Relation Between the Metabolic Syndrome and Ischemic Stroke or Transient Ischemic Attack
A Prospective Cohort Study in Patients With Atherosclerotic Cardiovascular Disease
N. Koren-Morag, PhD; U. Goldbourt, PhD; D. Tanne, MD

Background and Purpose—The combination of risk factors known as the metabolic syndrome is receiving increased attention, but prospective data on the syndrome’s association with ischemic cerebrovascular events are scarce. We explored the relation of metabolic syndrome versus frank diabetes with first-ever ischemic stroke or transient ischemic attack (TIA) in a large cohort of patients with atherosclerotic cardiovascular disease.

Methods—Patients with coronary heart disease, screened for a clinical trial, underwent an extensive medical evaluation and follow-up for cerebrovascular disease over 4.8 to 8.1 years. National Cholesterol Education Program Adult Treatment Panel III criteria were used to define the metabolic syndrome, with body mass index substituted for waist circumference. Patients with previously diagnosed diabetes or with a fasting plasma glucose level \( \geq 125 \text{ mg/dL} \) (\( \geq 7.0 \text{ mmol/L} \)) were considered diabetic.

Results—The study sample comprised 14,284 patients, of which 3703 (26%) fulfilled the criteria for the metabolic syndrome without diabetes and 3500 others (25%) the criteria for diabetes. Adjusting for stroke risk factors, patients with the metabolic syndrome without diabetes exhibited a 1.49-fold increased odds for ischemic stroke or TIA (95% confidence interval [CI], 1.20 to 1.84), whereas those with frank diabetes had a 2.29-fold increased odds (95% CI, 1.88 to 2.78). The relative odds for ischemic stroke or TIA, associated with presence of the metabolic syndrome per se, were 1.39 (95% CI, 1.10 to 1.77) in men but 2.10 (95% CI, 1.26 to 3.51) in women. Although all components of the metabolic syndrome were associated with increased risk for ischemic stroke or TIA, impaired fasting glucose and hypertension were the strongest predictors of risk.

Conclusions—The presence of the metabolic syndrome, even without diabetes, in patients with pre-existing atherosclerotic vascular disease identifies patients at increased risk for ischemic stroke or TIA. The suggestion of more pronounced risk associated with the metabolic syndrome in women deserves further assessment in other cohorts. (Stroke. 2005;36:1366-1371.)

Key Words: metabolism • prospective studies • stroke, ischemic

The term “metabolic syndrome” has been proposed to define a cluster of several risk factors for cardiovascular disease.1,2 The National Cholesterol Education Program Adult Treatment Panel III (NCEP/ATP III) report3 formulated their definition of metabolic syndrome for clinical use. It is based on the presence of \( \geq 3 \) of the following components: high fasting glucose, high blood pressure, low high-density lipoprotein cholesterol, high triglycerides, and abdominal obesity. Prospective studies have shown that the presence of the metabolic syndrome is associated with a significant increased risk of morbidity and mortality from cardiovascular disease.4–11 Although the metabolic syndrome is often considered a prediabetic condition and diabetes is a major risk factor for ischemic stroke, the association of the metabolic syndrome without diabetes with incident ischemic cerebrovascular events has not been studied in depth. The aim of the current study is to assess the prevalence of the metabolic syndrome in a large cohort of patients with atherosclerotic cardiovascular diseases and to explore the relation of the metabolic syndrome with first-ever ischemic cerebrovascular events.

Materials and Methods

Patients
The initial study sample comprised 15,524 patients with documented coronary heart disease (CHD) screened in 18 centers for inclusion in a placebo-controlled secondary prevention randomized clinical trial, assessing the effect of bezafibrate on recurrent events and mortality.
(the BIP randomized clinical trial). In this trial, bezafibrate retard users and nonusers exhibited comparable rates of incident stroke. We deduced that this justifies including the bezafibrate retard users with others in the current analysis. Patients were screened between February 1990 and October 1992. Patients aged 45 to 74 years with diagnosis of CHD were eligible for screening if they had evidence of myocardial infarction occurring ≥6 months but ≤5 years before enrollment, or coronary insufficiency observed either at rest or during effort, as manifested by typical pain and dynamic electrocardiographic changes, or both. Myocardial infarction was defined by standard clinical definition at the time of the screening. Coronary insufficiency episodes must have occurred between 6 months and 2 years before enrollment. During the first visit, records were obtained on the candidate’s medical history, conventional risk factors, and medication used, and a complete physical examination was performed. Patients with a history of previous stroke or transient ischemic attack (TIA) were excluded to assess the risk of first-ever stroke. For 805 patients who underwent the baseline examinations, the long-term fate is not known, because they were neither citizens nor permanent residents and were therefore excluded from analyses. Additional 435 patients were excluded because of diagnoses of subarachnoid hemorrhage or subdural hematoma or history of a previous cerebrovascular event. The final study sample therefore comprised 14,284 patients.

**Laboratory Examination**
Laboratory measurements were performed in a central laboratory (Physiological and Hygiene Laboratory, Wolfson Medical Center, Holon, Israel). All analyses were performed with a Boehringer-Hitachi 704 random-access analyzer with Boehringer diagnostic kits. Accuracy and precision were under periodic surveillance by the Centers for Disease Control and Prevention Service in Atlanta, Georgia. Blood samples were taken after 12 hours of fasting. Glucose concentrations were determined using an enzymatic colorimetric method (GOD/PAP). Cholesterol was determined by the CHOD-PAP method.

**Definition of Diabetes and Metabolic Syndrome**
According to the 1999 WHO Consultation recommendations for the diagnosis of diabetes, patients with previously diagnosed diabetes (reported history of diabetes diagnosed by a physician or patients who were taking antidiabetic medication) or with a fasting plasma glucose level >125 mg/dL (≥7.0 mmol/L) were considered as having diabetes. Patients were considered as having the metabolic syndrome if they had ≥3 of the following components, based on modification of the NCEP/ATP III: hypertension defined as a systolic blood pressure ≥130 mm Hg and/or a diastolic blood pressure ≥85 mm Hg and, by history of hypertension, raised plasma triglycerides (≥150 mg/dL [1.7 mmol/L]), low high-density lipoprotein cholesterol levels (<40 mg/dL in men and <50 mg/dL in women), and impaired fasting glucose defined as fasting plasma glucose concentration ≥110 mg/dL (6.1 mmol/L), but less than the criteria for diabetes of >125 mg/dL (≥7.0 mmol/L). For a definition of obesity, we used a body mass index ≥30 kg/m² instead of waist circumference because the latter was not measured in our cohort.

**Assessment of Cerebrovascular Disease**
We obtained computerized data files of hospitalizations with a diagnosis of cerebrovascular disease (ICD-9 codes 430 to 438 or code 38.1—endarterectomy surgery) during 1997 to 1998 4.8 to 8.1 years after the screening process that took place between 1990 and 1992. We matched the patients against a registry of all hospitals but one and the Clalit Health Services (insuring >60% of population) participating in the screening process. Patients were identified and attainable medical records and hospital discharge summaries were systematically reviewed. Data were collected on history, findings on neurological examination, brain CT, and ancillary examinations, as available, to verify the diagnosis and to determine stroke type. Stroke was defined according to World Health Organization (WHO) criteria. Ischemic stroke and intracerebral hemorrhage were differentiated by the results of brain CT performed at the acute stage. Ischemic stroke was diagnosed if the patient had an appropriate clinical event and had a brain CT that showed a compatible low-density lesion or was normal, or had findings compatible with hemorrhagic conversion of a cerebral infarct. Events resolving completely within <24 hours were diagnosed as TIA. Of 1111 cases considered having any incident ischemic cerebrovascular disease by ICD 9 codes, in 614 patients the diagnosis of ischemic stroke or TIA was verified after review of medical records, and these cases were regarded as the endpoint for this analysis. Remaining patients were admitted for carotid endarterectomy surgery for asymptomatic disease, or medical records were not available for review, or brain CT was not performed, so that the type of cerebrovascular disease could not be determined.

**Statistical Analysis**
ANOVA and the χ² tests were performed for the baseline characteristics and major risk factors differences between the 3 groups, including components of the metabolic syndrome. Age-adjusted rates of ischemic stroke or TIA incidence by the number of components of the metabolic syndrome were calculated. Adjusted odds ratios (ORs) for the incidence of ischemic stroke or TIA and 95% confidence intervals (CIs) were calculated from multivariate logistic regression for each component of metabolic syndrome. To estimate the risk prediction by the number of these components and the independent contribution of the metabolic syndrome, predicted ischemic stroke or TIA rates were calculated by the logistic regression model, adjusting for age, sex, current smoking, past myocardial infarction, peripheral vascular disease, lipid-modifying drugs, low-density lipoprotein cholesterol, and antplatelets and antihypertensive medications. The Hosmer-Lemeshow goodness-of-fit test was performed to assess overall model fit. Time-to-event measurements were calculated as time from screening to the occurrence of the events (fatal and nonfatal) or time of screening to death from other causes, or time to the end of follow-up. The log rank test was calculated to compare survival curves. Data were analyzed with the SPSS version 12.0 kit.

**Results**
The study sample comprised 14,284 patients, of which 7203 (50%) fulfilled the criteria for either the metabolic syndrome or diabetes. Criteria for the metabolic syndrome without diabetes were met by 3703 (26%) patients and for diabetes by an additional 3500 (25%) patients. Changing the criteria for impaired fasting glucose to plasma glucose concentration ≥100 mg/dL would have increased the rate of the metabolic syndrome without diabetes to 31% and of the metabolic syndrome or diabetes to 56%.

Comparisons of baseline clinical, demographic, and metabolic characteristics of patients with metabolic syndrome, diabetes, or neither are given in Table 1. Table 2 presents the rates and ORs for incident ischemic stroke or TIA by the different components of metabolic syndrome among patients without diabetes. Each of the components individually was a significant predictor for ischemic stroke or TIA. The strongest predictors were impaired fasting glucose and hypertension. As compared with patients without any component of the metabolic syndrome, the adjusted ORs for incident ischemic stroke or TIA among patients without diabetes increased from 1.27 for one component to 1.93 for 3 components and as high as 2.36 for 4 or 5 components (Table 3). Trends were more pronounced in women, as depicted in Figure 1.

Adjusting for stroke risk factors, patients with the metabolic syndrome without diabetes exhibited a 1.49-fold in-
creased odds of ischemic stroke or TIA (95% CI, 1.20 to 1.84), whereas those with frank diabetes had a 2.29-fold increased odds (95% CI, 1.88 to 2.78). The relative odds of ischemic stroke or TIA associated with presence of the metabolic syndrome per se were 1.39 (95% CI, 1.10 to 1.77) in men but 2.10 (95% CI, 1.26 to 3.51) in women (Table 4). Changing the criteria for impaired fasting glucose to plasma glucose concentration /H11022100 mg/dL, the ORs remained sig-

TABLE 1. Baseline Characteristics of Screened Patients With Coronary Heart Disease

<table>
<thead>
<tr>
<th></th>
<th>Neither Metabolic Syndrome nor Diabetes</th>
<th>Metabolic Syndrome Per Se</th>
<th>Diabetes n=3500</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, y</td>
<td>59.8±7.2</td>
<td>59.3±7.1</td>
<td>60.3±6.6</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Male</td>
<td>5898 (83)</td>
<td>2967 (80)</td>
<td>2722 (77)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Hypertension</td>
<td>1744 (25)</td>
<td>1520 (41)</td>
<td>1405 (40)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Current smoking</td>
<td>696 (10)</td>
<td>481 (13)</td>
<td>348 (10)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Past myocardial infarction</td>
<td>5073 (72)</td>
<td>2679 (72)</td>
<td>2565 (74)</td>
<td>0.203</td>
</tr>
<tr>
<td>Body mass index, kg/m²</td>
<td>25.6±2.8</td>
<td>28.1±3.8</td>
<td>27.4±3.9</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Systolic blood pressure</td>
<td>130±19</td>
<td>139±18</td>
<td>138±20</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Diastolic blood pressure</td>
<td>80±10</td>
<td>84±9</td>
<td>82±10</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Total cholesterol, mg/dL</td>
<td>220±37</td>
<td>230±41</td>
<td>226±42</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>LDL cholesterol, mg/dL</td>
<td>155±33</td>
<td>157±36</td>
<td>153±35</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>HDL cholesterol, mg/dL</td>
<td>41±11</td>
<td>33±7</td>
<td>37±10</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>%HDL</td>
<td>18.9±5.1</td>
<td>14.6±3.3</td>
<td>16.6±4.9</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Triglycerides, mg/dL</td>
<td>120±56</td>
<td>204±90</td>
<td>183±110</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Fasting glucose, mg/dL</td>
<td>93±10</td>
<td>99±13</td>
<td>172±61</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>White blood cells, 10⁹/L</td>
<td>6.66±1.72</td>
<td>6.98±2.07</td>
<td>7.00±1.81</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Antiplatelets, %</td>
<td>4399 (62)</td>
<td>2169 (58)</td>
<td>1903 (54)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>ACE inhibitors</td>
<td>631 (8.9)</td>
<td>397 (10.7)</td>
<td>456 (13.0)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Diuretics</td>
<td>847 (12.0)</td>
<td>641 (17.3)</td>
<td>669 (19.1)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>β-blockers</td>
<td>2310 (32.6)</td>
<td>1537 (41.5)</td>
<td>1218 (34.8)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Calcium antagonist</td>
<td>3475 (49.1)</td>
<td>1864 (50.3)</td>
<td>1863 (53.2)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Antihypertensive therapy (%)</td>
<td>5380 (76)</td>
<td>3009 (81)</td>
<td>2856 (82)</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

ACE indicates angiotensin-converting enzyme; HDL, high-density lipoprotein; %HDL, percent HDL out of total cholesterol; LDL, low-density lipoprotein.

Data for continuous variables is given as mean (SD) and for categorical variables as N (%).

TABLE 2. Rates and Odds Ratios for Incident Ischemic Stroke or Transient Ischemic Attacks by Each Component of Metabolic Syndrome Among Patients Without Diabetes

<table>
<thead>
<tr>
<th></th>
<th>Adjusted for Age and Sex</th>
</tr>
</thead>
<tbody>
<tr>
<td>Triglycerides</td>
<td></td>
</tr>
<tr>
<td>&lt;150 mg/dL</td>
<td>No.</td>
</tr>
<tr>
<td>≥150 mg/dL</td>
<td>4152</td>
</tr>
<tr>
<td>High-density lipoprotein cholesterol</td>
<td></td>
</tr>
<tr>
<td>≥50 mg/dL in females and ≥40 mg/dL in males</td>
<td>3245</td>
</tr>
<tr>
<td>&lt;50 mg/dL in females and &lt;40 mg/dL in males</td>
<td>7539</td>
</tr>
<tr>
<td>Obesity</td>
<td></td>
</tr>
<tr>
<td>Body mass index ≥30 kg/m²</td>
<td>9289</td>
</tr>
<tr>
<td>Body mass index &gt;30 kg/m²</td>
<td>1495</td>
</tr>
<tr>
<td>Hypertension</td>
<td></td>
</tr>
<tr>
<td>No history of hypertension and blood pressure &lt;130/85 mm Hg</td>
<td>2899</td>
</tr>
<tr>
<td>History of hypertension or blood pressure ≥130/85 mm Hg</td>
<td>7885</td>
</tr>
<tr>
<td>Glucose</td>
<td></td>
</tr>
<tr>
<td>No history of diabetes and glucose &lt;110 mg/dL</td>
<td>9548</td>
</tr>
<tr>
<td>No history of diabetes and glucose 110–126 mg/dL</td>
<td>1236</td>
</tr>
</tbody>
</table>

TABLE 1. Baseline Characteristics of Screened Patients With Coronary Heart Disease
The metabolic syndrome comprises a cluster of abnormal-
ities that occur as a result of perturbations in multiple
metabolic pathways, leading to hyperinsulinemia, insulin
resistance hyperglycemia, atherogenic dyslipidemia, and hy-
pertension. The root causes of the syndrome appear to be
multiple and include obesity (especially abdominal obesity),
physical inactivity, insulin resistance, aging, and genetics.19

Several studies have also shown that the metabolic syndrome
is a proinflammatory condition.20,21 The incremental increase in
ischemic stroke or TIA risk with increasing number of components constituting the meta-
abolic syndrome supports the requirement of the NCEP/ATP
III of at least 3 components for establishing the diagnosis of
metabolic syndrome3 and demonstrates the further increase in
risk for those with 4 or 5 components of the syndrome.
Comparable findings were observed for cardiovascular disease
with ≥5-fold increased risk in patients with ≥4 components
compared with those with ≤1 component during a 5-year observational period.10 Increment in the number of
components constituting the metabolic syndrome was also
significant for men (OR, 1.31; 95% CI, 1.03 to 1.61) and further
increased for women up to OR of 2.39 (95% CI, 1.63 to 4.61).
The Hosmer and Lemeshow goodness-of-fit test (P=0.352)
did not exhibit a meaningful departure of the observed from
the expected rates according to the model. The differences
(P<0.001, the log-rank test) between the cumulative event-
free curves of the 3 groups by gender, adjusting for age, are
depicted in Figure 2.

Compared with nondiabetic patients without the metabolic
syndrome, adjusted ORs were 1.45 (95% CI, 1.15 to 1.84) for
diabetic patients with 3 components of the metabolic syn-
drome, 1.69 (95% CI, 1.20 to 2.37) for nondiabetic patients
with >3 components of the metabolic syndrome, 1.95 (95%
CI, 1.42 to 2.68) for diabetic patients with <3 components
of the metabolic syndrome, and 2.47 (95% CI, 2.00 to 3.05) for
diabetic patients with ≥3 components of the metabolic
syndrome.

**Discussion**

In the current analysis of >14 000 CHD patients we found a
significant increase in the risk of ischemic stroke or TIA in
the presence of the metabolic syndrome without diabetes. The
presence of the metabolic syndrome per se was associated
with a 1.5-fold higher risk versus >2-fold higher risk associ-
ated with the presence of diabetes. This implies that
identification of the metabolic syndrome in this high-risk
category of patients, even before the occurrence of diabetes,
could identify patients at a greater risk of ischemic cerebro-
vascular event. Although both men and women with the
metabolic syndrome were at increased risk of ischemic stroke,
the latter was more pronounced in women (OR=2.10) than in men (OR=1.39), in agreement with increased relative
cardiovascular risk among prediabetic women in comparison
to men.13

Over half the patients in our cohort had either the meta-
bolic syndrome or diabetes (26% with metabolic syndrome
without diabetes and 25% diabetic). This high prevalence is
comparable to other cohorts of patients with manifest athero-
sclerotic vascular disease14 and higher than the prevalence
(26%) in a cohort representative of the adult US population.11
The newly recommended criteria for impaired fasting glucose
is ≥100 mg/dL,15 and such fasting glucose concentrations
identify patients at increased risk for ischemic stroke.16
Changing the criteria for impaired fasting glucose to ≥100
mg/dL increases the prevalence of the metabolic syndrome
without diabetes to nearly one-third of the cohort but does not
change materially the ORs for ischemic stroke or TIA.

Several studies have demonstrated that the presence of
metabolic syndrome is associated with an increased risk of
cardiovascular disease,4–11 but data on the association with
ischemic stroke is scarce. In a cross-sectional study from the
Third National Health and Nutrition Examination survey, the
metabolic syndrome was significantly associated with self-
reported myocardial infarction and stroke.17 The presence of
the metabolic syndrome was associated with increased car-
diovascular, as well as cerebrovascular, mortality.6,11 In a
prospective study of subjects with hypertension without
cardiovascular diseases, the metabolic syndrome was an
independent predictor for both cardiovascular and cerebro-
vascular disease (hazard ratio=2.1).18 Our current study extends
this association, finding an increased risk of ischemic stroke or
TIA in patients with atherosclerotic cardiovascular disease.

The metabolic syndrome comprises a cluster of abnormal-
ities that occur as a result of perturbations in multiple
metabolic pathways, leading to hyperinsulinemia, insulin
resistance hyperglycemia, atherogenic dyslipidemia, and hy-
pertension. The root causes of the syndrome appear to be
multiple and include obesity (especially abdominal obesity),
physical inactivity, insulin resistance, aging, and genetics.19
Several studies have also shown that the metabolic syndrome
is a proinflammatory condition.20,21

![Figure 1. Age-adjusted incidence rates per 100 person-years for ischemic stroke or TIA in men and in women by the number of metabolic syndrome components present.](http://stroke.ahajournals.org/)
TABLE 4. Adjusted Odds Ratios for Incident Ischemic Stroke or Transient Ischemic Attacks Associated With the Metabolic Syndrome and With Diabetes, by Gender*

<table>
<thead>
<tr>
<th></th>
<th>All (n=14 284), No. (%)</th>
<th>Adjusted OR</th>
<th>Men (n=11 587), No. (%)</th>
<th>Adjusted OR</th>
<th>Women (n=2697), No. (%)</th>
<th>Adjusted OR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neither metabolic syndrome nor diabetes</td>
<td>7081 214 (3.0)</td>
<td>1</td>
<td>187 (3.2)</td>
<td>1</td>
<td>27 (2.3)</td>
<td>1</td>
</tr>
<tr>
<td>Metabolic syndrome without diabetes</td>
<td>3703 161 (4.3)</td>
<td>1.49 (1.20–1.84)</td>
<td>126 (4.2)</td>
<td>1.39 (1.10–1.77)</td>
<td>35 (4.8)</td>
<td>2.10 (1.26–3.51)</td>
</tr>
<tr>
<td>Diabetes</td>
<td>3500 239 (6.8)</td>
<td>2.29 (1.88–2.78)</td>
<td>197 (7.2)</td>
<td>2.32 (1.88–2.88)</td>
<td>42 (5.4)</td>
<td>2.37 (1.43–3.90)</td>
</tr>
</tbody>
</table>

*Adjusted for age, sex, current smoking, past myocardial infarction, peripheral vascular disease, lipid-modifying drugs, LDL cholesterol, antiplatelets, and antihypertensives.

associated in a cross-sectional study with an increase in surrogate markers of vascular damage in patients with manifest atherosclerotic vascular disease.22

Our study has several limitations. First, information concerning potential spontaneous or therapy-induced changes in the components of metabolic syndrome during follow-up was not available. We have controlled for the use of lipid-modifying drugs at baseline. It should be noted, however, that statin therapy was gradually introduced only in the latter part of the follow-up period. Second, data on the incidence of ischemic stroke or TIA were obtained through medical records from participating hospitals. Patients with minor strokes not admitted to hospital and those who had been re-admitted to a nonparticipating hospital would have been missed. Incidence rates, however, were comparable in patients followed-up routinely as part of a randomized clinical trial12 and patients for whom data were obtained through medical records. Complete medical records were not available in all cases, but comparable findings were observed also for the endpoint of all ischemic cerebrovascular disease (n=1111) defined by ICD codes. Finally, our findings involve a cohort of patients with manifest atherosclerotic disease, and these results should not be generalized to other populations.

In the current study, we have found that components of metabolic syndrome are highly prevalent in patients with CHD. The components with strongest relation with ischemic stroke or TIA are hypertension and impaired fasting glucose. Although the metabolic syndrome without diabetes is a less potent risk factor for ischemic stroke or TIA than diabetes, it occurs more often than frank diabetes and its prevalence is reported to be continuously growing, making it a pertinent clinical entity.19 Further investigation is required in other cohorts to determine whether the metabolic syndrome increases the risk of ischemic stroke more in women than in men, as in the present cohort. Attention is required to identify the metabolic syndrome even in patients with pre-existing atherothrombotic disease. More intensive lifestyle changes and management protocols may be required in these patients for controlling the components of the syndrome, with the aim of preventing not only type II diabetes and cardiovascular disease but also ischemic cerebrovascular events.

References
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