

Metabolic Syndrome and Risk of Isolated ST-T Abnormalities and Type 2 Diabetes in Japanese Male Office Workers

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Abstract: Using a modified National Cholesterol Education Program (NCEP) definition of the metabolic syndrome (MS) with body mass index instead of waist circumference, we examined the associations of the MS with the risk of developing ST-T abnormalities in 3,405 Japanese men aged 35–59 yr who did not have a history of cardiovascular disease or ST-T abnormalities. Of 3,405 participants, 3,166 men without type 2 diabetes (as diagnosed with the revised criteria of American Diabetes Association) also constituted a non-diabetic cohort. Examinations including electrocardiogram and fasting plasma glucose were repeated annually for 7 subsequent years. The subjects were classified as having ST-T abnormalities or type 2 diabetes when evidence of either of these disorders was found during at least 2 consecutive annual examinations. After adjustment for potential risk factors, the relative risks of ST-T abnormalities were 1.0 (referent), 2.66, 3.07, 4.27, and 8.40 for the presence of 0, 1, 2, 3, and ≥ 4 components of the MS, respectively (P for trend < 0.001). The corresponding results for the risk of type 2 diabetes were 1.0 (referent), 3.49, 7.45, 15.00, and 24.04 (P for trend < 0.001). The estimated incident rates for men in the low-WBC count ($< 7.3 \times 10^9$ cells/L)/no MS, high-WBC count ($\geq 7.3 \times 10^9$ cells/L)/no MS, low-WBC count/yes MS, and high-WBC count/yes MS were 3.4%, 4.6%, 7.4%, and 13.1% for ST-T abnormalities, respectively and were 3.6%, 7.1%, 18.0%, and 27.2% for type 2 diabetes, respectively. The respective multivariate-adjusted relative risks were 1.0 (referent), 1.26, 2.07, and 3.45 for ST-T abnormalities and were 1.0 (referent), 1.75, 5.14, and 6.90 for type 2 diabetes. A modified NCEP MS definition predicts ST-T abnormalities and type 2 diabetes. WBC count adds clinically important information to new-onset ST-T abnormalities and type 2 diabetes.

Key words: Metabolic syndrome, ST-T abnormalities, Type 2 diabetes, White blood cell count

Introduction

The Adult Treatment Panel III of the National Cholesterol Education Program (NCEP) has recently proposed a definition of the metabolic syndrome (MS) to aid identification of individuals at risk for both coronary heart

disease (CHD) and type 2 diabetes¹). The definition incorporates thresholds for five easily measured variables linked to insulin resistance: waist circumference, triglyceride level, high-density lipoprotein (HDL) cholesterol level, fasting plasma glucose level, and blood pressure. The NCEP-defined MS classification is triggered when predefined limits of any three of these five criteria are exceeded. Body mass index (BMI), which most observers would accept as a

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satisfactory substitute for waist circumference in middle-aged men, is as effective as waist circumference for predicting the development of type 2 diabetes and other metabolic disturbances²⁻⁶). Indeed, BMI has been recently adopted instead of waist circumference for analyses of the MS^{7, 8}). Furthermore, markers of low-grade inflammation have been shown to be predictive of the occurrence of CHD and diabetes⁷⁻¹²). Because the main factors associated with white blood cell (WBC) count (i.e., glucose tolerance, obesity, hypertension, hypertriglyceridemia and low HDL cholesterol) are identical to the components of the MS^{13, 14}) and WBC count is positively associated with both insulin resistance and hyperinsulinemia¹⁴⁻¹⁶), it has been postulated that an increase in the WBC count could be the expression of an insulin-resistant state or involvement of the MS.

ST segment or T-wave abnormalities, or both (ST-T abnormalities) on the resting electrocardiogram (ECG) are among the most common nonspecific findings encountered in clinical examination of patients, in screening asymptomatic adults, and in epidemiologic surveys. ST-T abnormalities, particularly major abnormalities, are associated with increased risk of CHD incidence and mortality¹⁷⁻²⁷). Although the prognostic significance of minor ST-T abnormalities is less conclusive¹⁷⁻²⁰), recent investigations have indicated that minor ST-T abnormalities have a long-term prognostic impact for death from CHD in middle-aged men^{26, 27}). These findings indicate that ST-T abnormalities are significant markers of heightened CHD risk. Using a modified NCEP definition of the MS with BMI instead of waist circumference, we examined the associations of the MS with the risk of incidence of ST-T abnormalities and type 2 diabetes (as diagnosed with the revised criteria of American Diabetes Association [ADA] of 1997²⁸) for epidemiological studies) in Japanese male office workers. We additionally investigated whether WBC count might provide prognostic information to the association between the MS and development of ST-T abnormalities and type 2 diabetes or not.

Research Design and Methods

Subjects and study cohort

Our study is an ongoing cohort investigation designed to clarify risk factors for major diseases, including hypertension, dyslipidemia, and diabetes among Japanese male office workers at Corporation A, which is one of the biggest building contractors in Japan. The Industrial Safety and Health Law in Japan requires the employer to conduct annual health examinations of all employees; the employee data, which are anonymous, are available for research with the approval

of the employer. We interpreted the return of a self-administered questionnaire signed by the subjects as their consent to participate in the study. A total of 3,681 Japanese male office workers aged³⁵⁻⁵⁹) participated in this survey in May 1994 with a participation rate of 99.6%. All the participants were white-collar workers, most were professionals, and none were acutely ill.

Of 3,681 potential participants, 32 men with a past history of either CHD or stroke were excluded. In addition, to focus only on the incidence of isolated ST-T abnormalities, another 163 men were excluded because they had one or more of the following ECG abnormalities: Q-QS wave abnormalities (Minnesota Code [MC], 1-1-1 to 1-2-8); left ventricular hypertrophy with ST-T abnormalities (MC, 3-1 and 4-1 to 4-3 or 5-1 to 5-3), complete atrioventricular block (MC, 6-1), Wolff-Parkinson-White syndrome (MC, 6-4-1 or 6-4-2), complete bundle branch block or intraventricular block (MC, 7-1-1, 7-2-1, 7-4, or 7-8); and atrial fibrillation or flutter (MC, 8-3); and other ST-T segment abnormalities (MC, 4-1 to 4-4 or 5-1 to 5-4)²⁹). Thus, the baseline population consisted of 3,486 men. We also excluded 81 men who did not participate in all the consecutive annual health examinations. The remaining 3,405 men constituted the final study population for analysis of incidence of isolated ST-T abnormalities. Of 3,405 subjects, 239 (7.0%) were identified to have type 2 diabetes at the initial examination, and the remaining 3,166 men constituted the non-diabetic cohort. They were classified as having ST-T abnormalities or type 2 diabetes when evidence of either of these disorders was found in at least 2 consecutive annual examinations during the follow-up period. For the incidental cases of ST-T abnormalities or type 2 diabetes in 2001, either of these disorders in 2002 was checked to confirm the consecutive disorders. Fifty-seven participants who started taking medication for diabetes during the observation period were considered to be incidental cases of type 2 diabetes. Because of the age range of the study population, all cases of type 2 diabetes were diagnosed when they were older than age of 35.

Study design

Examinations including ECG and fasting plasma glucose were repeated at annual health examinations in May from 1994 to 2001. The participants were asked to fast for at least 8 h and to avoid smoking and heavy physical activity for more than 2 h before the examinations. Standard 12-lead ECG was obtained in supine position. Each record was coded independently using the MC²⁹) by a single cardiologist (Y.K), who was blinded to knowledge of clinical

and demographic data. The criteria for minor ST-T abnormalities were either of the following: MC, 4-3 to 4-4 or 5-3 to 5-4. The criteria for major ST-T abnormalities were either of the following: MC, 4-1 to 4-2 or 5-1 to 5-2 or left ventricular hypertrophy with ST-T abnormalities (MC, 3-1 and 4-1 to 4-3 or 5-1 to 5-3). Blood samples were drawn from an antecubital vein. Fasting plasma glucose levels were measured by the glucose dehydrogenase spectrophotometry with Olympus AU-5000 equipment in 1994 and Olympus AU-5200 equipment in 1995 to 2001 (Olympus Japan, Tokyo, Japan) by FALCO Biosystems Tokyo (Tokyo, Japan). Quality control of the laboratory was done internally, and the coefficients of variation between and within assays for plasma glucose were no more than 3% from 1994 to 2001. Normal fasting glucose, impaired fasting glucose (IFG), and type 2 diabetes were defined using the criteria of ADA²⁸). Normal fasting glucose was defined as fasting plasma glucose level of < 6.1 mmol/L. The criteria of IFG was fasting plasma glucose level of 6.1–6.9 mmol/L. Type 2 diabetes was defined as fasting plasma glucose level of ≥ 7.0 mmol/L or receipt of hypoglycemic medications, because an oral glucose tolerance test was not done for every subject.

Annual health examinations at study entry included medical history, physical examination, anthropometric measurements, biochemical measurements, and a questionnaire on health-related behavior. Medical history and history of use of prescription drugs were assessed by the examining physicians. A family history of diabetes was defined as the presence of a mother, father, sister, or brother with type 2 diabetes diagnosed by a physician. BMI, calculated as weight divided by the square of height in meters, was used as an index of relative weight. After a 5-min rest in a quiet room, systolic and diastolic blood pressures were measured in right arm by using a standard mercury sphygmomanometer in sitting position. The Olympus AU-5000 spectrophotometer was also used to measure total cholesterol, HDL cholesterol, and triglyceride. WBC counts were determined using a Sysmex E-4000 autoanalyzer (Sysmex Corporation, Kobe, Japan). As for health-related behavior, data on alcohol intake, smoking habits, and regular physical activity were obtained by interview. The questions about alcohol intake included items about the type of alcoholic beverage, the frequency on a weekly basis of alcohol consumption, and the usual amount consumed daily. Weekly alcohol intake was calculated and then converted to daily alcohol consumption (grams of ethanol per day) by using standard Japanese tables. The questionnaire also asked about smoking habits (never, past, or current smoker); past

or current smokers were asked about the number of cigarettes smoked per day and the duration of smoking in years. Participants were asked about the type and frequency on weekly basis of leisure-time physical activity. Physical exercise was defined as participation in any physical activity, such as jogging, cycling, swimming or tennis, that was performed long enough to cause sweating.

The 5 thresholds used were BMI ≥ 25 kg/m², proposed by the Japan Society for the Study of Obesity³⁰, systolic blood pressure ≥ 130 mm Hg or diastolic blood pressure ≥ 85 mm Hg or both, or prescription of antihypertensive medication, triglyceride level ≥ 1.69 mmol/L, HDL cholesterol level <1.03 mmol/L, and fasting plasma glucose level ≥ 6.1 mmol/L or medication for diabetes. According to the NCEP, men were classified as having the MS if they fulfilled 3 or more of the above criteria.

Statistical analyses

Data are presented as mean (SD) for continuous variables and number of subjects (%) for categorical variables by presence or absence of the MS. For each participant, person-years of follow-up were calculated from the date of enrollment to the date of the first incidence of the development of ST-T abnormalities or type 2 diabetes or the date of follow-up where either was diagnosed, whichever came first. The method of Kaplan-Meier was used to estimate the cumulative incidence of ST-T abnormalities and type 2 diabetes according to the four groups stratified by both WBC count ($< \geq 7.3 \times 10^9$ cells/L, the 75th percentile of WBC count) and presence or absence of the MS, and the log-rank test was used to assess the significance of the unadjusted difference among the incidence curves. Cox's proportional hazards models were used to evaluate the association between MS status and incidence of ST-T abnormalities or type 2 diabetes. Data were adjusted first for age alone, then for the following multiple covariates: age, family history of diabetes, alcohol consumption, cigarette smoking, and physical activity. Potentially confounding factors were treated as categorical variables: age (graded from 1 through 5 [first through fifth quintiles]); family history of diabetes (no or yes); alcohol consumption (graded as 1 [none] or as quartile 1 [grade 2] to quartile 4 [grade 5] for drinkers); cigarette smoking (graded as 1 [none] or as quartile 1 [grade of 2] to quartile 4 [grade of 5] for current smokers); and regular physical exercise (graded from 1 to 3 [hardly ever, once a week, or twice or more a week]). The linear trends in risks were evaluated by entering indicators for each category of exposure.

Data were analyzed with the SPSS/PC statistical package

Table 1. Baseline characteristics of 3,405 Japanese male office workers fulfilling metabolic syndrome criteria

Characteristic	Metabolic syndrome		P value
	Present n=525 (15.4%)	Absent n=2,880 (84.6%)	
Age, y	48.1 ± 5.9	46.8 ± 6.1	<0.001
Family history of diabetes, %	11.6	8.6	0.029
Current drinkers, %	83.4	85.6	0.207
Current smokers, %	52.4	49.8	0.275
Regular physical activity at least once a week, %	51.6	53.2	0.497
BMI, kg/m ²	26.1 ± 2.6	23.0 ± 2.4	N/A
Systolic blood pressure, mmHg	137.4 ± 13.3	126.0 ± 14.5	N/A
Diastolic blood pressure, mmHg	85.0 ± 10.4	76.8 ± 10.7	N/A
Fasting plasma glucose, mmol/L	6.23 ± 1.49	5.16 ± 0.69	N/A
Triglycerides, mmol/L	2.90 ± 1.94	1.27 ± 0.80	N/A
HDL cholesterol, mmol/L	1.12 ± 0.26	1.44 ± 0.32	N/A
WBC count, 10 ⁹ cells/L	6.91 ± 1.67	6.40 ± 1.68	<0.001

Data are means ± SD unless indicated otherwise. BMI indicates body mass index; HDL, high-density lipoprotein; WBC, white blood cell; N/A, not applicable because criteria for selection of cases is based on these parameters.

(SPSS, Chicago, IL, USA). All reported P values are two-tailed, and those less than 0.05 were considered to be statistically significant.

Results

As defined by the modified NCEP criteria, 525 men (15.4%) had the MS at baseline assessment. The characteristics of those with and those without the syndrome are shown in Table 1. Means of age and WBC count and the percentage of participants with a family history of diabetes were significantly higher in those with the MS than those without.

Altogether 123 and 74 men developed minor and major ST-T abnormalities during 21,373 and 21,767 person-years of follow-up, respectively. Incident rates per 1,000 person-years for minor and major ST-T abnormalities increased as the number of components of the MS increased (P for trend <0.001 for both minor and major ST-T abnormalities) (Fig. 1). Minor and major ST-T abnormalities were combined in this study, because we assumed a similar mechanism for the development of minor and major ST-T abnormalities.

Table 2 shows the risk of incidence of ST-T abnormalities and type 2 diabetes in relation to the number of components of the MS. As for a component of the MS, either IFG or type 2 diabetes was used for the risk of incidence of ST-T abnormalities and IFG for the corresponding risk of type 2 diabetes. After adjustment for age, family history of diabetes, alcohol intake, cigarette smoking, and regular physical activity, the relative risk of incidence of ST-T abnormalities

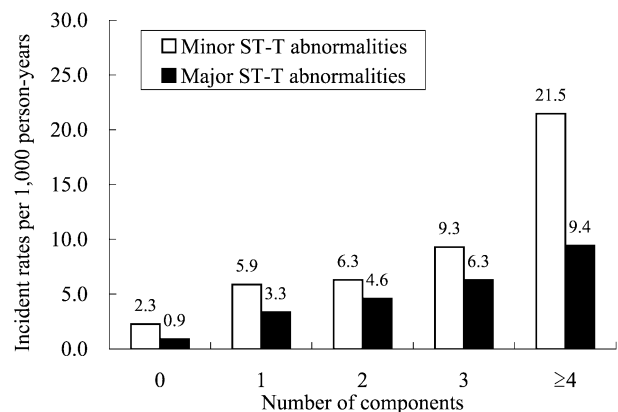


Fig. 1. Incident rates per 1,000 person-years for minor and major ST-T abnormalities according to the number of components of the metabolic syndrome among 3,405 Japanese men during 7 yr of follow-up.

compared with the presence of no components was 2.66, 3.07, 4.27, and 8.40 for the presence of 1, 2, 3, and ≥4 components, respectively (P for trend <0.001). The corresponding results for the risk of incidence of type 2 diabetes compared with the presence of no components were 3.49, 7.45, 15.00, and 24.04 (P for trend <0.001).

Figures 2-1 and 2-2 show the probabilities of incident ST-T abnormalities and type 2 diabetes stratified by both WBC count (<≥7.3 × 10⁹ cells/L) and presence or absence of the MS among 3,405 Japanese male office workers and among 3,166 non-diabetic Japanese male office workers, respectively. The estimated incident rates of ST-T

Table 2. Risk for development of ST-T abnormalities and type 2 diabetes by number of components of the metabolic syndrome among 3,405 Japanese men and 3,166 nondiabetic Japanese men during 7 yr of follow-up, respectively

	Number of components					P for trend
	0	1	2	3	≥4	
ST-T abnormalities						
Participants, <i>n</i>	1,013	1,167	700	405	120	
Cases, <i>n</i>	16	48	33	27	16	
Total person-years	6,600	7,293	4,257	2,461	697	
Rate per 1,000 person-years	2.4	6.6	7.8	11.0	23.0	
Age-adjusted relative risk	1.00	2.65	3.08	4.30	8.97	<0.001
(95%CI)	(referent)	(1.50, 4.67)	(1.69, 5.60)	(2.31, 8.01)	(4.48, 17.96)	
Multivariate-adjusted relative risk*	1.00	2.66	3.07	4.27	8.40	<0.001
(95%CI)	(referent)	(1.51, 4.69)	(1.69, 5.60)	(2.29, 7.95)	(4.18, 16.89)	
Type 2 diabetes						
Participants, <i>n</i>	1013	1126	635	323	69	
Cases, <i>n</i>	12	47	56	55	19	
Total person-years	6,598	7,060	3,783	1,842	370	
Rate per 1,000 person-years	1.8	6.7	14.8	29.9	51.4	
Age-adjusted relative risk	1.00	3.56	7.76	15.48	26.19	<0.001
(95%CI)	(referent)	(1.89, 6.71)	(4.16, 14.49)	(8.29, 28.94)	(12.70, 54.00)	
Multivariate-adjusted relative risk*	1.00	3.49	7.45	15.00	24.04	<0.001
(95%CI)	(referent)	(1.85, 6.58)	(3.99, 13.92)	(8.02, 28.06)	(11.64, 49.66)	

CI indicates confidence interval. *Controlled for age, family history of diabetes, alcohol consumption, cigarette smoking, and regular physical activity at study entry.

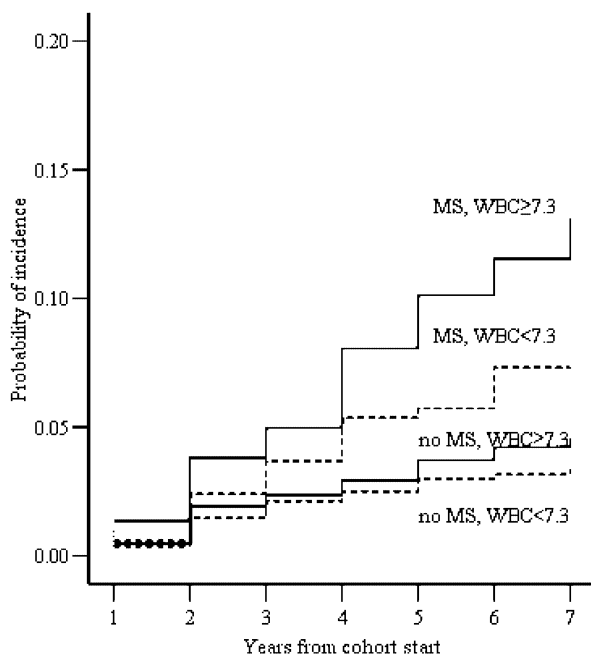


Fig. 2-1. Probability of incident ST-T abnormalities stratified by both white blood cell (WBC) count (</>7.3 × 10⁹ cells/L) and presence or absence of metabolic syndrome (MS) among 3,405 Japanese male office workers.

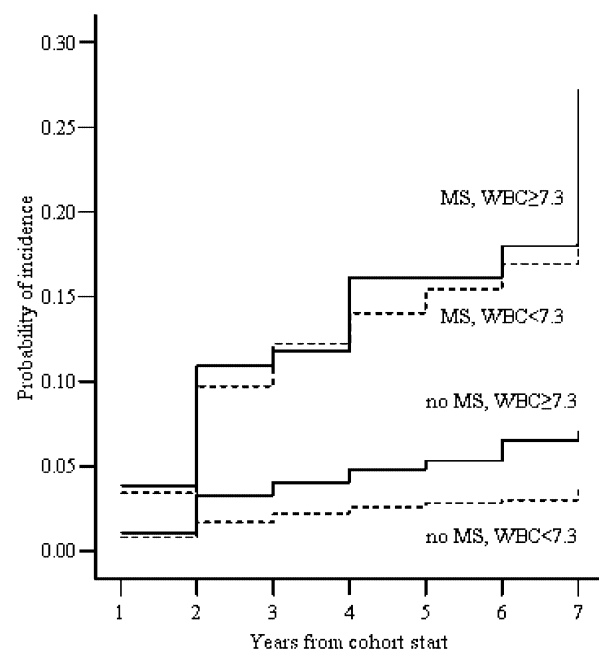


Fig. 2-2. Probability of incident type2 diabetes stratified by both white blood cell (WBC) count (</>7.3 × 10⁹ cells/L) and presence or absence of metabolic syndrome (MS) among 3,166 non-diabetic Japanese male office workers.

abnormalities for men in the low-WBC count/no MS, high-WBC count/no MS, low-WBC count/yes MS, and high-WBC count/yes MS were 3.4% (95% confidence interval [CI], 2.6 to 4.2%), 4.6% (95% CI, 3.0 to 6.2%), 7.4% (95% CI, 4.4 to 10.3%), and 13.1% (95% CI, 7.8 to 18.4%), respectively. The respective estimated incident rates of type 2 diabetes were 3.6% (95% CI, 2.8 to 4.5%), 7.1% (95% CI, 5.1 to 9.1%), 18.0% (95% CI, 13.1 to 23.0%), and 27.2% (95% CI, 18.9 to 35.5%), respectively. These differences were both statistically significant at <0.001 by the log-rank test. The multivariate-adjusted relative risks of ST-T abnormalities for men in the low-WBC count/no MS, high-WBC count/no MS, low-WBC count/yes MS, and high-WBC count/yes MS were 1.0 (referent), 1.26 (95% CI, 0.80 to 1.98), 2.07 (95% CI, 1.28 to 3.37), and 3.45 (95% CI, 2.07 to 5.75), respectively. The respective multivariate-adjusted relative risks of type 2 diabetes were 1.0 (referent), 1.75 (95% CI, 1.18 to 2.59), 5.14 (95% CI, 3.50 to 7.54), and 6.90 (95% CI, 4.43 to 10.76).

Discussion

In this study, we showed that the risk of development of ST-T abnormalities and type 2 diabetes increased in correlation with an increase in the number of components of the modified NCEP-defined MS. Analyses of interrelationships between WBC count, the MS, and incidence of ST-T abnormalities and type 2 diabetes demonstrated that WBC count provided additional information for men with the MS and without. These results indicate that the modified MS identifies men at elevated risk of development of ST-T abnormalities and type 2 diabetes and that WBC count adds relevant information in terms of development of ST-T abnormalities and type 2 diabetes. Information about the components of the MS (i.e., obesity, high blood pressure, hypertriglyceridemia, low HDL cholesterol level, and high plasma glucose level) is obtained at intervals from persons who undergo periodic health examinations at the workplace. Although it is still being debated whether the association of WBC count with CHD and type 2 diabetes is independent of or mediated by the presence of concomitant risk factors for CHD and type 2 diabetes, primarily cigarette smoking, recent studies have documented the WBC count as an independent risk factor for CHD and type 2 diabetes even when potential confounders are taken into account⁹⁻¹²). While traditionally used as an indication of current infection, a WBC count may be an important addition to risk assessment at annual health examinations. To prevent the development of ST-T

abnormalities and type 2 diabetes, individuals with the MS and elevated WBC count would certainly warrant special attention when monitoring their metabolic disturbances and WBC count.

Our study has several limitations. First, we used only a single ECG tracing and plasma glucose measurement to define ST-T abnormalities and type 2 diabetes. It is well recognized that single biologic measurements are subject to variability, a phenomenon that leads to underestimation of the strength of relative risk relations due to misclassification^{26,31}). Furthermore, the presence of ST-T abnormalities, especially minor ST-T abnormalities, has been reported to vary over time²⁶), and this makes it difficult to establish both accurate measures of individuals' ST-T abnormalities at study entry and subsequent incidence of ST-T abnormalities in epidemiological studies that rely on a limited number of ECG readings. We are fully aware of the limitations implied in our dependence on a single ECG tracing and plasma glucose measurement to define persons at risk and those developing ST-T abnormalities and type 2 diabetes, and the subjects were classified as incidental cases of ST-T abnormalities or type 2 diabetes when evidence of either of these disorders was found during 2 consecutive annual examinations. Furthermore, an assessment of IFG or type 2 diabetes, entirely dependent on fasting plasma glucose concentration, may underestimate overt longer-term diabetes. Hemoglobin (Hb) A_{1c} was measured using high performance liquid chromatography method (Sekisui Chemical Co, Ltd., Osaka, Japan) with Olympus AU-5000 in 1994 and Olympus AU-5200 in 1995 to 2001. From the distribution of fasting plasma glucose and HbA_{1c}, the cut-off points of 6.1 mmol/L and 7.0 mmol/L of fasting plasma glucose were compatible with those of 5.9% and 6.5% of HbA_{1c}, respectively. Among 3,405 men who did not have a history of cardiovascular disease or ST-T abnormalities, using a modified MS definition with HbA_{1c} instead of fasting plasma glucose, the multivariate-adjusted relative risk of developing ST-T abnormalities compared with the presence of no components was 2.78 (95% CI, 1.58 to 4.88), 3.43 (95% CI, 1.89 to 6.22), 4.32 (95% CI, 2.28 to 8.15), and 10.25 (95% CI, 5.03 to 20.88) for the presence of 1, 2, 3, and ≥ 4 components, respectively (P for trend <0.001). Of 3,405 participants, 3,274 men who had HbA_{1c} of $< 5.9\%$ also constituted a non-diabetic cohort. The corresponding results for the risk of developing HbA_{1c} $\geq 6.5\%$ compared with the presence of no components were 2.55 (95% CI, 1.51 to 4.29), 5.02 (95% CI, 3.00 to 8.40), 8.20 (95% CI, 4.80 to 14.03), and 21.02 (95% CI, 11.46 to 38.56) (P for trend <0.001). These results are consistent with those of

the analyses using fasting plasma glucose, and the rise in fasting plasma glucose observed in this cohort may express overt longer-term diabetes or glucose intolerance.

Second, WBC count during follow-up was not included in the analysis. In this study, WBC count at study entry was strongly associated with that at the date of diagnosis of ST-T abnormalities and type 2 diabetes or at the end of follow-up (Spearman's rank correlation coefficient: 0.684 and 0.680, respectively; $P < 0.001$ for both). This indicates that those who had the higher WBC count at study entry tended to continue to do so during follow-up. The observed findings that WBC at baseline and the increased risk of developing ST-T abnormalities and type 2 diabetes may thus reflect the effects of WBC count during a given observation period.

Third, bias in case-finding could have occurred. Specifically, men with the MS are more likely to visit a doctor for reasons other than ST-T abnormalities and diabetes, so that ST-T abnormalities and diabetes could have been found by chance. However, because all incidental cases of ST-T abnormalities and type 2 diabetes were found during periodic annual screening in our study, such a bias is unlikely to have occurred.

Finally, we used a modified NCEP definition of the MS with BMI instead of waist circumference. Some data show that waist circumference predicts diabetes marginally better than BMI^{2,4}. Nevertheless, most physicians routinely assess BMI, whereas the value of waist measurements has not been widely examined in clinical practice because waist measurements are subject to variability when waist circumference was not measured by technicians properly trained for measuring waist circumference. A number of investigations have also shown that BMI predicts the development of type 2 diabetes and other metabolic disturbances as strongly as waist circumference²⁻⁶. Moreover, the use of BMI versus waist measurements has been evaluated as a determinant of the MS and type 2 diabetes^{7,8}.

Despite these potential limitations, our findings demonstrate that the modified NCEP-defined MS identifies men at elevated risk of development of ST-T abnormalities and type 2 diabetes and that WBC count adds relevant information in terms of development of ST-T abnormalities and type 2 diabetes.

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