The aim of this study was to determine the impact of the metabolic syndrome on vascular disease risk in patients with type-2 diabetes. A prospective cohort study was carried out. The main dependent variable was the combination of coronary disease, stroke, and lower leg amputation. Cox regression modeling was used. In total, 317 patients were followed for a mean of 7.7 years. The prevalence of metabolic syndrome was 87%. Multivariate analysis identified the following as predictors of incident vascular disease: age (relative risk [RR] = 1.06; 95% confidence interval [CI], 1.02-1.1; \( P = 0.0003 \)), baseline cardiovascular disease (RR = 1.8; 95% CI, 1.1-3.0; \( P = 0.017 \)), and the simultaneous presence of four metabolic risk factors (RR = 5.8; 95% CI, 1.8-18; \( P = 0.003 \)). The most predictive factor was microalbuminuria (\( \chi^2 = 5.9; P = 0.015 \)). Microalbuminuria accounts for the increased risk of vascular disease in patients with type-2 diabetes. It is more important to consider the total number of metabolic risk factors than the presence of metabolic syndrome alone.

**Key words:** Syndrome X, Diabetes mellitus. Cardiovascular disease.

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**INTRODUCTION**

There are a number of definitions of metabolic syndrome (MS),\(^1\) an entity that nearly doubles the risk of cardiovascular disease (CVD).\(^2\) Nevertheless, the utility of identifying diagnostic criteria for MS in patients who have already developed type 2 diabetes mellitus (DM2), and even MS itself, has recently been questioned.\(^3,5\)

In a previous article,\(^6\) we demonstrated that the simultaneous presence of all the components of MS, defined according to the World Health Organization (WHO),\(^7\) was related to an increase in the cardiovascular risk of patients with DM2. In the present report, we attempt to validate the utility of diagnosing MS in patients with DM2 and to determine whether all its components have the same prognostic value.

**METHODS**

A prospective cohort study was carried out in a previously defined population.\(^6\) Between June 1, 1994 and June 1, 1998, DM2 patients were selected from the out-patient
endocrinology clinic of the Regional Hospital in Alcañiz, Teruel, in eastern Spain. The present study involves 317 of the 318 patients of the original cohort.

The definition of MS was based on that provided by the WHO, according to which a person with diabetes has MS if he or she meets 2 or more of the following criteria: hypertension (systolic pressure ≥140 mm Hg and/or diastolic pressure ≥90 mm Hg, and/or receiving hypotensive agents), dyslipidemia (triglyceride levels ≥150 mg/dL and/or high-density lipoprotein level <35 mg/dL in men, or <39 mg/dL in women), obesity (body mass index >30 and/or waist-to-thigh ratio >0.9 in men, or >0.85 in women), and microalbuminuria (albumin excretion rate >30 mg/24 hours).

The follow-up of the cohort was prospective in all the patients until their death or until the end of the study, on February 14, 2005. The development of clinical events and causes of death were obtained from the hospital records or through the attending primary care physician, as described in our previous article.

The numbers of events per 1000 person-years were compared using Kaplan-Meier analysis and the log-rank test. The independent contribution of MS was evaluated progressively by means of the $\chi^2$ test. A $P$ value less than .05 was considered to indicate statistical significance.

**RESULTS**

The study included 317 patients (129 men and 188 women), with a mean age (standard deviation [SD]) of 64.6 (9) years and a duration of diabetes of 10.8 (7.7) years. The prevalence of MS was 87%.

The mean duration of follow-up in event-free patients was 7.7 years, with a total of 2151 patient-years. There were 15 new-onset anginas (4.7%), 18 nonfatal AMI (5.7%), 9 fatal AMI (2.8%), 12 TIA (3.8%), 16 nonfatal strokes (5%), 2 fatal strokes (0.6%), 5 sudden deaths (1.6%), and 4 above-knee amputations (1.3%). The incidence rates of CVD and coronary artery disease increased as the number of metabolic risk factors grew ($P=0.007$ in a linear trend for CVD and $P=0.01$ for coronary events; Figures 1 and 2).

The univariate predictors of CVD and coronary artery disease with a $P<.1$ appear in Table 1.

In the multivariate analysis, with adjustments for age, sex, duration of diabetes, smoking, glycohemoglobin (HbA1c), low-density lipoprotein cholesterol (LDL-C), and prevalent CVD, MS did not significantly increase the risk of incident CVD (relative risk [RR]=2.5; 95% confidence interval [CI], 1.1-5; $P=0.07$) or of coronary events (RR=2.7; 95% CI, 0.6-11; $P=0.18$).

The significant predictors of incident CVD in the multivariate analysis were: age (RR=1.06; 95% CI, 1.02-1.1; $P=0.003$), prevalent CVD (RR=1.8; 95% CI, 1.1-3; $P=0.017$), and the simultaneous existence of 4 metabolic risk factors (RR=5.8; 95%CI, 1.8-18; $P=0.003$). For
coronary artery disease, they were: LDL-C (RR=1.01; 95% CI, 1.00-1.02; \( P = .03 \)), prevalent CVD (RR=2.3; 95% CI, 1.2-4.3; \( P = .01 \)), and the simultaneous existence of four metabolic risk factors (RR=7.4; 95% CI, 1.5-36; \( P = .013 \)). In an additional analysis, according to the ATP-III definition, MS was not related to an increase in total cardiovascular risk (RR=1.22; 95% CI, 0.7-2.1; \( P \) not significant) or coronary risk (RR=1.016; 95% CI, 0.49-2.28; \( P \) not significant).

### TABLE 1. Predictive Variables for the Onset of Total Cardiovascular and Coronary Events With \( P < .1 \) in Univariate Analysis

<table>
<thead>
<tr>
<th>Variable</th>
<th>Total CVD RR</th>
<th>95% CI</th>
<th>( P )</th>
<th>Coronary Artery Disease RR</th>
<th>95% CI</th>
<th>( P )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (1 year)</td>
<td>1.05</td>
<td>1.02-1.08</td>
<td>.0002</td>
<td>1.03</td>
<td>1.01-1.07</td>
<td>.07</td>
</tr>
<tr>
<td>Prevalent CVD</td>
<td>2.3</td>
<td>1.4-3.6</td>
<td>.0005</td>
<td>2.9</td>
<td>1.6-5.2</td>
<td>.0003</td>
</tr>
<tr>
<td>Current smoking</td>
<td>1.7</td>
<td>0.9-3.2</td>
<td>.08</td>
<td>2.9</td>
<td>1.3-6.4</td>
<td>.03</td>
</tr>
<tr>
<td>LDL-C (1 mg/dL)</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>1.01</td>
<td>1.01-1.02</td>
<td>.05</td>
</tr>
<tr>
<td>Metabolic syndrome</td>
<td>2.5</td>
<td>1.6-6.2</td>
<td>.047</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>3 metabolic RF</td>
<td>2.6</td>
<td>1.6-7.7</td>
<td>.04</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>4 metabolic RF</td>
<td>4.8</td>
<td>1.7-13</td>
<td>.003</td>
<td>5.5</td>
<td>1.5-20.5</td>
<td>.01</td>
</tr>
</tbody>
</table>

CI indicates confidence interval; CVD, cardiovascular disease; LDL-C, low-density lipoprotein cholesterol; RF, risk factors; RR, relative risk (unadjusted) conferred by each variable.

### TABLE 2. Improvement in the Plausibility of the Cox Regression Models for Predicting the Onset of Total Cardiovascular and Coronary Events When the Different Components of the Metabolic Syndrome (MS) Were Introduced Progressively, and, Finally, MS Itself

<table>
<thead>
<tr>
<th>Variable</th>
<th>Total CVD (-2LL)</th>
<th>( \chi^2 )</th>
<th>( P )</th>
<th>Coronary Artery Disease (-2LL)</th>
<th>( \chi^2 )</th>
<th>( P )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial model(^1)</td>
<td>831.75</td>
<td>—</td>
<td>—</td>
<td>472.12</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Obesity</td>
<td>830.70</td>
<td>1.05</td>
<td>.3</td>
<td>472.09</td>
<td>0.03</td>
<td>.86</td>
</tr>
<tr>
<td>Dyslipidemia</td>
<td>829.35</td>
<td>1.35</td>
<td>.24</td>
<td>471.03</td>
<td>1.06</td>
<td>.3</td>
</tr>
<tr>
<td>Hypertension</td>
<td>826.00</td>
<td>3.35</td>
<td>.07</td>
<td>467.65</td>
<td>3.38</td>
<td>.07</td>
</tr>
<tr>
<td>Microalbuminuria</td>
<td>820.06</td>
<td>5.94</td>
<td>.015</td>
<td>464.06</td>
<td>3.59</td>
<td>.05</td>
</tr>
<tr>
<td>Metabolic syndrome</td>
<td>819.95</td>
<td>0.12</td>
<td>.5</td>
<td>464.01</td>
<td>0.05</td>
<td>.82</td>
</tr>
</tbody>
</table>

CVD indicates cardiovascular disease; \(-2LL\), plausibility of the Cox regression models.

\(^{1}\) Constituted by age, sex, duration of diabetes, smoking, glycohemoglobin, low-density lipoprotein cholesterol, and prevalent CVD.
DISCUSSION

In the present report, we have confirmed the fact that there is an increase in total cardiovascular risk and coronary risk in patients with DM2 who present the largest number of metabolic risk factors, and that microalbuminuria was the factor with the greatest predictive power.

Type 2 diabetes mellitus is associated with insulin resistance and a high prevalence of MS. The advisability of performing diagnostic tests for MS in patients with DM2 is a matter of controversy, with inconsistent results reported in the medical literature with regard to its ability or inability to predict cardiovascular events. Other findings of these studies are that the risk increases as the number of metabolic risk factors grows and that microalbuminuria is the component with the greatest predictive power.

In our study, MS did not significantly increase vascular risk, probably because of the limited number of subjects. Given the high prevalence of MS in DM2, in these patients, we consider it to be of greater interest to take into account the total number of metabolic risk factors than whether or not they have MS. The fact that the greatest part of the risk conferred by MS was due to the inclusion of microalbuminuria, a marker of generalized endothelial dysfunction, in its definition was also very interesting. In fact, when the ATP-III definition was applied, MS was related to a lesser increase in vascular risk (1.22 vs 2.5) than when the WHO definition was employed. Thus, we consider the elimination of microalbuminuria from the recent definitions of MS to be the right move.

In conclusion, we think it is more important to consider the number of metabolic risk factors than MS in the evaluation of the vascular risk of the patient with DM2. Given that microalbuminuria is a marker of endothelial dysfunction, we feel that its exclusion from the definition of MS to be the proper approach.

REFERENCES