

# Does the prevalence of the metabolic syndrome improve by applying the International Diabetes Federation criteria?

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## Abstract

**Objective:** To estimate the prevalence of the metabolic syndrome (MS) in a population of patients with overweight and obesity of the A Coruña and Granada health areas, using the definitions of the Third Report of the National Cholesterol Education Program Expert Panel on Detection, Evaluation and Treatment of High Blood Cholesterol in Adults (ATP III) and of the International Diabetes Federation (IDF).

**Patients and methods:** During a period extending from 1996 to 2003, only those patients attending endocrinology outpatient clinics for whom all the anthropometric and biochemical parameters used to define the MS, both according to the ATP III and the IDF, were available were selected. The final study sample consisted of 285 patients, 198 females (69.5%) and 87 males (30.5%).

**Results:** The prevalence of the MS was 29.8% when the ATP III definition was applied, and 41.1% according to the IDF criteria. Prevalence by sex was 32.2% in men and 28.8% in women according to the ATP III, and 42.5% and 40.4%, respectively, according to the IDF.

**Conclusions:** In a patient population with overweight or obesity, the prevalence of the MS is higher when the IDF criteria, instead of the ATP III criteria, are used. These findings may have significant implications when it comes to addressing early diagnosis of cardiovascular disease and diabetes mellitus in these patients, in order to perform therapeutic measures at the initial stages and thereby reduce metabolic and cardiovascular complications.

## Keywords

Prevalence

Definition of the metabolic syndrome  
Insulin resistance

The factors associated with an increased risk of developing diabetes mellitus<sup>1</sup> or cardiovascular disease (CVD)<sup>2</sup> include, but are not limited to, advanced age, physical inactivity, high blood pressure, low high-density lipoprotein (HDL) levels, high triglyceride levels, hyperglycaemia and obesity. Many of these risk factors are the ones that make up the so-called syndrome X<sup>3</sup>, insulin resistance syndrome<sup>1</sup> or metabolic syndrome (MS)<sup>4</sup>.

The most widely accepted classifications for defining the MS are as laid down by the World Health Organization (WHO) in 1999<sup>5</sup>, the European Group for the study of Insulin Resistance (EGIR), also of 1999<sup>6</sup>, the Third Report of the National Cholesterol Education Program Expert Panel on Detection, Evaluation and Treatment of High Blood Cholesterol in Adults (ATP III), of 2001<sup>7</sup>, and the American Association of Clinical Endocrinologists (AAACE

IRS)<sup>8</sup>. The ATP III and International Diabetes Federation (IDF) definitions were published more recently, in 2005<sup>9,10</sup>.

Estimations of the prevalence of the MS vary considerably, partly because of the different diagnostic definitions used<sup>11</sup>, and also because of the different demographic regions studied and the varying study duration<sup>12</sup>. In Spain, only very partial data of the exact prevalence of MS are known because the epidemiological studies available are complex and often only provide estimations of the prevalence in a specific area or population<sup>13–16</sup>.

This study was intended to assess the prevalence of the MS in a sample of patients with overweight and obesity who have attended consecutive consultations for this problem, using the ATP III<sup>9</sup> and IDF<sup>10</sup> definitions.

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## Patients and methods

An observational study was undertaken of the prevalence of patients attending the endocrinology and general nutrition outpatient clinics of a hospital in the A Coruña health area and a hospital in the Granada health area over the 1996–2003 period. All adults over 18 years of age with a clinical diagnosis of overweight or obesity who gave their informed consent were consecutively included for evaluation. In addition to patient refusal to take part, exclusion criteria included the presence of neoplastic disease under treatment, pregnancy, heart failure and steroid treatment. Patients with a prior diagnosis of hypertension or dyslipidemia or diabetes under treatment were admitted, but a record was maintained of the medication schedule and dosage administered. Only those patients for whom all the anthropometric and biochemical parameters used to define the MS, both according to the ATP III and the IDF were available, were selected. The final study sample consisted of 285 patients, 198 females (69.5%) and 87 males (30.5%), diagnosed of overweight or obesity using the criteria defined by the World Health Organization (WHO) in 1998<sup>17</sup>.

The anthropometric parameters included weight, height, body mass index (BMI), hip and waist perimeter (wp), waist-to-hip ratio, and sagittal perimeter was measured using standard methods. Weight was measured in kilograms using Seca<sup>®</sup> scales, and height was measured in centimeters using the Holtain<sup>®</sup> stadiometer. BMI was calculated by dividing the weight in kilograms by the height in square meters. The waist perimeter in centimetre was measured with a tape measure at a point midway between the last rib and the iliac crest, with the patient standing and on expiration, while hip circumference in centimetre was measured around the buttocks at the level of the greater trochanters with the patient in a standing position. The waist-to-hip ratio was calculated by dividing the value of the waist by the value of the hip. Anthropometric evaluation of regional fat distribution, estimated by waist perimeter and waist-to-hip ratio, was carried out based on the same criteria.

Blood samples were taken after a 12-hour overnight fast, and plasma was separated immediately by refrigerated centrifugation at 2500–3000 rpm for a period of 10 min.

The samples were processed immediately or in the first week following preservation at  $-20^{\circ}\text{C}$ . Total cholesterol (TC), triglycerides (TG) and cholesterol bound to HDL were determined using enzymatic methods<sup>18,19</sup> in a Technicon<sup>®</sup> analyzer RA<sup>TM</sup> 1000. Glucose was measured via an enzymatic method<sup>20</sup>, and insulin was determined using a radioimmunoassay<sup>21</sup>.

Blood pressure was measured with an approved sphygmomanometer after a 10-min rest period in a supine position; two separate measurements were performed with a 5-min interval. The criterion for hypertension was current use of antihypertensive treatment in patients

diagnosed of hypertension and with a systolic or diastolic blood pressure  $\geq 130$  mmHg or  $\geq 85$  mmHg respectively, according to ATP III and IDF criteria. Patients with a prior diagnosis of hypertension and with normal pressure values at the time of evaluation were considered to be hypertensive patients.

To estimate the prevalence of MS, the definitions most widely used in clinical practice, namely those of the ATP III and IDF, were considered. While the criteria used are common to both classifications, each of them has a different diagnostic cutoff point for both central obesity and basal glucose (Table 1).

## Statistical analysis

Descriptive analysis was performed of all the variables collected, and 95% confidence intervals were calculated. A  $\chi^2$  test or a Fisher's exact test was used, and the odds ratio (OR) and its 95% confidence intervals were calculated. A Student's *t*-test or a Mann–Whitney test was used to compare between-group numerical parameters, after checking normality with the Kolmogorov–Smirnov test. Values of  $P < 0.05$  were considered significant. All the tests were two-sided. The statistical analysis was carried out with SPSS 12.0 for Windows and EpiInfo software.

## Results

A total of 285 patients with a mean age of 40.41 years (SD = 13.95) were studied. Of these, 198 were females

**Table 1** Diagnostic criteria for metabolic syndrome using the ATP III and IDF definitions

(A) Third Report of the National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation and Treatment of High Blood Cholesterol in Adults (ATPIII) 2005

Three or more of the following criteria:

1. Central obesity: waist perimeter  $> 102$  cm in males and  $> 88$  cm in females.
2. Hypertriglyceridaemia: triglyceride levels  $\geq 150$  mg dl<sup>-1</sup> ( $\geq 1.7$  mmol l<sup>-1</sup>) or specific treatment.
3. HDL  $< 40$  mg dl<sup>-1</sup> ( $< 1.1$  mmol l<sup>-1</sup>) in males and  $< 50$  mg dl<sup>-1</sup> ( $< 1.3$  mmol l<sup>-1</sup>) in females or specific treatment.
4. Hypertension: systolic BP  $\geq 130$  mmHg or diastolic BP  $\geq 85$  mmHg or antihypertensive treatment.
5. Fasting plasma glucose  $\geq 100$  mg dl<sup>-1</sup> ( $\geq 5.6$  mmol l<sup>-1</sup>) or drug treatment for elevated blood glucose.

(B) International Diabetes Federation (IDF) 2005

Central obesity: waist perimeter  $\geq 94$  cm in males and  $\geq 80$  cm in females plus two of the following criteria:

1. Hypertriglyceridaemia: triglycerides  $\geq 150$  mg dl<sup>-1</sup> ( $\geq 1.7$  mmol l<sup>-1</sup>) or specific treatment.
2. HDL  $< 40$  mg dl<sup>-1</sup> ( $< 1.1$  mmol l<sup>-1</sup>) in males and  $< 50$  mg dl<sup>-1</sup> ( $< 1.3$  mmol l<sup>-1</sup>) in females or specific treatment.
3. Hypertension: systolic BP  $\geq 130$  mmHg or diastolic BP  $\geq 85$  mmHg or specific antihypertensive treatment.
4. Fasting plasma glucose  $\geq 100$  mg dl<sup>-1</sup> ( $\geq 5.6$  mmol l<sup>-1</sup>) or prior diagnosis of type 2 diabetes mellitus.

HDL – high-density lipoprotein cholesterol.

**Table 2** Anthropometric and biochemical characteristics of the study subjects (with overweight and obesity)

	Males ( <i>n</i> = 87) Mean (SD)	Females ( <i>n</i> = 198) Mean (SD)	<i>P</i>
Systolic blood pressure (mmHg)	126.2 (±10.8)	125.1 (±13.7)	0.074
Diastolic blood pressure (mmHg)	74.0 (±7.0)	73.2 (±7.2)	0.491
Waist circumference (cm)	104.1 (±1.6)	91.0 (±12.8)	<0.001
HDL (mg dl <sup>-1</sup> )	47.3 (±45.9)	51.5 (±16.4)	<0.001
Triglycerides (mg dl <sup>-1</sup> )	158.1 (±102.7)	117.2 (±58.0)	0.003
Fasting glucose (mg dl <sup>-1</sup> )	102.6 (±30.3)	101.5 (±25.8)	0.837
Body mass index	32.8 (±4.2)	32.2 (±5.4)	0.083
	%	%	
Waist circumference ≥94 cm ♂ and ≥80 cm ♀	77.8	79.3	0.786
Waist circumference ≥102 cm ♂ and ≥88 cm ♀	61.2	54.3	0.129
Triglycerides ≥150 mg dl <sup>-1</sup> (≥1.7 mmol l <sup>-1</sup> ) or treatment	36.8	19.8	<0.001
HDL <40 mg dl <sup>-1</sup> (<1.1 mmol l <sup>-1</sup> ) ♂ and 50 mg dl <sup>-1</sup> (1.3 mmol l <sup>-1</sup> ) ♀ or treatment	49.3	59.3	0.049
Glucose ≥100 mg dl <sup>-1</sup> (≥5.6 mmol l <sup>-1</sup> ) or prior diagnosis of type 2 diabetes mellitus or treatment	34.9	36.0	0.852
Hypertension ≥130/85 mmHg or treatment	45.2	36	0.178

SD – standard deviation; HDL – high-density lipoprotein cholesterol.

**Table 3** Prevalence of metabolic syndrome according to ATP III and IDF

Definitions	Total		
	<i>n</i>	%	95% CI
ATP III	118	41.4	35.7–47.4
IDF	117	41.1	35.3–47.0

ATP III – Third Report of the National Cholesterol Education Program Expert Panel on Detection, Evaluation and Treatment of High Blood Cholesterol in Adults; IDF – International Diabetes Federation.

(69.5%) and 87 males (30.5%). The proportion of subjects with overweight was 35.4% (*n* = 101), while patients with obesity represented 64.6% (*n* = 184). Males were seen to have a worse metabolic pattern, with significantly increased anthropometric parameters and lipid levels (Table 2).

Prevalence of MS was different according to the two definitions used. When the ATP III definition was applied, the total prevalence was 41.4% (CI = 35.7–47.4), while prevalence according to IDF criteria was 41.1% (CI = 35.3–47.0). Only one patient diagnosed of MS according to the ATP III criteria did not meet the IDF criteria (Table 3). On the other hand, 33 (16.5%) patients who did not meet the ATP III criteria were diagnosed of MS using the IDF criteria. Regardless of the definition used, a higher prevalence of MS was found in men as compared to women, but the difference was not significant. Using the ATP III definition, MS prevalence was 43.7% in males and 40.4% in females (OR = 0.87; *P* = 0.605), while according to the IDF definition, MS was diagnosed in 42.5% of men as compared to 40.4% of women (OR = 0.92; *P* = 0.737) (Table 4).

According to the ATP III classification, MS prevalence was 18.8% in overweight patients, and 53.8% in obese patients (*P* < 0.001). Using the IDF definition, the

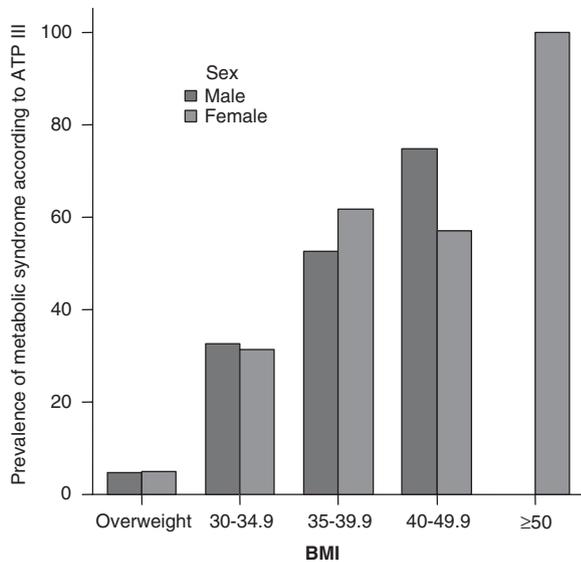
**Table 4** Prevalence of metabolic syndrome according to ATP III and IDF by sex

	Males		Females		<i>P</i>	OR (95% CI)
	<i>n</i>	%	<i>n</i>	%		
ATP III	38	43.7	80	40.4	0.605	0.87 (0.52–1.45)
IDF	37	42.5	80	40.4	0.737	0.92 (0.55–1.52)
	Overweight		Obesity		<i>P</i>	OR (95% CI)
	<i>n</i>	%	<i>n</i>	%		
ATP III	19	18.8	99	53.8	<0.001	5.03 (2.82; 8.95)
IDF	18	17.8	99	53.8	<0.001	5.4 (3.0–9.6)

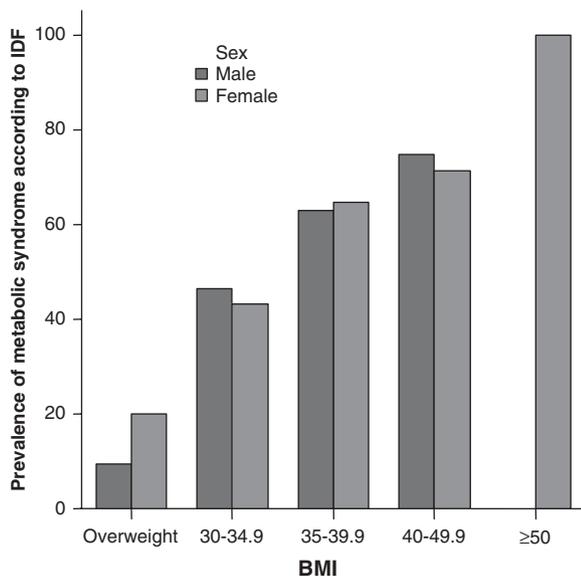
OR – odds ratio; CI – confidence interval; ATP III – Third Report of the National Cholesterol Education Program Expert Panel on Detection, Evaluation and Treatment of High Blood Cholesterol in Adults. IDF – International Diabetes Federation. Overweight: body mass index ≥25 to <30 kg m<sup>-2</sup>. Obesity – body mass index >30 kg m<sup>-2</sup>; SD – standard deviation; HDL – high-density lipoprotein cholesterol.

prevalence of MS was 17.8% in overweight patients and 53.8% in obese patients (*P* < 0.001). Establishing the degrees of obesity defined by the SEEDO 2000<sup>16</sup>, a steady rise is seen in MS prevalence as the BMI of patients increases, both for the ATP III and the IDF definitions. This is more marked in men, but the difference is not statistically significant (Table 4, Figs. 1 and 2).

No differences were also seen in the number of components of the ATP III or IDF definitions between males and females. Thus, it was shown that 24.2%, 33.3%, 13.6% and 28.8% of females met 0, 1, 2, 3 or more criteria of the ATP III definition, respectively, while the corresponding proportions in males were 20.7%, 27.6%, 19.5% and 32.2%. When the IDF criteria were applied, 29.5%, 16.8%, 32.2% and 21.5% of females met 0, 1, 2, 3 or more criteria, respectively, as compared to 23.8%, 17.5%, 30.2% and 28.6% of males, respectively (Figs. 3 and 4).

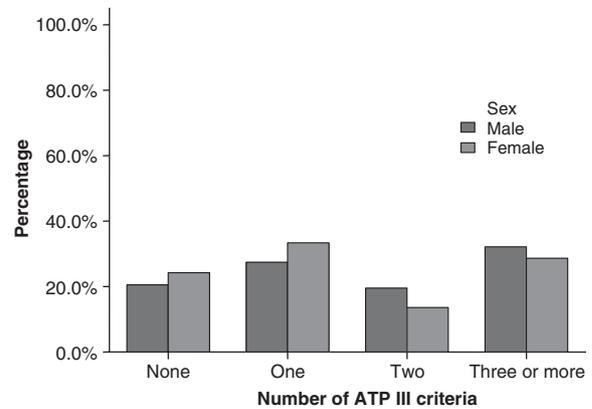


**Fig. 1** Prevalence of metabolic syndrome (MS) according to ATP III, by body mass index (BMI) and sex. ATP III: Third Report of the National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation and Treatment of High Blood Cholesterol in Adults

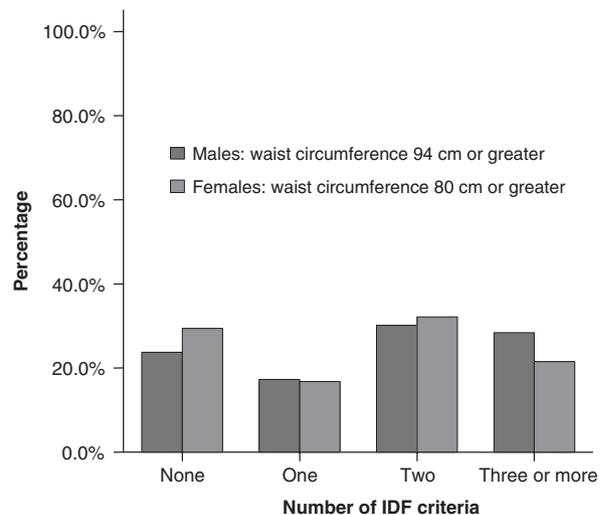


**Fig. 2** Prevalence of metabolic syndrome (MS) according to the International Diabetes Federation (IDF), distributed by body mass index (BMI) and sex

Finally, Table 5 shows the prevalence of each of the factors associated with the presence of MS according to the two classifications by sex and body mass index. It is seen that the presence of central obesity was the most prevalent parameter among the MS criteria, according to both the ATP III (53.5%) and the IDF (78.8%) definition. The prevalence of all changes is increased among obese patients as compared to overweight patients, with a greater difference being noted among females. This



**Fig. 3** Sex distribution of the study population according to the number of ATP III criteria used to define the metabolic syndrome they meet. ATP III: Third Report of the National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation and Treatment of High Blood Cholesterol in Adult



**Fig. 4** Sex distribution of the study population according to the number of International Diabetes Federation (IDF) criteria used to define the metabolic syndrome they meet

increase is more marked in the following risk factors: hyperglycaemia (28.6% vs. 36.9% in males; 18.8% vs. 47.9% in females); hypertension (22.2% vs. 46.7% in males; 14.6% vs. 37.9% in females); waist perimeter, as defined both by the ATP III (0% vs. 74.2% in males; 14.5% vs. 77.7% in females) and by the IDF (42.1% vs. 88.7% in males; 55.3% vs. 95.5% in females); and triglyceride levels (23.8% vs. 46.9% in males; 10.1% vs. 31.4% in females).

**Discussion**

The existence of multiple definitions of the MS has caused confusion, despite the fact that different expert groups have attempted to establish a more precise definition of

**Table 5** Prevalence of factors of metabolic syndrome

	Males						Females					
	Overweight		Obesity		Total		Overweight		Obesity		Total	
	n	%	n	%	n	%	n	%	n	%	n	%
Glucose (IDF-ATP III) $\geq 100 \text{ mg dl}^{-1}$ ( $\geq 5.6 \text{ mmol l}^{-1}$ ) or prior diagnosis of type 2 diabetes mellitus or treatment	6	28.6	24	36.9	15	18.8	56	47.9	101	35.7		
Waist circumference (ATP II) $> 102 \text{ cm}$ en $\delta$ $> 88 \text{ cm}$ en $\text{f}$	0	0	46	74.2	11	14.5	87	77.7	144	53.5		
Waist circumference (IDF) $\geq 94 \text{ cm}$ en $\delta$ $\geq 80 \text{ cm}$ en $\text{f}$	8	42.1	55	88.7	42	55.3	107	95.5	212	78.8		
Triglycerides (ATP III/IDF) $\geq 150 \text{ mg dl}^{-1}$ ( $\geq 1.7 \text{ mmol l}^{-1}$ ) or treatment	5	23.8	30	46.9	8	10.1	37	31.4	80	28.4		
HDL (ATP III/IDF) $< 40 \text{ mg dl}^{-1}$ ( $< 1.1 \text{ mmol l}^{-1}$ ) $\delta$ $y < 50 \text{ mg dl}^{-1}$ ( $< 1.3 \text{ mmol l}^{-1}$ ) $\text{f}$ or treatment	6	28.6	25	37.9	33	42.9	65	55.6	129	45.9		
SBP/DBP (ATP III/IDF) $\geq 130/85 \text{ mmHg}$ or treatment	2	22.2	21	46.7	7	14.6	25	37.9	55	32.7		

ATP III – Third Report of the National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation and Treatment of High Blood Cholesterol in Adults. IDF – International Diabetes Federation. HDL – high-density lipoprotein cholesterol.

the syndrome<sup>5-7</sup>. Accurate estimations of MS prevalence are therefore difficult. The prevalence of MS has been estimated to be approximately 20–25% of the population at large<sup>22</sup>. People with MS have a two-fold higher risk of mortality and a three-fold higher risk of experiencing a cardiovascular event as compared to people without MS<sup>2</sup>. While the definitions most widely used are those of ATP III, WHO and EGIR, the IDF reached in May 2005 a consensus for defining the MS, taking into account the opinion of experts from all over the world, including diabetologists, cardiologists, lipidologists, epidemiologists, geneticists and experts on metabolism and nutrition. All above definitions include among their criteria estimations of abdominal obesity, high blood pressure, dyslipidemia and hyperglycaemia. However, it should be noted that some of these criteria used to define MS are ambiguous or incomplete<sup>5,7,23</sup>. For instance, it is not clear whether the definition of blood pressure is  $\geq 130$  and  $85 \text{ mmHg}$ , or if it is systolic blood pressure  $\geq 130 \text{ mmHg}$  or diastolic blood pressure  $> 85 \text{ mmHg}$ . Similarly, it has not been defined whether blood pressure should be measured with the patient sitting or in a supine position, or whether one or two serial measurements with a 5-min interval should be made. This ambiguity will affect the sensitivity and specificity of MS diagnosis. Similarly, the impact of false positive or false negative results has not been calculated either. The ATP III and IDF definitions are possibly the ones proving to be most straightforward in daily clinical practice, because they are based on easily obtained anthropometric and laboratory measurements<sup>24</sup>. The WHO definition is more difficult to apply for a number of reasons<sup>25</sup>. The first of these is the need to perform an oral glucose tolerance test in some patients, when the current trend set by the American Diabetes Association (ADA) is not to perform this test for diagnosis in risk patients, but to establish instead increasingly lower cutoff points in fasting blood glucose values<sup>5</sup>. The second reason is that microalbuminuria is infrequently measured in standard clinical practice in non-diabetic patients, and the final reason is that basal blood insulin is not routinely measured, and its concentrations are not properly standardised<sup>26</sup>. Moreover, a specific cutoff point has not been established in basal insulin values for the calculation of insulin resistance.

The main differences between the ATP III and IDF classifications used in this study lie in the central obesity criterion, as each definition uses different cutoff points. The IDF emphasises ethnic differences in the correlation between abdominal obesity and MS risk factors. The IDF also believes it essential for MS diagnosis that the waist perimeter criterion should be met, but it should be considered in a closer correlation with insulin resistance than other risk factors, unlike the ATP III definition, for which it would not be required for diagnosing MS if other three criteria are present.

Both definitions used in this study consider fasting glucose values  $\geq 100$  mg dl<sup>-1</sup>, by applying the ADA criterion for altered basal blood glucose of glycaemia<sup>27</sup>, unlike previous classifications of MS.

Will this difference in cutoff points improve the value of MS for predicting cardiovascular risk? In a study conducted in males with MS, Lakka *et al.*<sup>28</sup> found that CVD and mortality were more prevalent when a waist circumference of 102 cm was used as compared to a waist circumference of 94 cm. Other investigators<sup>29</sup> showed that lowering the diagnostic cutoff point of altered basal glycaemia from 110 to 100 mg dl<sup>-1</sup> did not result in any change in the calculation of the odds ratio for estimating the risk of CVD, although the number of individuals identified increased. Similarly, there is no evidence to warrant the use of different cutoff points by sex, race or ethnic group in order to define the MS criteria as cardiovascular risk predictors, although the American Heart Association (AHA) and the National Heart, Lung and Blood Institute (NHLBI)<sup>30</sup> think that the waist circumference cutoff point should be different depending on the ethnic group, because they believe that some ethnic groups (e.g. Asian Americans) are particularly prone to insulin resistance and MS with only moderate waist circumference increases (e.g.  $\geq 90$  cm in males and  $\geq 80$  cm in females).

Of the five classifications, only the EGIR and AACE exclude diabetes as a diagnostic criterion for the MS, in contrast to the ATP III, WHO and IDF definitions; this is a controversial point<sup>31</sup>. Apart from the IDF and ATP III 2005, no definition explicitly includes the use of medications for high blood pressure or dyslipidaemia as part of the definition.

It should be borne in mind that estimation of the prevalence of MS in this study was carried out in a white European population. This fact is important for data interpretation, because the prevalence of the MS varies according to the different population studies. An interesting demonstration of the effect of race on the MS is the comparison of its prevalence, defined according to the ATP III criteria, in studies conducted in Finnish males<sup>32</sup> and American Indians<sup>33</sup>. These studies included age-matched subjects and reported MS prevalences of 14% in Finnish subjects and 43.6% in American Indians. This difference may be due to a lower prevalence of atherogenic dyslipidaemia in the white population<sup>22</sup>. MS prevalence appears to be higher when the WHO definition is used as compared to the ATP III criteria, and even more so when compared to the prevalence using the EGIR definition. Such difference is more marked among men, particularly between the EGIR and the WHO definitions. No data are yet available from epidemiological studies using the IDF definition. The prevalence of MS using the ATP III, EGIR and WHO definitions was analyzed in two studies, one by an Australian group<sup>34</sup> and the other, the Mauritius study<sup>35</sup>. In these studies, MS prevalence using

the WHO definition was higher than when the EGIR or ATP III definitions were used. In the Mauritius study, MS prevalence in men using the ATP III, EGIR and WHO definitions was 10.6%, 9% and 20.9%, respectively. The corresponding values for women were 14.7%, 10.2% and 17.6%. In the Australian study (AusDiab study), the prevalence of MS among males was 19.5%, 18.6% and 25.2% using the ATP III, EGIR and WHO definitions, respectively, and prevalence in females was 17.2%, 13.3% and 16.7%, respectively. This difference between the three classifications is seen in this study, which found prevalence values of the MS in males of 32.7%, 20.5% and 44% with the ATP III, EGIR and WHO definitions, respectively. A similar difference was also found in women, in whom the prevalence of MS was 25.5%, 13.6% and 32.2%, respectively. A possible explanation as to why MS prevalence cannot exceed 25% when the EGIR definition is used is that the first criterion of such definition involves having basal insulin levels above the 75th percentile for a non-diabetic population. It should be noted that the variation in MS prevalence among men and women in the different populations using the ATP III and WHO criteria is not so marked as when the EGIR definition is applied.

When it comes to interpreting the higher prevalence of MS apparent in this study as compared to other previously reported studies, it should be taken into account that subjects included in this study had overweight or obesity, unlike in an epidemiological study of the population at large. The association between the prevalence of the MS and BMI was also evaluated in a recent study of the Third National Health and Nutrition Examination Survey, which shows an increment of the prevalence of MS in patients with overweight and obesity. They find that 4.6%, 22.4% and 59.6% of normal-weight, overweight and obese men met the MS diagnostic criteria, with similar results in women<sup>36</sup>.

In the present study, the prevalence of all changes is substantially increased among obese patients as compared to overweight patients, but we are unable to establish whether this difference is significant or not, probably because of the limited number of patients in each comparison group. In both the ATP III and IDF classifications, the presence of central obesity is the most prevalent parameter among the MS criteria. This fact was also observed in other studies, such as the Insulin Resistance in Atherosclerosis Study (IRAS)<sup>37</sup>. In both definitions, waist perimeter was used to evaluate central obesity, but with a different cutoff point. Based on the results of the participants in the Han *et al.*<sup>38</sup> and Lean *et al.*<sup>39</sup> studies, three levels of cardiovascular risk were established according to the waist perimeter cutoff point. They proposed that a waist circumference value less than 94 cm in men and 80 cm in women would be low risk; the 94–102 cm range in men and 80–88 cm in women would be an intermediate risk; and a value above 102 cm in men

and 88 cm in women would be high risk, in which case medical attention and a weight loss program would be indicated. The ATP III adopted this last level as the criterion for MS. The IDF, however, uses the intermediate risk range as the criterion for MS diagnosis.

## Conclusions

The results of this study show a higher prevalence of the MS in the population of patients with overweight or obesity as compared to a general population, as was to be expected. Few prevalence studies have been performed, but they all report the difference between the various classifications, showing that they are probably not measuring the same thing. Although the ATP III and IDF definitions are easier to apply in daily clinical practice, we think that further studies are required to ascertain their correlation with insulin resistance, so that criteria may be unified when it comes to defining MS, and a more valid comparison may be made of the worldwide extent of this epidemic.

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A.S. had the original idea, analysed the data, wrote the first draft, and edited subsequent versions. D.B. and M.B. analysed the data, and edited the manuscript, S.P. carried out the statistical analysis, D. de Luis supervised the field data collection, and M. Lopez de la Torre supervised the study and edited the manuscript.

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