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Gender-specific association between urinary sodium excretion and body composition: Analysis of the 2008–2010 Korean National Health and Nutrition Examination Surveys

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ABSTRACT

Objective. Few studies have reported the relationship between sarcopenia and the estimated amount of sodium excreted in 24 h, as measured by the spot urine test (E24UNA), in a community-dwelling cohort. We investigated the gender specific association between E24UNA values and body composition indices.

Materials and methods. Data from a total of 7162 participants (3545 men and 3617 postmenopausal women) aged 45 years or older were obtained from multiple Korea National Health and Nutrition Examination Surveys (2008–2010) and analyzed. The total amount of sodium excreted in the urine in a 24-h period was estimated with spot urine specimens. Sarcopenia was defined as an appendicular skeletal muscle mass divided by body weight (ASM/Wt) that was less than 1 standard deviation below the sex-specific mean for young adults.

Results. E24UNA values were positively correlated with body mass index, waist circumference, total fat mass, and blood pressure; in contrast, E24UNA values were negatively correlated with ASM/Wt in both sexes. Compared with those in the lowest E24UNA tertile, participants in the highest E24UNA tertile were at higher risk for sarcopenia (men: odds ratio (OR) = 1.3 [95% confidence interval (CI) = 1.07–1.59]; women: OR = 1.41 [95% CI = 1.16–1.73]). Further classification of subjects with sarcopenia into sarcopenic obese and sarcopenic nonobese groups revealed that the highest E24UNA values were found in the sarcopenic obese group; this difference was statistically significant. The next highest levels were found in the sarcopenic nonobese group, followed by the nonsarcopenic group. This trend was observed in both sexes.

Conclusion. High E24UNA values were independently associated with both sarcopenia and obesity in Korean individuals older than 45 years. These results suggest that high salt intake may have a deleterious effect on body composition.

Abbreviations: MetS, metabolic syndrome; KNHANES, Korea National Health and Nutrition Examination Surveys; TG, triglyceride; HDL, high-density lipoprotein; HOMA-IR, homeostasis model assessment of insulin resistance; E24UNA, estimated 24-h urinary Na excretion; ASM, appendicular skeletal muscle mass; ASM/Wt, ASM divided by weight; BMI, body mass index; HbA1c, glycated hemoglobin.

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1. Introduction

Sarcopenia is a syndrome characterized by progressive loss of skeletal muscle mass and strength during the aging process [1]. Sarcopenia is an emerging health problem, especially in the older population, and can lead to disability, increased risk of fracture, metabolic disorder, and substantial healthcare costs [2]. Moreover, Szulc et al. reported that loss of muscle mass is a strong predictor of mortality in later life [3]. Therefore, the preservation of muscle mass and function in the older population is extremely important. Multiple factors contribute to the development of sarcopenia, including altered levels of multiple hormones (growth hormone, insulin-like growth hormone, and testosterone), increased levels of proinflammatory cytokines, and a reduction in the movement of intracellular calcium, which is required for muscle contractility [4–6]. However, to date, specific modifiable risk factors for sarcopenia have not been identified.

Consumption of a high sodium diet is a well-known risk factor for various metabolic disorders, including hypertension and cardiovascular events [7]. Increased sodium intake has also been reported to be associated with insulin resistance and type 2 diabetes mellitus [8]. Furthermore, several studies have demonstrated that high 24-h urinary sodium excretion values are associated with increased body weight and body fat [9,10]. Although high salt intake is considered to negatively impact on body composition, few studies have examined the association between sodium intake and sarcopenia. In addition, even though several reports have demonstrated that high sodium intake is associated with multiple metabolic abnormalities [11,12], few studies have examined whether high sodium intake is associated with metabolic syndrome considering gender-specificity in a community-dwelling cohort.

Measuring 24-h urinary sodium excretion values has become the preferred method for assessing salt intake in population surveys because accurate dietary recall is difficult. However, 24-h urine collection procedures are expensive and laborious for study participants. Therefore, obtaining sodium excretion estimates from spot urine specimens is an attractive alternative because it is economical and less burdensome [13]. Recent studies have shown that sodium excretion values estimated this way are significantly correlated with exact sodium excretion values measured via 24-h urine collection and assessment of salt intake [14,15]. Tanaka's equation is a developed formula to estimate 24-h urinary sodium excretion from spot urine specimens collected at any time, using 591 Japanese data items from the INTERSALT study. This study clearly demonstrated that estimated sodium excretion using Tanaka's equation was significantly correlated with measured sodium excretion using 24-h urine collection among these populations [16]. In this study, we aimed to determine whether estimated 24-h urinary sodium excretion values using Tanaka's equation are associated with sarcopenia, obesity, and/or metabolic syndrome (MetS) in a relatively healthy community-dwelling older population.

2. Methods

2.1. Study Population and Design

Participants in the 2008–2010 Korea National Health and Nutrition Examination Surveys (KNHANES) were recruited for this study. The KNHANES has been periodically performed by the Division of Chronic Disease Surveillance of the Korean Centers for Disease Control and Prevention since 1998. The purpose of the KNHANES is to assess the health and nutritional status of the civilian, noninstitutionalized population of the Republic of Korea. The KNHANES was a cross-sectional and nationally representative survey that was composed of a health interview survey, a nutrition survey, and a health examination survey [17]. Data were collected by household interviews and by direct, standardized physical examinations conducted in mobile examination centers. Nutritional status and medical history were evaluated using a 24-h recall method. Women were additionally asked whether menstruation had stopped and whether they have been treated with hormone replacement therapy. Regular exercise was indicated as "yes" when the subject exercised for more than 20 min at a time and more than three times per week. Subjects with any pathological disorder (such as cancer, hyperthyroidism, malabsorption, end-stage renal failure, or hepatic failure), subjects using medications known to alter metabolic parameters (such as corticosteroids and statin) and premenopausal women were excluded from analysis. Of all survey participants who met the inclusion criteria, 7162 (3545 men and 3617 postmenopausal women) participants aged 45 years or older were recruited for the present study. All participants were provided with written informed consents to participate in this survey, and we received the data in anonymized form. The study was carried out in accordance with the ethical standards of the Helsinki Declaration.

2.2. Measurements

During the survey, a random urine sample (early morning, if possible) was collected. All samples were refrigerated and transported to the central laboratory within 24 h. Urinary sodium levels were measured using the ion-selective electrode method. Serum and urine creatinine levels were assessed with the Jaffe reaction and measured with an automatic analyzer (ADVIA 1650 system; Bayer Health Care, Tarrytown, NY). Well-trained observers manually measured blood pressure with a mercury sphygmomanometer (Baumanometer; Baum, Copiague, NY). Blood samples were immediately refrigerated, transported to the Central Testing Institute in Seoul, Korea, and analyzed within 24 h. Fasting plasma glucose, total cholesterol, triglyceride (TG), and high-density lipoprotein (HDL) cholesterol levels were measured with a Hitachi 700–110 chemistry analyzer (Hitachi, Tokyo, Japan). Serum 25(OH)D concentrations were measured with a radioimmunoassay kit (DiaSorin, Stillwater, MN) using a γ-counter (1470 Wizard; PerkinElmer, Turku, Finland). Homeostasis model assessment of insulin resistance (HOMA-IR) values were calculated using the following formula: fasting (plasma glucose (milligrams per deciliter) × fasting insulin (milliinternational units per milliliter))/22.5 [18].

2.3. Estimation of 24-h Urinary Sodium Excretion Values

The 24-h urinary sodium values were estimated from the sodium and creatinine values of random urine samples using Tanaka's equation [16], as follows: estimated 24-h urinary Na excretion (E24UNA) (mmol/day) = $21.98 \times U_{Na}/U_{Cr} \times [-2.04 \times$