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Original Contribution

Relationship of cotinine-verified and self-reported smoking status with metabolic syndrome in 116,094 Korean adults

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KEYWORDS:
Cigarette smoke;
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Cotinine;
Secondhand smoke;
Metabolic syndrome;
Dyslipidemia;
Hypertension

BACKGROUND: No study has reported the relationship between cotinine-verified and self-reported smoking status with metabolic syndrome (MetS).

OBJECTIVE: This study was performed to evaluate the relationship between urinary cotinine-verified and self-reported smoking status with MetS and determine the effects of unobserved smokers on MetS in Korean adults.

METHODS: A total of 116,094 individuals (66,875 men and 49,219 women) with mean age of 36.7 ± 6.8 years included in Kangbuk Samsung Health Study and Kangbuk Samsung Cohort Study between 2011 and 2013 who had urinary cotinine measurements were enrolled. Cotinine-verified current smoking was defined as urinary cotinine level of above 50 ng/mL. Unobserved smoking was defined as urinary cotinine level of above 50 ng/mL in self-reported never smokers.

RESULTS: The overall prevalence rates of cotinine-verified current smokers and MetS were 22.9% and 10.5%, respectively. The misclassification rate to cotinine-verified current smokers among self-reported never smokers was 1.7%. A multivariate logistic regression model adjusted for variables with univariate relationship (model 1) showed that cotinine-verified current smokers significantly increased the odds ratio for MetS compared with cotinine-verified never smokers (odds ratio [95% confidence interval], 1.30 [1.23, 1.37]). Log-transformed cotinine levels were also associated with MetS (1.04 [1.03, 1.05]). However, the association was not significant in the previously mentioned model including the traditional 5 components of MetS (model 2). Unobserved smokers significantly increased the ORs for MetS in both model 1 (1.43 [1.23, 1.67]) and model 2 (1.57 [1.06, 2.33]).

CONCLUSION: This study shows that unobserved smoking and cotinine-verified current smoking are associated with MetS but urinary cotinine could be 1 conditional factor that interacts with traditional MetS components.

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Introduction

Although the pathophysiological interaction between cigarette smoking and metabolic syndrome (MetS) has not yet been fully clarified, most previous epidemiologic studies have reported that chronic smoking is associated with the prevalence of MetS, 1 risk factor for future cardiovascular morbidity.[1–3] However, information on cigarette smoking in these studies is generally based on self-reported questionnaire.

Cotinine, the main metabolite of nicotine, is extensively used as a biomarker for assessing cigarette smoking status. Several studies have demonstrated that cotinine-verified smoking is associated with the prevalence of MetS.[4,5] However, these studies did not compare the relationship between self-reported smoking and cotinine-verified smoking with MetS.

Recently, various discrepancies between self-reported and biomarker-verified smoking status have been reported.[6] In particular, unobserved smokers such as secondhand smokers and underestimated self-reported current smokers as hidden smokers could raise public health concern as a kind of hidden smokers. Assessment of smoking status using biomarkers such as cotinine may classify the category of smokers more accurately. Two recent studies have reported the relationship between secondhand smokers and MetS.[7,8] However, both studies had relatively small sample sizes and one of them was limited to children.

Therefore, the aim of this study was to evaluate the relationship of urinary cotinine-verified and self-reported smoking status with MetS in Korean adults and determine the effects of unobserved smoking status (urinary cotinine level above 50 ng/mL in self-reported never smokers) on MetS.

Methods

Study population

Among 169,926 individuals who participated in the Kangbuk Samsung Health Study and the Kangbuk Samsung Cohort Study between 2011 and 2013, 53,832 individuals were excluded because of missing data for MetS ($n = 40,105$) or smoking histories ($n = 13,727$). Finally, 116,094 individuals (66,875 men and 49,219 women, with mean age of 36.7 ± 6.8 years) were enrolled in this study.

Anthropometry and laboratory tests

Medical history, daily alcohol consumption (grams), smoking status (never, former, or current smokers), daily number of cigarette smoked, and level of vigorous exercise (≥3 times per week) were evaluated with standard questionnaires.[9–11] Smoking status was defined according to the answer to a question "How much have you smoked in your life until now in total?" Never smokers were defined as individuals who answered "No, I have not ever smoked" or "I have smoked less than 5 packs in my life but I do not smoke." Former smokers were defined as those who answered "I have smoked more than 5 packs but I do not smoke now." Current smokers were defined as those who answered "I smoke now." Waist circumference was measured at the mid-level between the lowest rib and the iliac crest. Body mass index (BMI) was calculated as weight (kilogram) divided by height (square meter). Blood pressure was measured by a trained nurse using a standardized sphygmomanometer.

After at least 10 hours of fasting, serum levels of glucose, total cholesterol, triglycerides, low-density lipoprotein cholesterol (LDL-C), high-density lipoprotein cholesterol (HDL-C), and uric acid were measured using an automated chemistry analyzer (Modular DPP; Roche Diagnostics, Tokyo, Japan). Serum creatinine level was assessed with the isotope dilution mass spectroscopy–traceable method using Modular D2400 (Roche Diagnostics, Tokyo, Japan). High-sensitivity C-reactive protein (hsCRP) level was determined with particle-enhanced immunoturbidimetric assay using Modular P800 (Roche Diagnostics, Tokyo, Japan).

Urinary cotinine level was determined using DRI Cotinine Assay (Microgenics Corp., Fremont, CA) with modular P800 (Roche Diagnostics, Tokyo, Japan). Cotinine-verified current smoker was defined as individuals having a urinary cotinine level of above 50 ng/mL.[12] Urinary cotinine level was subdivided into the following 4 quartile groups: 50 to 312 ng/mL, 313 to 827 ng/mL, 828 to 1445 ng/mL, and ≥1446 ng/mL. Unobserved smokers were defined as those having a urinary cotinine of above 50 ng/mL among self-reported never smokers and mean the individuals who were classified as cotinine-verified current smokers among self-reported never smokers.

This study was approved by the Institutional Review Board of Kangbuk Samsung Hospital (Approval No. 2016-04-056).

Definition of MetS

MetS was defined according to a previous joint interim statement for the definition of MetS.[13] Three or more of the following conditions were necessary for the presence of MetS: (a) elevated waist circumference (>90 cm in men and > 80 cm in women); (b) elevated triglyceride level ≥ 150 mg/dL or drug treatment; (c) reduced HDL-C level (<40 mg/dL in men and < 50 mg/dL in women) or drug treatment; (d) elevated blood pressure (systolic ≥ 130 and/or diastolic ≥ 85 mmHg) or anti-hypertensive medication; (e) elevated fasting glucose level ≥ 100 mg/dL or anti-diabetic medication.

Statistical analyses

Data are expressed as means ± standard deviation or as median (interquartile ranges) for continuous variables. They are expressed as percentages (%) for categorical