

# Prevalence and Determinant Factors of Sarcopenia in Patients With Type 2 Diabetes

The Korean Sarcopenic Obesity Study (KSOS)

TAE NYUN KIM, MD<sup>1</sup>  
 MAN SIK PARK, PHD<sup>2</sup>  
 SAE JEONG YANG, MD<sup>1</sup>  
 HYE JIN YOO, MD<sup>1</sup>  
 HYUN JOO KANG, PHD<sup>3</sup>  
 WOOK SONG, PHD<sup>4</sup>

Ji A. SEO, MD<sup>1</sup>  
 SIN GON KIM, MD<sup>1</sup>  
 NAN HEE KIM, MD<sup>1</sup>  
 SEI HYUN BAIK, MD<sup>1</sup>  
 DONG SEOP CHOI, MD<sup>1</sup>  
 KYUNG MOOK CHOI, MD<sup>1</sup>

## RESEARCH DESIGN AND METHODS

The Korean Sarcopenic Obesity Study (KSOS) enrolled 446 well-functioning community-dwelling healthy volunteers without diabetes recruited from residents of Seoul, Korea, and 428 diabetic patients treated at the Diabetes Center of Korea University Guro Hospital. Analysis was conducted on 810 subjects (414 patients with type 2 diabetes and 396 control subjects) who were examined using dual-energy X-ray absorptiometry (Hologic Discovery A; Hologic, Bedford, MA). Medical histories and lifestyle information were collected by personal interview using a detailed questionnaire (6). The Korea University Institutional Review Board approved this study protocol.

Appendicular skeletal muscle mass (ASM), ASM/height<sup>2</sup>, and SMI were performed as previously described (7–10). Sarcopenia was defined as SMI <2 SD below the mean of the young reference group (see supplementary Table 2, available in an online appendix at <http://care.diabetesjournals.org/cgi/content/full/dc09-2310/DC1>). We previously established cutoff values for sarcopenia (5). Further information on study design and methods is given in the online appendix.

**RESULTS** — Figure 1 presents the scatter plots for the association between age and ASM and SMI, according to sex and diabetes status. Total lean body mass and SMI in men with diabetes were lower than in control subjects after adjustment for covariates such as age, BMI, health-related behaviors, medication, and metabolic parameters. In women, ASM/height<sup>2</sup> and SMI in patients with diabetes were lower than in nondiabetic counterparts (supplementary Table 1).

Prevalence of sarcopenia in patients with diabetes and in the control group was 15.7 and 6.9%, respectively. In subjects older than 60 years, prevalence of sarcopenia was greater in both men and women with diabetes than in non-

**OBJECTIVE** — We examined prevalence of sarcopenia in Korean patients with type 2 diabetes and compared body compositional parameters between subjects with and without type 2 diabetes.

**RESEARCH DESIGN AND METHODS** — The Korean Sarcopenic Obesity Study (KSOS) included 810 subjects (414 patients with diabetes and 396 control subjects) who were examined using dual-energy X-ray absorptiometry. Prevalence of sarcopenia was defined using the skeletal muscle index (SMI).

**RESULTS** — Prevalence in patients with diabetes and in the control group was 15.7 and 6.9%, respectively. In both men and women, SMI values were significantly decreased in patients with diabetes compared with subjects without diabetes. Furthermore, multiple logistic regression analysis showed that type 2 diabetes was independently associated with sarcopenia.

**CONCLUSIONS** — Type 2 diabetes was associated with increased risk of sarcopenia. These characteristics may contribute to physical disability and metabolic disorders in older adults with diabetes.

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People in Asia tend to develop type 2 diabetes with less degree of obesity (1). In addition, Asian populations are more prone to abdominal obesity and low skeletal muscle mass (sarcopenia) with increased insulin resistance compared with their Western counterparts (2).

Type 2 diabetes is associated with lower skeletal muscle strength and quality as well as excessive loss of skeletal muscle mass in the Health, Aging, and Body Composition (Health ABC) study (3,4).

Recently, we examined prevalence of sarcopenia in nondiabetic Korean adults and found that sarcopenic obesity defined using the skeletal muscle index (SMI (%): total skeletal muscle mass (kg)/weight (kg) × 100) was associated with increased risk of metabolic syndrome (5).

The aim of the current study was to examine prevalence of sarcopenia in Korean patients with type 2 diabetes and to compare body compositional parameters between subjects with and without diabetes.

From the <sup>1</sup>Division of Endocrinology and Metabolism, Department of Internal Medicine, College of Medicine, Korea University, Seoul, Korea; the <sup>2</sup>Department of Statistics, College of Natural Sciences, Sungshin Women's University, Seoul, Korea; <sup>3</sup>Sports Medicine, Division of Physical Education, Soonchunhyang University, A-San, Korea; and the <sup>4</sup>Health and Exercise Science Laboratory, Institute of Sports Science, Department of Physical Education, Seoul National University, Seoul, Korea.

Corresponding author: Kyung Mook Choi, [medica7@gmail.com](mailto:medica7@gmail.com).

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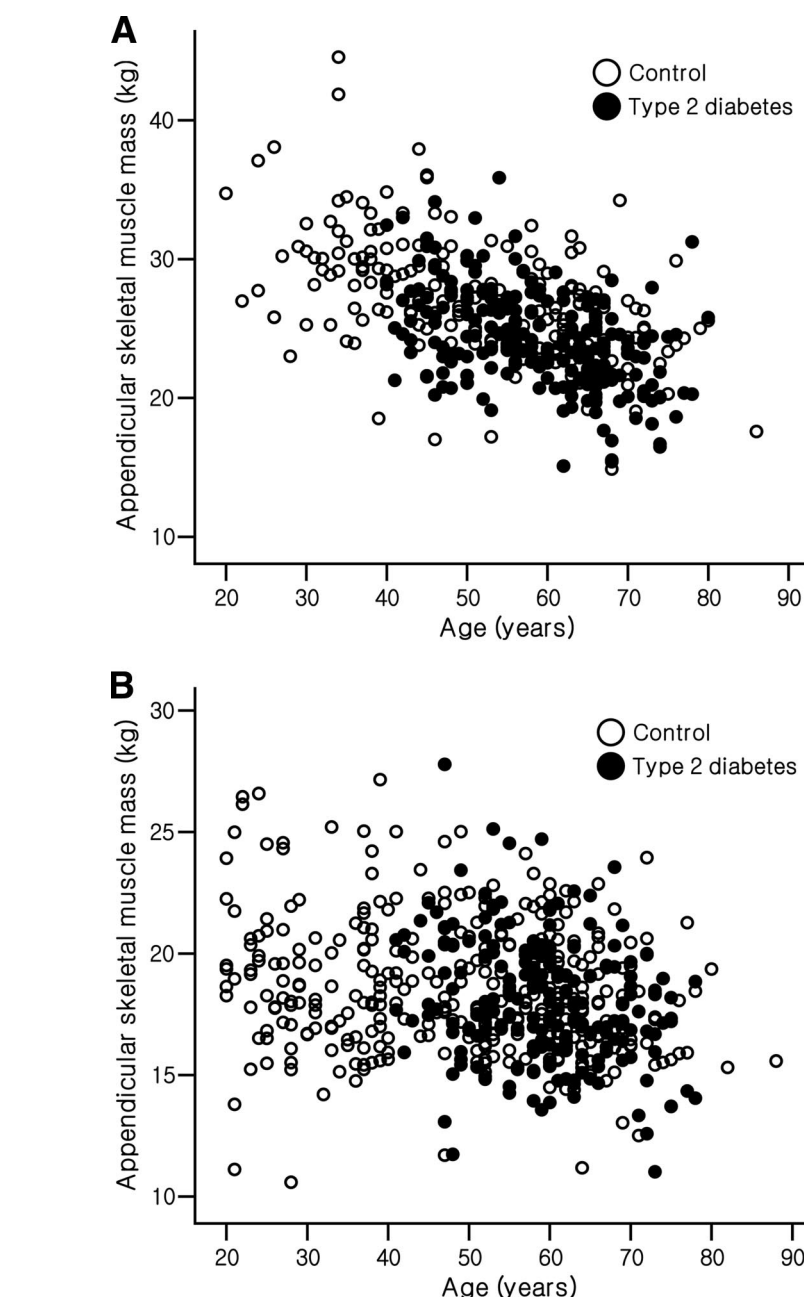
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diabetic counterparts (19.0 vs. 5.1%,  $P = 0.005$ , in men and 27.0 vs. 14.0%,  $P = 0.013$ , in women). However, in the middle-aged group (age 40–59 years), a significant difference in prevalence of sarcopenia between groups with and without diabetes was observed only in women (16.7 vs. 4.1%,  $P = 0.002$ ) (supplementary Table 3). Patients with diabetes had three times higher risk of sarcopenia (odds ratio 3.06, 95% CI 1.42–6.62) than subjects without diabetes after adjusting for age, sex, BMI, smoking, alcohol drinking, physical activity, medications, blood pressure, and lipid profiles (supplementary Table 4).

**CONCLUSIONS**— In the present study, we first examined prevalence of sarcopenia in patients with type 2 diabetes, and the present study showed that men with diabetes had decreased lean body mass and increased body fat mass, even though they had similar BMI compared with nondiabetic subjects. Moreover, compared with nondiabetic counterparts, both men and women with diabetes had decreased SMI values. However, in a cross-sectional analysis of the Health ABC study that included Western elderly subjects, patients with type 2 diabetes exhibited increases in both lean body mass and body fat mass compared with subjects without diabetes, because, compared with nondiabetic subjects, those with diabetes were more obese and had higher BMI (3). Alternatively, this study reported that individuals with diabetes had either weaker (men) or not stronger (women) muscle strength than individuals without diabetes despite larger muscle mass. This difference of sarcopenia between Asian patients and Western patients with type 2 diabetes might originate from ethnic differences in characteristics of type 2 diabetes.

Interestingly, middle-aged women as well as elderly women with diabetes exhibited higher prevalence of sarcopenia than individuals without diabetes, despite this difference not being significant in middle-aged men. Our findings are in agreement with several previous studies demonstrating that men lose greater skeletal muscle mass with aging, even though they have greater skeletal muscle mass than women (11,12) and that women with diabetes are at particularly high risk for loss of skeletal muscle mass (4). These results imply that type 2 diabetes is an important predictor of sarcopenia, partic-



**Figure 1**—Relationships between age and appendicular skeletal muscle mass (A: men; B: women) and skeletal muscle index (C: men; D: women) across category of type 2 diabetes for each sex in the study subjects.

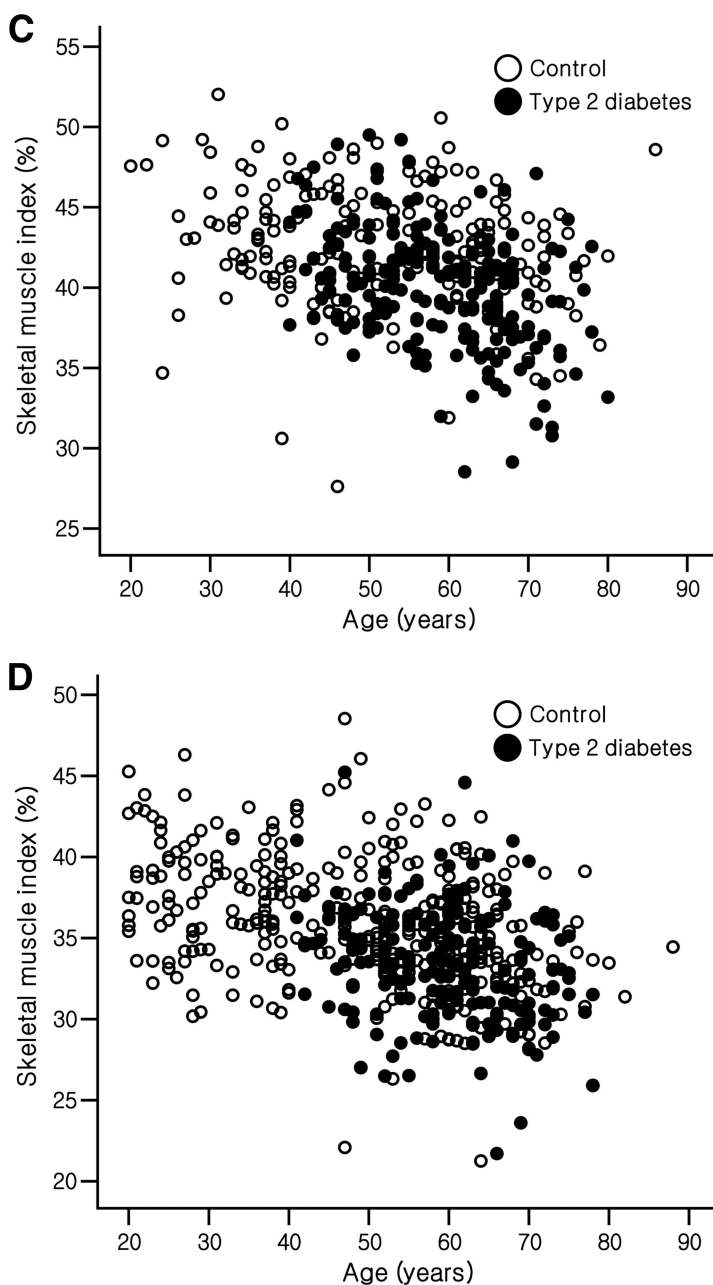
ularly in women, and that this relationship in men is mainly restricted to elderly people.

A limitation of this study was that our study was performed using baseline data from an ongoing prospective cohort study. Therefore, it is not possible to impute causality. However, we are performing a follow-up survey to explore the longitudinal interrelationship between diabetes and sarcopenia in Korean adults.

In conclusion, the present study showed that prevalence of sarcopenia

was higher in Korean patients with type 2 diabetes, particularly in women and the elderly. Furthermore, type 2 diabetes was independently associated with increased risk of sarcopenia after adjusting for potential risk factors. These results suggest that patients with type 2 diabetes are at risk of developing sarcopenia.

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**Figure 1—Continued.**

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