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Original Research

Low muscle mass is associated with metabolic syndrome only in nonobese young adults: the Korea National Health and Nutrition Examination Survey 2008-2010☆

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ABSTRACT

Little is known about the relationship between body composition and metabolic risk factors in young adults. We hypothesized that low muscle mass (LMM) is associated with metabolic syndrome (MetS) and its components in young adults and that the associations vary by obesity. A cross-sectional analysis was conducted using the Korea National Health and Nutrition Examination Survey data. In total, 5300 young adults aged 19 to 39 years were evaluated. *Low muscle mass* was defined as an appendicular skeletal muscle mass/weight less than 1 SD below the mean for each participant's corresponding sex and age group. *Obesity* was defined as a body mass index greater than or equal to 25 kg/m^2. The prevalence of LMM was higher in obese than nonobese participants (37.6% vs 9.6%). In the nonobese participants, the prevalence of MetS, high waist circumference, high triglycerides, and high blood pressure was significantly greater in the LMM group than in the high muscle mass group. In the nonobese group, compared with high muscle mass participants, those with LMM had odds ratios for MetS of 3.6 (95% confidence interval, 1.48-8.76; $P < .001$) and 3.6 (95%

Abbreviations: ASM, appendicular skeletal muscle mass; ASM/Wt, ASM divided by weight; BMI, body mass index; BP, blood pressure; CI, confidence interval; CVD, cardiovascular disease; DBP, diastolic BP; DM, diabetes mellitus; DXA, dual-energy x-ray absorptiometry; FPG, fasting plasma glucose; HDL-C, high-density lipoprotein cholesterol; HMM, high muscle mass; HOMA-IR, homeostasis model assessment of insulin resistance; IR, insulin resistance; KNHANES, Korea National Health and Nutrition Examination Survey; LMM, low muscle mass; MetS, metabolic syndrome; OR, odds ratio; RSE, relative SE; SBP, systolic BP; TG, triglyceride; WC, waist circumference.

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confidence interval, 1.48-8.71; $P < .001$) in men and women, respectively, after adjusting for confounding factors. However, no significant association of LMM with MetS or its components was found in obese participants. In conclusion, our results suggest that young adults with LMM may have a high risk of MetS, especially when they are nonobese. Interventions aimed at increasing muscle mass at younger ages may have the potential to reduce MetS.

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1. Introduction

Metabolic syndrome (MetS), which encompasses a range of metabolic abnormalities including abdominal obesity, high glucose, high blood pressure (BP), dyslipidemia, and insulin resistance (IR), contributes to an increased risk of type 2 diabetes mellitus (DM) [1] and cardiovascular disease (CVD) [2]. The prevalence of MetS is increasing worldwide [3], presenting a global health burden.

It is known that MetS is closely associated with cardiovascular risk in middle- and old-aged populations [1], but the presence of MetS in young adults should also be of clinical importance. A recent Korean study showed that the prevalence of metabolic obesity, defined by IR, was highest in young women [4]. Although cardiovascular events develop in later life, the pathologic process may start at an earlier age. In young adults, MetS is related to an increased atherosclerotic burden and a consequent increased cardiovascular risk [5]. Thus, correction of modifiable risk factors and prevention of MetS are important in terms of decreasing the morbidity and mortality associated with CVD.

Low muscle mass (LMM) is known to be related to MetS due to the fact that muscles use large amounts of glucose [6] and a reduction in muscle mass may increase the risk of IR [7]. In addition, low skeletal muscle mass itself is related to a high prevalence of CVD [8]. Previous studies investigating the relationship between skeletal muscle mass and metabolic risk factors have focused mainly on elderly people, who have sarcopenia and decreased muscle mass and strength, due to the natural physiological process of aging [9-11]. Furthermore, the concept of sarcopenic obesity, that is, the combination of sarcopenia and obesity, has also been proposed as characterizing age-related changes in body composition in elderly people (ie, decreasing muscle mass accompanied by increasing fat mass) [12]. It has been reported that sarcopenic obesity increases the risk of metabolic abnormalities, such as hypercholesterolemia, atherosclerosis, hyperinsulinemia, IR, type 2 DM, and hypertension, in elderly people [13,14].

However, little is known about the relationship between body composition and metabolic risk factors in young adults. There may also be effect modification by obesity in this association, as exemplified by the finding that Asians have more body fat and less muscle mass than whites (at the same body mass index [BMI]) [15], implying that Asians may be more susceptible to MetS than their white counterparts are. We hypothesized that LMM is associated with MetS and its components in young adults and that the associations vary by obesity. Thus, we assessed the relationship between LMM and MetS and its components in young Korean adults and examined whether the associations vary by obesity.

2. Methods

2.1. Study population

The study was performed using data from the Korea National Health and Nutrition Examination Survey (KNHANES) 2008-2010, which was conducted by the Korea Centers for Disease Control and Prevention. The KNHANES applied a rolling sampling design with a complex, stratified, multistage probability cluster survey, ensuring that the KNHANES sample from each year represents the noninstitutionalized Korean population [16-18]. The KNHANES included a health interview survey, a health examination survey, and a nutrition survey, all of which were conducted by specially trained interviewers or examiners following standardized protocols [16-18]. All participants signed an informed consent form. In total, 9308 (74.3%) of 12528 identified individuals in 2008, 10078 (79.2%) of 12722 in 2009, and 8473 (77.5%) of 10938 in 2010 participated in the survey. From this population, our study focused on young adults, aged 19 to 39 years. After excluding those with insufficient data on muscle mass, with any cancer history, with a current pregnancy, or with menopausal status, the number of study participants for final analysis was 5300 (2298 men and 3002 women).

2.2. Measurements

Appendicular skeletal muscle mass (ASM) and total body fat mass were measured by dual-energy x-ray absorptiometry (DXA; Hologic, Bedford, MA, USA). Appendicular skeletal muscle mass was calculated as the sum of lean soft tissue in the arms and legs. Total body fat percentage was calculated as total body fat mass (kilograms) divided by body weight (kilograms). Weight was measured to the nearest 0.1 kg with an electronic scale. Height was measured to the nearest 0.1 cm with a portable stadiometer. Body mass index was calculated as weight (kilograms) divided by height squared (square meter). Waist circumference (WC) was measured to the nearest 0.1 cm using a measuring tape at end expiration at the narrowest point between the lower border of the rib cage and the iliac crest. Blood pressure was measured in the right arm using a mercury sphygmomanometer (Baumanometer; WA Baum Co, Copiague, NY, USA). Venous blood samples were obtained after fasting for at least 8 hours. Triglyceride (TG), total cholesterol, high-density lipoprotein cholesterol

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