MI, medications if any, and smoking status. They underwent a comprehensive physical examination, which included height, weight, waist and hip measurements. This research followed the guidelines set by the British Hypertension Society.[15] A properly maintained mercurial sphygmomanometer was used, as this is still considered gold standard for routine clinical practice. For each patient, blood pressure was measured after 30 minutes of complete rest. Two measurements were made at each visit, with possible home blood pressure monitoring to exclude "white coat hypertension". If at several determinations the BP exceeds 140/90 mm Hg, the diagnosis of hypertension was then confirmed. The body mass index (BMI) was calculated as weight in kilogram divided by height in squared meters. The waist-hip ratio (WHR) was calculated as waist (cm) divided by hips (cm) and was rounded off to the nearest centimeter. Each participant underwent a resting of 12-L ECG from which probable CHD was diagnosed on the basis of past medical history, present medications and the presence of Q waves. They were also required to provide overnight fasting blood samples as well as written and informed consent for utilization of personal information. Ethical approval was obtained from the Ethics Committee of the College of Medicine Research Center in King Saud University Riyadh, Kingdom of Saudi Arabia. Of the 581 subjects, 294 were males (age 43.95 ± 11.21; BMI 31.01 ± 7.47) and 287 were females (age 51.01 ± 12.22, BMI 27.71 ± 4.99). Out of this population, 276 had probable CHD and were taking medications for hypertension (n=180) and for dyslipidemia (n=96). A total of 195 (33.6%) were diabetic and were on hypoglycemics. Even though these current medications can alter the levels of metabolic values, we chose not to exclude them from the study since they can still provide values for individual components of metabolic syndrome as well as helping to avoid selection bias. Blood samples obtained were analyzed using routine laboratory procedures, which included lipid profile, creatinine, fasting plasma glucose and insulin. Plasma homocysteine was measured by high-performance liquid chromatography (HPLC) with electrochemical detection (Shimadzu Corp, Kyoto, Japan).[16] In brief, samples were reduced with dithiothreitol to liberate HCYS, the protein was precipitated by sulphosalicylic acid and the supernatant analyzed by HPLC. Hyperhomocysteinemia was defined as homocysteine levels exceeding the cut-off value of 5-15µmol/L. Participants were carefully screened for the presence of risk factors of MS as defined by WHO, ATPIII and IDF. For definition purposes, IDF criteria have 5 factors with abdominal obesity, plus 2 other factors needed for the diagnosis. These include waist circumference ≥94 cm for male and ≥80 cm for female, which are specific for Middle Eastern people; blood pressure ≥130 mm Hg / ≥85 mm Hg; fasting glucose of ≥5.6mmol/L or with pre-existing diabetes; fasting triglycerides of ≥1.7 mmol/L; and HDL cholesterol of <1.04 mmol/L for male and <1.3 mmol for female. The ATP III criteria also have 5 factors but instead of the above require any 3 risk factors. These include a higher cut-off for waist circumference, ≥102 cm for male and ≥88 cm for female; and a higher fasting glucose of ≥6.1 mmol/L or on medication for diabetes; the other 3 factors agree with the IDF definition. Lastly, the WHO criteria have 6 risk factors with a urinary albumin excretion rate ≥20 ug/min included. Others include BMI of 30 kg/m^2 and/or waist-hip ratio ≥0.9 for male and ≥0.85 for female; a more elevated blood pressure at ≥140/90 mm Hg or on medications; with diabetes, impaired glucose tolerance or insulin resistance; and with triglycerides ≥1.7 mmol/L and/or HDL <0.91 mmol/L for male and <1.01 mmol/L for female. The WHO definition centered more on diabetes, impaired glucose intolerance or insulin resistance plus any ≥2 risk factors for its diagnosis.

Table 1 shows that based on each set of criteria, the IDF definition was able to diagnose the most, with 222 (75.5%) males and 256 (89.2%) females followed by the WHO definition, with a total of 189

(64.3%) males and 254 (88.5%) females. The ATPIII definition had the lowest number, with 168 (57.1%) males and 251 (87.5%) females. Given the fact that all the subjects were hypertensive individuals, 100% of the population had already satisfied one criterion among the 3 definitions. In the IDF definition, 151 subjects (26%) fulfilled all 5 factors, while 111 (19.1%) and 211 (36.3%) subjects had all the criteria set by ATPIII and WHO respectively.

Statistical Package for Social Sciences for Windows Version 11.5 (Chicago, Illinois) was utilized for the statistical evaluation of data. Variables exhibiting non-Gaussian distribution were logarithmically transformed. The remaining variables were presented as means (SD). An independent T-test was carried out on the continuous variables, with an analysis of variance for a comparison of the 3 groups. The odds-ratio was used to assess risk and kappa statistics were used for the agreement between the 3 definitions. A p-value of <0.05 was considered statistically significant.

Results. For comparison purposes, the subjects were divided into male group and female group. **Table 2** reveals the clinical and metabolic characteristics of male and female participants diagnosed to have MS, according to the 3 definitions used in this study. In males, those who were diagnosed according to the IDF definition were younger (45.46 ± 11.67); had significantly lower

Table 1 - Diagnosed subjects using the three criteria for metabolic syndrome (MS).

Metabolic Syndrome Criteria	Number of male subjects with MS in cumulative percent (%) (n=294)		Number of female subjects with MS in cumulative percent (%) (n = 287)		Total subjects with MS in cumulative percent (%) (n=581)	
International Diabetes Federation Consensus 2005	222	(75.5)	256	(89.2)	478	(82.3)
Adult Treatment Panel III Criteria 2001	168	(57.1)	251	(87.5)	419	(72.1)
World Health Organization Criteria 1999	189	(64.3)	254	(88.5)	443	(76.2)

Table 2 - Female and male subjects diagnosed with metabolic syndrome (MS) (clinical and metabolic parameters).

Parameters	Females			Males		
	IDF	ATPIII	WHO	IDF	ATPIII	WHO
Age (years)	51.7 ±12.0	51.6 ± 12.0	51.5 ± 12.0	45.5 ± 11.7	46.8 ± 1.7*	46.1 ± 12.0*
Body mass index (kg/m²)	28.3 ± 4.8	28.4 ± 4.7	28.2 ± 4.8	32.4 ± 7.5	33.3 ± 8.0*	33.3 ± 7.6*
Systolic (mm Hg)	165.0 ±7.3	165.0 ± 7.3	164.9 ± 7.3	154.5 ± 8.3	154.4 ± 8.7	154.4 ± 8.5
Diastolic (mm Hg)	77.1 ± 15.1†	77.4 ± 15.0†	76.7 ± 15.1	76.9 ± 16.2	79.0 ± 16.8*	78.9 ± 16.2*
Waist circumference (cm)	96.9 ± 12.8	97.3 ± 12.5*†	96.5 ± 12.9	95.9 ± 13.5	97.9 ± 14.1*	97.0 ± 13.6*
Waist-hips ratio	1.0 ± 0.2	1.0 ± 0.2*†	1.0 ± 0.2	0.9 ± 0.1	0.9 ± 0.2	0.9 ± 0.1
Fasting plasma glucose (mmol/l)	8.2 ± 4.5†	8.1 ± 4.5	8.2 ± 4.5	8.0 ± 4.0	8.9 ± 4.6*	8.4 ± 4.5*
Triglycerides (mmol/l)	2.4 ± 1.5	2.4 ± 1.5	2.4 ± 1.5	2.0 ± 1.1	2.2 ± 1.1*	2.0 ± 1.1*
High-density lipoprotein-cholesterol (mmol/l)	0.8 ± 0.4*†	0.8 ± 0.4	0.8 ± 0.4	0.9 ± 0.4*†	0.8 ± 0.3	0.8 ± 0.3
Low-density lipoprotein-cholesterol (mmol/l)	3.6 ± 1.6	3.5 ± 1.6	3.6 ± 1.6	3.7 ± 1.4	3.8 ± 1.4	3.7 ± 1.4
Total-cholesterol (mmol/l)	5.5 ± 1.5	5.5 ± 1.5	5.5 ± 1.5	5.4 ± 1.5	5.6 ± 1.5	5.4 ± 1.4
Apolipoproteins I (mg/dl)	1.0 ± 0.5	1.0 ± 0.5	1.0 ± 0.4	1.2 ± 2.2	1.3 ± 2.4†	1.2 ± 2.2
Apolipoproteins II (mg/dl)	0.4 ± 0.1	0.4 ± 0.1	0.4 ± 0.1	0.4 ± 0.1	0.48 ± 0.1	0.4 ± 0.1
Homocysteine (µmol/L)#	10.6 (2 - 42)	10.7 (2 - 42)	10.6 (2 - 42)	8.8 (3 - 45)	8.9 (3 - 45)	9.0 (3 - 45)
Insulin (µIU/ml)	16.0 ± 13.4	16.3 ± 13.4	16.3 ± 13.5	13.7 ± 9.9	14.4 ± 10.5	13.7 ± 9.7
Creatinine (mmol/l)	90.9 ± 36.9	90.0 ± 37.6	88.0 ± 38.6	64.0 ± 32.2	64.8 ± 33.5	68 ± 32.8

Data presented as means ± SD. # Data presented as mean (range); not compared according to gender, *significant compared to International Diabetes Federation (IDF), †significant compared to Adult Treatment Panel III (ATPIII) or World Health Organization, or both.

Table 3 - Comparison of anthropometric and clinical parameters using International Diabetes Federation Criteria (n=581).

Variable	Without MS (n=103)	With MS (n=478)	*P*-value
Age (years)	41.05 ± 10.15	48.82 ± 12.22	<0.0005
Body mass index (kg/m^2)	25.72 ± 5.50	30.17 ± 6.53	<0.0005
Systolic BP (mm Hg)	156.50 ± 8.55	160.12 ± 9.37	<0.0005
Diastolic BP (mm Hg)	62.89 ± 13.94	76.98 ± 15.61	<0.0005
Waist circumference (cm)	82.56 ± 11.69	96.43 ± 13.13	<0.0005
Waist-hips ratio	0.88 ± 0.21	0.94 ± 0.16	<0.0005
Fasting plasma glucose (mmol/L)	4.61 ± 1.35	8.11 ± 4.38	<0.0005
Triglycerides (mmol/L)	1.10 ± 0.58	2.21 ± 1.34	<0.0005
High-density lipoprotein-cholesterol (mmol/L)	1.08 ± 0.55	0.85 ± 0.39	<0.0005
Low-density lipoprotein-cholesterol (mmol/L)	3.27 ± 1.35	3.62 ± 1.50	0.03
Total cholesterol (mmol/L)	4.83 ± 1.18	5.47 ± 1.49	<0.0005
Apolipoproteins I (mg/dl)	0.83 ± 0.26	1.06 ± 1.44	0.62
Apolipoproteins II (mg/dl)	0.37 ± 0.14	0.37 ± 0.12	0.89
Homocysteine (µmol/L)	10.58 (5.0 – 43.7)	9.81 (2.5 – 45.6)	0.12
Insulin (µIU/ml)	13.48 ± 12.20	15.02 ± 12.02	0.57
Creatinine (mmol/L)	71.67 ± 33.51	77.87 ± 37.13	0.33

Data presented as mean ± SD or as mean (range)
P-value significant at <0.05, MS - metabolic syndrome

Table 4 - Comparison of anthropometric and clinical parameters using Adult Treatment Panel III Criteria (n=581).

Variable	Without MS (n=162)	With MS (n=419)	*P*-value
Age (years)	41.66 ± 10.57	49.66 ± 12.11	<0.0005
Body mass (kg/m^2)	26.86 ± 5.56	30.36 ± 6.68	<0.0005
Systolic blood pressure (mmHg)	156.19 ± 8.27	160.74 ± 9.41	<0.0005
Diastolic blood pressure (mmHg)	65.37 ± 13.82	78.01 ± 15.73	<0.0005
Waist circumference (cm)	84.80 ± 11.41	97.52 ± 13.18	<0.0005
Waist-hips ratio	0.87 ± 0.16	0.96 ± 0.17	<0.0005
Fasting plasma glucose (mmol/L)	5.10 ± 1.74	8.42 ± 4.54	<0.0005
Triglycerides (mmol/L)	1.17 ± 0.62	2.34 ± 1.37	<0.0005
High-density lipoprotein-cholesterol (mmol/L)	1.07 ± 0.48	0.82 ± 0.39	<0.0005
Low-density lipoprotein-cholesterol (mmol/L)	3.30 ± 1.34	3.62 ± 1.53	0.11
Total cholesterol (mmol/L)	4.98 ± 1.28	5.50 ± 1.51	<0.0005
Apolipoproteins I (mg/dl)	0.93 ± 0.40	1.06 ± 1.50	0.69
Apolipoproteins II (mg/dl)	0.35 ± 0.10	0.37 ± 0.12	0.60
Homocysteine (µmol/L)#	9.74 (2.8 – 43.7)	9.99 (2.5 – 45.6)	0.86
Insulin (µIU/ml)	11.78 ± 9.93	15.56 ± 12.35	0.07
Creatinine (mmol/L)	69.52 ± 31.40	79.43 ± 37.96	0.057

Data presented as mean ± SD or as mean (range),
P-value significant at <0.05

BMI (32.37 ± 7.49), diastolic blood pressure (76.85 ± 16.17), waist circumference (95.87 ± 13.46), fasting plasma glucose (8.04 ± 4.03), and triglycerides (1.98 ± 1.1) and at the same time had higher levels of HDL cholesterol (0.86 ± 0.35), as opposed to the ATPIII and WHO definitions. The females in contrast exhibited a more homogenous distribution of values. Subjects in this category when diagnosed by ATPIII had a significantly bigger waist circumference (97.26 ± 12.51), waist-hip ratio (0.99 ± 0.17) and had lower fasting plasma glucose (8.13 ± 4.46) compared with the IDF and WHO definitions. Like the males, the females diagnosed with MS according to IDF had significantly higher HDL cholesterol levels (0.86 ± 0.35) than in the ATPIII and WHO definitions. The WHO group, however, had significantly lower diastolic blood pressure (76.68 ± 15.10). The remaining values, including homocysteine, were comparably non-significant.

In **Tables 3 to 5** we compare the anthropometric and metabolic values of patients without MS with the values of those diagnosed with MS according to the 3 definitions. As expected and regardless of the criteria chosen, all subjects with MS were significantly older, had higher values for BMI, systolic and diastolic blood pressure, waist circumference and waist-hip ratio, fasting plasma glucose, triglycerides and total cholesterol, and had lower levels of HDL compared to the subjects without MS. It is interesting to note; however, that in **Table 3** only patients with MS according to the IDF definition exhibited significantly higher LDL cholesterol than those without MS, as opposed to the non-significant difference in their ATPIII and WHO counterparts.

K statistics were used to assess the measure of agreement between the 3 definitions. The agreement between ATPIII and WHO was 0.69 (p<0.0005) while the agreement of IDF with ATPIII and WHO was 0.66 (p<0.0005) and 0.57 (p<0.0005) respectively (not shown in the table). Hyperhomocysteinemia, as defined previously, was documented in 70 (12%) subjects. Based on the different criteria, the IDF was able to identify 53 (9.1%) patients as having hyperhomocysteinemia with MS, followed by ATPIII with 56 (9.6%) subjects and WHO with 59 (10.2%) subjects (**Table 6**). From the set of values we made logistic regression analysis using hyperhomocysteinemia as the dependent variable and the 3 definitions as independent variables and found that although the definition of IDF was able to identify more hyperhomocystenemic patients by percentage, the risk for hyperhomocysteinemia in subjects with MS was higher using the ATPIII definition [odds ratio (OR) 3.30, 95% confidence interval (CI) 0.87-12.56; p=0.08] as opposed to that of the IDF (OR 0.59, CI 0.17-2.10; p=0.41) and the WHO (OR 0.45, CI 0.16-1.25 p=0.12). We identified an increased risk for probable CHD in patients with MS diagnosed under

Table 5 - Comparison of anthropometric and clinical parameters using World Health Organization Criteria (n=581).

Variable	Without MS (n=138)	With MS (n=443)	*P*-value
Age (years)	41.80 ± 10.19	49.18 ± 12.30	<0.0005
Bodu mass index (kg/m^2)	26.28 ± 5.19	30.35 ± 6.66	<0.0005
Systolic blood pressure (mmHg)	156.51 ± 8.50	160.40 ± 9.39	<0.0005
Diastolic blood pressure (mmHg)	64.38 ± 14.03	77.63 ± 15.59	<0.0005
Waist circumference (cm)	85.22 ± 12.64	96.70 ± 13.17	<0.0005
Waist-hips ratio	0.88 ± 0.21	0.95 ± 0.16	<0.0005
Fasting plasma glucose (mmol/L)	4.91 ± 1.24	8.30 ± 4.51	<0.0005
Triglycerides (mmol/L)	1.26 ± 0.74	2.24 ± 1.37	<0.0005
High-density lipoprotein-cholesterol (mmol/l)	1.12 ± 0.48	0.82 ± 0.39	<0.0005
Low-density lipoprotein-cholesterol (mmol/l)	3.36 ± 1.29	3.62 ± 1.53	0.07
Total-cholesterol (mmol/l)	5.04 ± 1.20	5.45 ± 1.52	0.004
Apolipoproteins I (mg/dl)	1.06 ± 0.91	1.04 ± 1.43	0.97
Apolipoproteins II (mg/dl)	0.39 ± 0.10	0.37 ± 0.12	0.60
Homocysteine (µmol/L) #	9.82 (3.0 – 22.7)	9.96 (2.5 – 45.6)	0.78
Insulin (µIU/ml)	12.87 ± 11.69	15.19 ± 12.01	0.33
Creatinine (mmol/L)	68.85 ± 32.49	78.94 ± 37.37	0.08

Data presented as mean ± SD or as mean (range)
P-value significant at <0.05, MS - metabolic syndrome

the WHO definition (OR 2.17, CI 1.11-4.25; *p*=0.02) with 160 cases (27.5%) compared to the criteria of ATPIII (OR 2.14, CI 1.05-4.35; *p*=0.035) with 154 (26.5%) and the IDF (OR 0.81, CI 0.37-1.78; *p*=0.6) with 162 (27.9%). Since part of the diagnosis among the 3 definitions is fasting plasma glucose in at least its impaired tolerance value, the risk for diabetes is high in all criteria and highest in the IDF definition (OR 13.07, CI 1.66-102.94; *p*=0.015) with 194 cases (33.4%) (**Table 6**).

Discussion. In this cross-sectional study we attempted to determine the prevalence of MS in a hypertensive Saudi population using the 3 of the more commonly used definitions, namely those of the WHO, ATPIII, and IDF, and to identify which criteria has an increased risk for hyperhomocysteinemia and probable CHD. This is the first of its kind in the Middle East area and probably the first study ever to compare homocysteine levels using the 3 criteria. Very recently, the 34th publication of the Chennai Urban Rural Epidemiology Study (CURES-34) assessed the prevalence of MS as defined by the above-mentioned authorities, using Asian Indians as subjects, as opposed to the Arabian subjects in the present study.[17] Their findings were consistent with the present study in which IDF criteria identified the greatest number of MS patients compared with those of the WHO and ATPIII. Moreover, it strengthens the claim of Earl Ford in his recent study in the US that the use of IDF definition of MS leads to a higher prevalence estimate of MS than the estimate based on NCEP definition.[18] These results of course were secondary to the lower values set by the IDF criteria than those of the other 2 authorities, in terms of systolic and diastolic blood pressure as well as fasting plasma glucose, not to mention the fact that the waist circumference cut-off point was ethnic-specific. The present study also supports their findings on the increased risk of CHD using WHO definition as mentioned previously, and also the findings on measures of agreement among the definitions. Harzallah et al[19] have the credit for initially conducting a survey on the prevalence of the MS using the 3 given definitions in a cohort of randomly selected Arabian population. This study not only strengthens their findings of a higher incidence of MS in Arab women and increased prevalence using the IDF definition; it also answers their question as to which definition can better predict harder outcomes, such as diabetes and CHD. A similar study comparing MS definitions was conducted on male Japanese workers by Miyaki et al,[20] this time identifying the association and prevalence of brachial-ankle pulse wave velocity (baPWV), as opposed to the homocysteine levels used in the present study. They concluded that the IDF criterion was the better predictor of baPWV. Regardless of the dependent variable used, with different definitions for MS as the independent variables, there is an on-going trend in exploring the prevalence and association of these definitions among different races with a view to discover the suitable definition to their ethnicity.[21-23] In the present study it was found for the first time that the definition of ATPIII has a higher risk than the WHO and IDF criteria of predicting hyperhomocysteinemia in hypertensive Saudi patients with MS. Furthermore,

Table 6 - Odds ratio for probable coronary heart disease, diabetes mellitus and hyperhomocysteinemia using logistic regression analysis.

MS Criteria	No. of cases identified (%)	ß	SE	Odds-ratio	Confidence interval	*P*-value
Coronary heart disease						
IDF	162 (27.9)	-0.21	0.40	0.81	0.37-1.78	0.60
ATP III	154 (26.5)	0.76	0.36	2.14	1.05-4.35	0.04
WHO	160 (27.5)	0.78	0.34	2.17	1.11-4.25	0.02
Diabetes mellitus						
IDF	194 (33.4)	2.57	1.05	13.07	1.66-102.94	0.02
ATPIII	186 (32.0)	0.95	0.41	2.58	1.15-5.78	0.02
WHO	192 (33.0)	2.38	0.62	10.85	3.20-36.81	0.00
Hyperhomocysteinemia						
IDF	53 (9.1)	-0.53	0.65	0.59	0.17-2.10	0.41
ATPIII	56 (9.6)	1.19	0.68	3.30	0.87-12.56	0.08
WHO	59 (10.2)	-0.8	0.52	0.45	0.16-1.25	0.12

IDF - International Diabetes Federation, ATP III - Adult Treatment Panel III, WHO - World Health Organization

the predisposition to DM of subjects with MS is highest using the IDF criteria. Al-Nozha et al[24,25] in a recent study observed that homocysteine levels in the Saudi population are not correlated to coronary heart disease and are inversely related to diabetes mellitus. Nevertheless, owing to the fact that homocysteine is an established independent risk factor for atherosclerosis, this study supersedes the findings from the latter's report, since homocysteine concentrations are influenced by several other mechanisms apart from demographics and a survey of their associated risk, using the definitions of MS, another independent risk factor, has never been conducted.

In summary, the prevalence of metabolic syndrome in a hypertensive Saudi population regardless of which guideline used is considerable; it is highest using the IDF criteria, and so is the risk of having diabetes. The emergence of different definitions for metabolic syndrome from 1998 to the present suggests further evolution of the criteria in the future. There is a need to evaluate and investigate these different classification schemes on the basis of risk assessment to see which criteria best suit individual races. On reports regarding homocysteine, this study recommends the use of ATPIII guidelines as it predicts hyperhomocysteinemia better than the IDF and WHO definitions. The use of WHO definition however, is best suited to the Arab population, since patients diagnosed under its criteria presents the higher risk of coronary heart disease. The author acknowledges the limitations present in this study which include the use of hypertensive subjects only and the exclusion of other definitions of metabolic syndrome that are not as commonly used as the three criteria included in this study. Further documentation is essential using other groups of population with the same ethnicity to strengthen the findings of this study.

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