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A cross-sectional relationship between vital capacity and diabetes in Japanese men

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ABSTRACT

Aims: The aim of the present study was to examine the cross-sectional relationship between vital capacity and diabetes, metabolic syndrome (MS), and high-sensitivity C-reactive protein (hs-CRP) among Japanese men.

Methods: Medical check-up data of 1353 men were examined. Spearman's correlation coefficients between respiratory function and MS-related risk factors were calculated excluding subjects with hypoglycemic medication. The prevalence of diabetes and MS were compared between subjects with the lowest and the highest quartiles of % vital capacity (%VC). Area under receiver operating characteristic curve (AUC) were calculated for risk factors excluding fasting glucose. Logistic regression using diabetes as a dependent variable and %VC and MS-related risk factors excluding fasting glucose as independent variables was performed.

Results: %VC was significantly correlated with some components of MS and hs-CRP. The prevalence of diabetes, MS, and MS components other than blood pressure were significantly lower in the highest quartile than in the lowest quartile of %VC. AUC of -%VC was highest among MS-related risk factors excluding fasting glucose though statistically not significant. %VC was an independent marker of diabetes in the multivariable logistic regression analysis.

Conclusions: Vital capacity was an independent marker of diabetes and associated with MS and hs-CRP in Japanese men.

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1. Introduction

Insulin resistance or metabolic syndrome (MS) predicts diabetes, but the definition and the clinical usefulness of MS are controversial [1–3]. MS as a clustering of interrelated metabolic risk factors may evolve through adipose tissue disease [4] and is not restricted to a risk factor for diabetes and cardiovascular disease but related to many other systemic disorders such as chronic kidney disease (CKD) [5,6], chronic obstructive pulmonary disease (COPD) [7], and fatty liver disease [8]. Similarly, respiratory function predicts the development of insulin resistance or diabetes [9–13]. Lazarus et al. showed that forced vital capacity (FVC) and forced expiratory volume in 1 s (FEV1) were associated with insulin resistance [9] and Engstrom et al. reported that impaired lung function predicted the development of diabetes [10,11]. Later, Ford et al. [12] and Yeh et al. [13] confirmed lower vital capacity as an independent risk factor of diabetes. However, there are few reports on the relationship between respiratory function and diabetes in Japanese [14,15].

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2. Subjects and methods

2.1. Subjects

Between April 1 and September 30 in 2008, 1386 men and 837 women were visited our medical check-up center for Ningen Dock, one of medical check-up programs of our center. Visitors were all required to fill out a questionnaire made by Ministry of Health, Labor, and Welfare for the purpose of ''Special Health Examination and Instruction'' including history of cardiovascular disease, smoking status, antihypertensive and hypoglycemic medication, and alcohol consumption. Among these persons, seven men and eight women without signed consent, seven men and eight women without ventilatory function data, and nineteen men and eight women with serum levels of high-sensitivity C-reactive protein (hs-CRP) higher than 10 mg/L were excluded. Further, the statistical analysis was inappropriate among women because there were only fourteen diabetic women (1.2%). Therefore, the present study was performed only among 1353 male subjects. The protocol for the present study was approved by the ethics committee in Tachikawa Medical Center and signed informed consent was obtained from each subject.

2.2. Measurements

After an overnight fast, blood samples were withdrawn to measure serum levels of routine medical check-up markers: glucose, triglycerides, high-density lipoprotein cholesterol (HDLc), low-density lipoprotein cholesterol (LDLc), hemoglobin A1c, uric acid, blood cell counts, electrolytes, liver and kidney function tests including gamma glutamyltransferase (GGT), alanine aminotransferase (ALT), and hs-CRP. Chemical measurements were all performed at BML Nagaoka (Nagaoka, Niigata, Japan) except for hs-CRP which was measured at BML General Laboratory (Tokyo, Japan) with nephelometry using N-latex CRP-2 (Siemens Healthcare Japan, Tokyo, Japan). The measurement limit of hs-CRP was 0.02 mg/L and the value of hs-CRP less than the measurement limit was considered as 0.01 mg/L. Respiratory function tests including % vital capacity (%VC) and forced expiratory volume in 1 s divided by forced vital capacity (FEV1/FVC) were performed with Autospirometer System 7 (Minato Medical Science, Osaka, Japan). Body fat% was measured with bioelectrical impedance analysis using TBF-210 (TANITA, Tokyo, Japan). An average blood pressure was calculated from two measurements with the subjects in a sitting position after 5 min rest. Body weight was measured with the subjects wearing a light wear provided by our center and the weight of the wear was subtracted from the measured body weight. Waist circumference (WC) was measured at the level of the umbilicus. Body mass index (BMI) was calculated as weight in kilogram divided by the square of height in meter. Estimated glomerular filtration rate (eGFR) was calculated as eGFR (mL/min/1.73 m^2) = $194 \times \text{creatinine}^{-1.094} \times \text{age}^{-0.287}$ in men, and $194 \times \text{creatinine}^{-1.094} \times \text{age}^{-0.287} \times 0.739$ in women according to the Japanese Society of Nephrology.

2.3. Statistical analysis

Diabetes was defined as fasting glucose levels equal to or higher than 126 mg/dL or receiving hypoglycemic medication. MS was defined by revised NCEP-ATPIII criteria [2] as three or more of five components in which the cut point of WC was modified for Japanese as 90 cm in men and 80 cm in women according to the recommendation by International Diabetes Federation [1], the cut points of the other components were systolic pressure of $\geqq$130 mmHg and/or diastolic pressure of $\geqq$85 mmHg for blood pressure, $\geqq$150 mg/dL for triglycerides, <40 mg/dL in men and <50 mg/dL in women for HDLc, and $\geqq$100 mg/dL for glucose. Subjects receiving antihypertensive agents or hypoglycemic medication were considered to have the respective component. The Japanese metabolic syndrome (JMS) proposed by the Examination Committee for Criteria of Metabolic Syndrome [16] was also examined. Spearman's correlation coefficients between respiratory function and MS-related risk factors were calculated excluding subjects with hypoglycemic medication to avoid confounding effects of such medication. The prevalence of diabetes and MS, and MS components were compared between subjects with the lowest and the highest quartiles of %VC. Receiver operating characteristic (ROC) curve analysis for diagnosing diabetes was performed to obtain area under ROC curve (AUC) of MS-related risk factors. Multivariable stepwise logistic regression analysis was performed using diabetes as a dependent variable and %VC, FEV1/FVC, components of MS excluding fasting glucose, hs-CRP, GGT, ALT, and heart rate as independent variables. Statistical analyses were conducted with Dr. SPSS-2. p-values of less than 0.05 were considered to be statistically significant.

3. Results

Basal data are shown in Table 1. A thousand and three hundred fifty three men aged 52 ± 9 (mean ± S.D.) years were the subjects of the present study. Mean, S.D., and median of basal laboratory data are presented. Prevalence of diabetes, MS, JMS, smoking, and cardiovascular disease were 4.7%, 13.5%, 12.1%, 34.4%, and 6.4%, respectively. Table 2 presents Spearman's correlation coefficients of respiratory function with MS-related risk factors excluding subjects with hypoglycemic medication. There were significant correlations between %VC and hs-CRP, triglycerides, HDL cholesterol, ALT and body fat%, not WC. Table 3 shows prevalence of diabetes, MS, and MS components by the quartile of %VC. The prevalence of diabetes, MS, and MS components other than blood pressure were significantly lower in the highest quartile than in the lowest quartile of %VC. AUC using diabetes as a dependent variable were presented in Table 4. The AUC of %VC was 0.66 which was highest among MS-related risk factors excluding fasting glucose, though statistically not significant. Table 5 shows the final result of stepwise multivariable logistic regression analysis with backward elimination method using diabetes as a dependent variable and MS components excluding fasting glucose, hs-CRP, GGT, ALT, %VC, FEV1/FVC, and heart rate as initial independent variables. %VC, waist circumference, and systolic blood pressure

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