

Original Article

Metabolic syndrome and its components as risk factors for prolonged corrected QT interval in apparently healthy Korean men and women

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KEYWORDS:

Metabolic syndrome;
Insulin resistance;
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BACKGROUND: Metabolic syndrome (MetS) is clinically important because of its association with increased risk of sudden cardiac death, as well as cardiovascular disease-related mortality. Data between MetS and prolonged corrected QT (QTc) intervals, a useful predictor of sudden cardiac death, are limited in apparently healthy adults.

OBJECTIVE: This study determined the association between MetS and QTc interval in apparently healthy Korean men and women.

METHODS: We examined the association between MetS and QTc interval in 2157 Korean adults (1317 men and 840 women) in a health examination program but excluded participants with a history of ischemic heart disease, stroke, cardiac arrhythmia, cancer, thyroid, respiratory, renal, hepatobiliary, or rheumatologic disease. The QTc interval was calculated using Bazett's formula ($QTc = QT/\sqrt{RR}$). Multivariate-adjusted mean QTc values by the number of MetS components were calculated after sex stratification and compared using analysis of covariance test.

RESULTS: The overall prevalence of MetS was 30.5% in men and 19.8% in women. The QTc interval positively correlated with age, body mass index, blood pressure, fasting plasma glucose, triglycerides, and potassium level in both men and women and negatively correlated with calcium and potassium levels and smoking status in men. The multivariate-adjusted mean QTc value increased proportionally with increasing number of MetS components (P values < 0.001 for both men and women).

CONCLUSION: We confirmed the arrhythmogenic potential of MetS in apparently healthy Korean men and women. These findings suggest that careful monitoring of electrocardiography is necessary to evaluate possible arrhythmic risk in individuals with MetS.

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Introduction

The QT interval is the duration between depolarization and repolarization of the ventricular myocardium.¹ Because the QT interval is highly influenced by heart rate, a corrected QT (QTc) interval adjusted for heart rate has been proposed from an electrophysiology perspective. Prolonged QTc interval is well known to be an arrhythmogenic

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parameter in electrocardiography (ECG) and is associated with electrical instability of myocardium, which leads to all-cause and sudden cardiac death, including ventricular arrhythmia such as ventricular tachycardia and fibrillation.^{2,3} Prolonged QTc interval is a useful predictor for sudden cardiac death in patients after myocardial infarction and with heart failure and type 2 diabetes⁴⁻⁶ and even in apparently healthy adults.⁷

Metabolic syndrome (MetS), which is a combination of cardiometabolic risk factors including obesity, elevated blood pressure, insulin resistance, and atherogenic dyslipidemia, has emerged as a public health problem with epidemic prevalence worldwide. MetS is associated with an increased risk of developing type 2 diabetes and atherosclerotic cardiovascular disease.⁸ Accumulating evidence suggests that MetS is associated with increased risk of sudden cardiac death as well as cardiovascular disease-related mortality.⁹ Although the underlying mechanisms are not known, a recent prospective study showed that individuals with MetS are more susceptible to sudden cardiac death.¹⁰ Because it is common knowledge that most cases of sudden cardiac death are related to severe ventricular arrhythmia, we expect that the link between MetS and sudden cardiac death is mediated by an arrhythmogenic process.

Several previous studies reported prolonged QTc intervals in subjects with MetS; however, most studies were conducted on a small scale, with subjects that visited hypertensive centers, or on participants not stratified by sex.¹¹⁻¹⁴ Therefore, this study examined the association between MetS and QTc interval in apparently healthy men and women.

Methods

Study participants

We retrospectively reviewed the medical records of 2912 participants aged ≥ 20 years, who underwent a medical examination at the Health Promotion Center of Gangnam Severance Hospital in Seoul, Korea, between November 2011 and July 2013. The subjects voluntarily visited the health promotion center to regularly undergo health assessment. Informed consent was obtained from each participant. This study was conducted in accordance with the ethical principles of the Declaration of Helsinki and was approved by the Institutional Review Board of Yonsei University College of Medicine, Seoul, Korea. We excluded participants who met one or more of the following criteria: missing data; a history of ischemic heart disease, stroke, cardiac arrhythmia, cancer, thyroid, respiratory, renal, hepatobiliary, or rheumatologic disease; and not fasting for 12 hour before testing. A total of 2157 Korean adults (1317 men and 840 women) were included in our final analysis.

Data collection

Each participant completed a questionnaire about his or her lifestyle and medical history. Self-reported cigarette smoking, alcohol consumption, and physical activity were determined from the questionnaires on a weekly basis. Smoking status was categorized into nonsmoker, ex-smoker, and current smoker. Alcohol drinking was defined as alcohol consumption \geq two times per week. Regular

Table 1 Clinical characteristics of the study population according to the presence of MetS

Variables	Men			Women		
	With MetS	Without MetS	<i>P</i> value	With MetS	Without MetS	<i>P</i> value
N	402	915		166	674	
Age, y	49.2 (9.8)	46.5 (9.1)	<.001	51.2 (7.6)	45.8 (8.1)	<.001
Body mass index, kg/m ²	26.9 (2.4)	24.2 (2.4)	<.001	26.8 (2.7)	22.9 (2.4)	<.001
Systolic BP, mmHg	138.4 (13.5)	125.3 (12.7)	<.001	135.1(16.1)	117.0 (14.0)	<.001
Diastolic BP, mmHg	87.2 (8.9)	78.8 (8.3)	<.001	83.0 (8.6)	72.6 (9.0)	<.001
Fasting plasma glucose, mg/dL	105.4 (26.7)	92.9 (17.5)	<.001	97.7 (15.0)	87.1 (13.7)	<.001
Total cholesterol, mg/dL	191.9 (32.2)	184.4 (30.0)	<.001	193.6 (33.6)	181.4 (31.6)	<.001
Triglyceride, mg/dL	227.5 (137.5)	128.1 (66.6)	<.001	181.8 (85.9)	93.2 (43.0)	<.001
HDL cholesterol, mg/dL	44.9 (9.8)	51.2 (10.4)	<.001	48.3 (8.9)	59.5 (12.1)	<.001
TG/HDL ratio	5.5 (4.1)	2.7 (1.6)	<.001	4.0 (2.2)	1.7 (1.0)	<.001
Calcium, mEq/L	9.5 (0.3)	9.4 (0.4)	<.001	9.4 (0.4)	9.2 (0.4)	<.001
Potassium, mEq/L	4.2 (0.4)	4.1 (0.3)	.059	4.0 (0.3)	4.0 (0.4)	.694
Current smoker, %	42.9	40.0	.262	3.8	6.2	.542
Alcohol drinking [*] , %	87.8	83.1	.031	40.3	46.5	.187
Regular exercise [†] , %	68.2	67.1	.706	54.8	51.2	.437

BP, blood pressure; HDL, high-density lipoprotein; MetS, metabolic syndrome; TG/HDL, triglyceride to HDL-cholesterol ratio.

Values are expressed as mean \pm SD or percentage.

P values from independent two sample *t*-test for continuous outcomes and chi-squared test for categorical variables. Alcohol drinking was defined as alcohol consumption \geq two times per wk.

*Alcohol consumption \geq two times/wk.

†Regular exercise was defined as exercise \geq three times per wk.

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