OBJECTIVE — We investigated the prevalence of sarcopenic obesity (SO) and its relationship with metabolic syndrome in a community-based elderly cohort in Korea.

RESEARCH DESIGN AND METHODS — In this study, 287 men and 278 women aged 65 or older were recruited. Sarcopenia was defined as the appendicular skeletal muscle mass (ASM) divided by height squared (Ht2) (kg/m²) or by weight (Wt) (%) of <1 SD below the sex-specific mean for young adults. Obesity was defined as a visceral fat area ≥100 cm².

RESULTS — The prevalence of SO was 16.7% in men and 5.7% in women with sarcopenia defined by ASM/Ht²; however, it was 35.1% in men and 48.1% in women by ASM/Wt. Using ASM/Wt, the homeostasis model assessment of insulin resistance of subjects with SO was higher and they were at higher risk for metabolic syndrome (odds ratio [OR] 8.28 [95% CI 4.45–15.40]) than the obese (5.51 [2.81–10.80]) or sarcopenic group (2.64 [1.08–6.44]).

CONCLUSIONS — SO defined by ASM/Wt was more closely associated with metabolic syndrome than either sarcopenia or obesity alone.

Sarcopenic Obesity: Prevalence and Association With Metabolic Syndrome in the Korean Longitudinal Study on Health and Aging (KLoSHA)

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The number of obese elderly people is increasing worldwide. Aging is associated with increased fat mass and reduced muscle mass or strength, even in those with stable body weight. This sarcopenic obesity (SO) is associated with deteriorations in physical disability, morbidity, and mortality. Therefore, sarcopenia and obesity might act synergistically on metabolic and functional impairments in the elderly (1–2). However, there have been few reports investigating the association of SO with metabolic syndrome, particularly in Asian ethnic groups. The aim of the present study was to investigate the prevalence of SO and its association with metabolic syndrome in a community-based elderly cohort in Korea.

RESEARCH DESIGN AND METHODS — This study was a part of the Korean Longitudinal Study on Health and Aging (KLoSHA), which has been described in detail (3). Appendicular skeletal muscle mass (ASM) was measured by dual energy X-ray absorptiometry (DXA; Lunar Corporation, Madison, WI). We used two definitions for sarcopenia: 1) ASM divided by height squared (ASM/Ht²) (kg/m²), as proposed by Baumgartner et al. (+) and 2) ASM as a percentage of body weight (ASM/Wt), which was modified from the study of Janssen et al. (5). Sarcopenia was defined as <1 SD below the sex-specific mean for a young reference group. The cutoff point for sarcopenia was 7.09 kg/m² in men and 5.27 kg/m² in women as measured using ASM/Ht². For ASM/Wt, the cutoff was 29.9% in men and 25.1% in women. The sex-specific young reference group included 32 men and 38 women. Their mean age ± SD was 28.4 ± 3.1 and 26.3 ± 2.6 years, respectively. Obesity was defined as a visceral fat area exceeding 100 cm² on abdominal computed tomography (Somatom Sensation 16; Siemens, Munich, Germany) (6). The subjects were classified into sarcopenic obese, obese, sarcopenic, and normal groups according to the definitions set out above.

Metabolic syndrome was defined according to the National Cholesterol Education Program criteria using the Asia-Pacific abdominal obesity criteria (waist circumference ≥90 cm in men and ≥80 cm in women) (7–8). Differences between the four groups were tested using ANOVA. Pearson’s correlation and multiple logistic regression models were used. P < 0.05 was considered statistically significant.

RESULTS — The prevalence of SO was 16.7% in men and 5.7% in women with sarcopenia defined by ASM/Ht². However, it was 35.1% in men and 48.1% in women when defined by ASM/Wt. When sarcopenia was defined by ASM/Ht², the obese group showed a higher BMI, greater waist circumference, more visceral fat mass, and more insulin resistance than any other group in either sex, although the SO group had poorer profiles than the group with sarcopenia alone. In contrast, the SO group defined by ASM/Wt showed a higher BMI, more visceral fat mass, and more insulin resistance than any other group in either sex (Table 1).
In the metabolic profiles, the triglyceride level in the SO group was significantly higher than that of other groups. Fasting glucose concentration was to be higher than that of other groups. In contrast, BMI and waist circumference were lower in the SO group than in other groups. Although it was not statistically significant, we calculated the odds ratios from logistic regression predicting metabolic syndrome. The odds ratio for metabolic syndrome was 2.90 (1.78–3.75) in the SO group.

**CONCLUSIONS** — We found that the SO group defined by ASWAM had a higher risk of developing metabolic syndrome than the obese or sarcopenic groups. However, there was some debate as to whether SO leads to metabolic syndrome. Baumgartner et al. (1) showed that obesity together with sarcopenia in the elderly population may accelerate sarcopenia in the form of fat and increase muscle mass while leading to more functional limitations and metabolic disorders. Adiposity and sarcopenia both contribute to metabolic syndrome. Therefore, it is appropriate to consider obesity and sarcopenia in the elderly population.

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### Table 1 — Anthropometric and Biochemical Parameters Among Groups With SO, obesity, or sarcopenia defined by ASWAM or ASWAM

| Sex | SO | Sarcopenia | Obesity | Normal |
|-----|----|-----------|---------|--------|
| M   | 1  | 1         | 1       | 1      |
| F   | 1  | 1         | 1       | 1      |

**BMI (kg/m²)**

- M: 23.8 ± 3.7
- F: 24.0 ± 4.1

**Fasting glucose (mg/dL)**

- M: 103.4 ± 6.6
- F: 132.3 ± 7.9

**Total cholesterol (mg/dL)**

- M: 226.2 ± 25.8
- F: 170.7 ± 18.3

**Triglycerides (mg/dL)**

- M: 74.7 ± 11.3
- F: 50.0 ± 6.6

**HOMA-IR**

- M: 1.77 ± 0.76
- F: 1.61 ± 0.90

**HDL cholesterol (mg/dL)**

- M: 42.6 ± 15.2
- F: 34.4 ± 25.8

**LDL cholesterol (mg/dL)**

- M: 128.9 ± 10.7
- F: 116.7 ± 7.9

**Fasting insulin (µU/mL)**

- M: 23.2 ± 7.9
- F: 13.2 ± 6.6

**Waist circumference (cm)**

- M: 84.5 ± 7.9
- F: 82.4 ± 6.6

**BMI (kg/m²)**

- M: 23.8 ± 3.7
- F: 24.0 ± 4.1
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our study. In contrast, ASM/Wt was negatively correlated with these factors. Therefore, we suggest that ASM/Wt is the more appropriate index for SO.

This study had several advantages over previous studies. First, subjects were recruited from a community-based elderly population, represented a single ethnic group, and were all aged 65 years or older. Second, previous studies used BMI or the percentage of fat mass for the definition of obesity to obtain a sufficient number of subjects within the group for statistical analysis (14). In contrast, we used the criterion of visceral fat area for defining abdominal obesity, which is known to be highly associated with metabolic impairment (6). In this study, people with a visceral fat area ≥ 100 cm² showed relatively low BMI or waist circumference compared with Caucasians.

There were several limitations of this study. First, the cross-sectional nature of this study makes it impossible to interpret any cause-effect relationship. Second, we did not consider muscle quality or the infiltration of fat into muscle, which has been shown to be associated with reduced strength, the incidence of mobility disability, and insulin resistance (13,15).

In conclusion, subjects with SO defined by ASM/Wt were more insulin resistant and had a higher risk for metabolic syndrome than simply obese or sarcopenic subjects.

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