# Prevalence of Sarcopenia and Sarcopenic Obesity in the Korean Population Based on the Fourth Korean National Health and Nutritional Examination Surveys 

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Background. Sarcopenia is an important factor of functional impairment related to aging. This study is conducted to investigate the prevalence of sarcopenia and sarcopenic obesity in Korean population.


#### Abstract

Methods. Representative Korean men $(4,486)$ and women $(5,999)$ aged 20 years or older were analyzed from the Fourth Korean National Health and Nutritional Examination Surveys. Sarcopenia was classified into Class I defined relative skeletal muscle mass loss within 1-2 SD of the gender-specific mean for healthy young adults and Class II below 2 $S D$. Relative skeletal muscle mass was represented by the appendicular skeletal muscle mass adjusted by height and body weight. Sarcopenic obesity was considered present in Class II sarcopenic participants whose waist circumference was more than or equal to 90 cm for men and more than or equal to 85 cm for women, respectively.

Results. The prevalence of Class II sarcopenia in the Korean elderly population was $12.4 \%$ for men and $0.1 \%$ for women by height-adjusted definition and $9.7 \%$ for men and $11.8 \%$ for women by weight-adjusted definition. The prevalence of sarcopenic obesity was $7.6 \%$ for men and $9.1 \%$ for women by weight-adjusted definition but nearly zero for men and women by height-adjusted definition. The prevalence of sarcopenia increased with age for men but for women only when applied with weight-adjusted definition.


Conclusions. The prevalence of sarcopenia and sarcopenic obesity differs by gender and definition criteria. The heightadjusted definition may tend to underestimate the prevalence of sarcopenia and sarcopenic obesity, especially in women.

Key Words: Sarcopenia—Sarcopenic obesity—Prevalence—Korean population-KNHANES.
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MUSCLE mass loss is an important age-related health implication for older persons. In 1989, Rosenberg proposed the term "sarcopenia" to describe the loss of muscle mass associated with aging (1). Because sarcopenia can be a modifiable factor in the older persons (2), it is important to recognize the status of sarcopenia. To actualize sarcopenia, alternative definitions have been derived (3-5). These include defining relative muscle mass as heightadjusted (3) or body weight-adjusted (4) appendicular skeletal muscle mass (ASM). Baumgartner and colleagues (3) suggested the height-adjusted definition for the first time and reported that the prevalence of sarcopenia in Caucasian participants aged 80 years or older was $53 \%$ for men and $43 \%$ for women in New Mexico.

An epidemiological study reported declining muscle mass with age and that, at any given age of adulthood, women have a remarkably smaller muscle mass than men
(6). A decline in lean body mass is likely to become detectable after 45 years of age. Since total body mass significantly increases from 20 to 40 years of age while total muscle mass remains nearly constant, the onset of the decline in muscle mass expressed as percentage of total body mass is detectable as early as the third decade of life (7).

The loss of muscle mass promotes insulin resistance (8). Because various chronic morbidities are based on insulin resistance (8), sarcopenia may be the underlying condition. As with sarcopenia, obesity can increase the risk for the development of functional impairment and physical disability in older adults $(9,10)$. The association between sarcopenic obesity (SO) and sarcopenia likely sets up a vicious cycle, resulting in further loss of muscle mass and mobility, insulin resistance, and risk of metabolic syndrome development (11).

Along with the rapid growth of the number of elderly population in Korea, age-related health problems are becoming
more important. For this reason, sarcopenia and SO are important issues in the Korean population. Several studies have attempted to address the prevalence of sarcopenia in Korea (12,13). However, their results could not be applied to the general population.
In this study, we investigated the prevalence of sarcopenia and SO in the Korean population based on the Fourth Korean National Health and Nutritional Examination Surveys (KNHANES IV) conducted in 2008-2009.

## Methods

## Study Participants

This study is based upon the data acquired in the second and third year (2008-2009) of KNHANES IV. KNHANES has been conducted periodically since 1998 to assess the health and nutritional status of the civilian noninstitutionalized population of Korea. KNHANES IV was a crosssectional and nationally representative survey conducted from 2007 to 2009 by the Division of Chronic Disease Surveillance, Korea Centers for Disease Control and Prevention. The overall survey consisted of a health interview survey, a nutrition survey, and a health examination survey. Data were collected via household interviews and by direct standardized physical examinations conducted in specially equipped mobile examination centers. The sampling frame was developed based on the 2005 population and housing census in Korea. Household units were selected by a stratified multistage probability sampling design. KNHANES IV had 264,186 primary sampling units, each of which contained about 60 households. Two hundred sampling frames from primary sampling units were randomly sampled, respectively, in 2008 and 2009. Finally, 9,307 individuals in 2008 and 10,078 in 2009 participated in the health interviews and health examination surveys. The response rate was $77.8 \%$ in 2008 and $82.8 \%$ in 2009, respectively. Among the participants, 3,583 in 2008 and 7,920 in 2009 were assessed for body composition by dual-energy x-ray absorptiometry (DXA). We analyzed the data of 4,486 men and 5,999 women aged 20 years or older. Among them, 962 men and 1,370 women were 65 years or older. All the participants in this survey signed an informed consent form.

## Definition of Sarcopenia and SO

DXA (Hologic Discovery-W; Hologic) was used for the measurement of body composition of the participants. ASM was calculated as the sum of muscle mass in arms and legs, assuming that all nonfat and nonbone tissue is skeletal muscle.

According to the definition proposed in previous studies, we used the height-adjusted ASM and body weightadjusted ASM $(3,14)$. To establish the cutoff value of sarcopenia, the gender-specific mean and $S D$ of the ASM/height ${ }^{2}$ and ASM/weight $\times 100$ of the young reference group
(healthy men and women aged 20-39 years) were used. To select the healthy reference, those who had any history of specific diseases such as diabetes, stroke, coronary artery diseases, thyroid disease, arthritis, tuberculosis, asthma, chronic obstructive lung disease, liver cirrhosis, and any cancer were excluded. Among a total of 3,364 participants aged 20-39 years, 851 who had any of those history were excluded. Individuals whose height- or weight-adjusted ASM was higher than $1 S D$ below the gender-specific mean for young reference group were considered normal according to each definition. Class I sarcopenia was indicated by definition in participants whose height- or weight-adjusted ASM was from 1 to $2 S D$ below the mean for young adults. Class II sarcopenia was indicated by definition in participants whose height- or weight-adjusted ASM was below 2 $S D$ (14). Obesity was defined as a waist circumference more than or equal to 90 cm for men and more than or equal to 85 cm for women, according to the result of a study that redefined the waist circumference cutoff points for central obesity in Korean adults (15). SO was considered as the combination of class II sarcopenia and obesity according to each definition.

## Statistical Analyses

Statistical analyses were performed using SPSS software for Windows version 18.0 (SPSS Inc., Chicago, IL). The general characteristics of the young reference group were described with mean and $S D$. The cutoff values of Class I and Class II sarcopenia were calculated according to each definition.

The participants were grouped by years of age: 20-39 (reference group), 40-49, 50-59, 60-69, 70-79, and more than or equal to 80 . Those aged 65 years or older were considered elderly subjects. To describe and compare the characteristics of age groups and the elderly population, we took the stratified and clustered structure of the sample and sampling weights into account with complex sample design. The sampling weights were computed using sampling rate and response rate. To estimate the prevalence of sarcopenia and SO in the elderly population with minimal difference between this sample and the actual population, we conducted standardization by the direct method. Direct method was done by applying the rates of sarcopenia in this representative sample being compared with a standard population (16). This method yielded the number of cases that would be expected if the age-specific rates in standard population were true for the study population. The population structure in 2005 was used as a standard population. The number of Korean elderly population in 2005 was $1,733,661$ for men and $2,632,981$ for women, respectively. Logistic regression analysis was used to examine the difference of prevalence with age. Linear regression was used to verify the differences of the mean of height- and weight-adjusted ASM with age. To estimate $p$ for trend, the age group variable was regarded as a continuous variable in

Table 1. Characteristics of the Young Reference Group

|  | Young Reference Group <br> $(N=2,513)$ |  |
| :--- | :---: | :---: |
|  | Men <br> $(N=1,245)$ | Women <br> $(N=1,268)$ |
| Age (y) | $31.0 \pm 5.5$ | $30.8 \pm 5.6$ |
| Height (cm) | $173.4 \pm 5.8$ | $160.4 \pm 5.4$ |
| Weight (kg) | $72.2 \pm 11.1$ | $56.9 \pm 9.7$ |
| Waist circumference (cm) | $82.6 \pm 9.2$ | $74.0 \pm 9.6$ |
| Body mass index $\left(\mathrm{kg} / \mathrm{m}^{2}\right)$ | $24.0 \pm 3.4$ | $22.1 \pm 3.5$ |
| ASM/height ${ }^{2}\left(\mathrm{~kg} / \mathrm{m}^{2}\right)$ | $8.42 \pm 0.92$ | $6.18 \pm 0.79$ |
| ASM/weight | $35.4 \pm 3.1$ | $28.1 \pm 2.6$ |
| Cutoff values for height-adjusted |  |  |
| $\quad$ definition (kg/m²) |  |  |
| Class I sarcopenia | 7.50 | 5.38 |
| Class II sarcopenia | 6.58 | 4.59 |
| Cutoff values for weight-adjusted |  |  |
| definition | 32.2 | 25.6 |
| Class I sarcopenia | 29.1 | 23.0 |
| Class II sarcopenia |  |  |

Note: Results are expressed as mean $\pm S D$. Participants with Class I sarcopenia are those whose height- or weight-adjusted ASM was between mean - $1 S D$ and mean $-2 S D$ for gender-specific young reference group. Participants with Class II sarcopenia are those whose height- or weight-adjusted ASM is below mean - $2 S D$ for gender-specific young reference group. $\mathrm{ASM}=$ appendicular skeletal muscle mass.
the trend analysis. All tests were two-sided, and $p<.05$ was considered statistically significant.

## Results

Among the young reference group, the mean of heightadjusted ASM was $8.42 \mathrm{~kg} / \mathrm{m}^{2}$ for men and $6.18 \mathrm{~kg} / \mathrm{m}^{2}$ for women, and the mean of weight-adjusted ASM was 35.4 for men and 28.1 for women. The cutoff values of Class II sarcopenia were determined as $6.58 \mathrm{~kg} / \mathrm{m}^{2}$ for men and 4.59 $\mathrm{kg} / \mathrm{m}^{2}$ for women by the height-adjusted definition and $29.1 \%$ for men and $23.0 \%$ for women by the weightadjusted definition (Table 1).

The characteristics of Korean older population were analyzed using direct standardization (Table 2). By the heightadjusted definition, the prevalence of Class I and Class II sarcopenia was $30.8 \%$ and $12.4 \%$ for older men, respectively, and $10.2 \%$ and $0.1 \%$ for older women, respectively. The prevalence of SO was low in both sexes by this definition. By the weight-adjusted definition, the prevalence of Class I and Class II sarcopenia was $29.5 \%$ and $9.7 \%$ for older men, respectively, and $30.3 \%$ and $11.8 \%$ for older women, respectively. More than $75 \%$ of the sarcopenic participants in both sexes also were judged to have central obesity (Table 2).

The characteristics of sarcopenia according to age groups were analyzed with complex sample design. Height- and weight-adjusted ASM by age is shown in Figure 1. For men, the levels of both height- and weight-adjusted ASM decreased with age (each $p$ for trend $<.001$ ). For women, the height-adjusted ASM did not show the decreasing tendency ( $p$ for trend $=.249$ ); the tendency of change in weight-adjusted ASM was similar for men ( $p$ for trend < .001) . In the same fashion, the prevalence of Class II sarcopenia in

Table 2. Estimation of General Characteristics and Prevalence of Sarcopenia and Sarcopenic Obesity for Korean Elderly Populations

|  | Men | Women |
| :--- | ---: | ---: |
| Height (cm) | $164.3(0.4)$ | $151.2(0.3)$ |
| Weight (kg) | $62.3(0.8)$ | $54.6(0.4)$ |
| Waist circumference (cm) | $84.7(0.7)$ | $83.2(0.5)$ |
| Body mass index (kg/m²) | $23.0(0.2)$ | $23.9(0.2)$ |
| ASM/height $\left(\mathrm{kg} / \mathrm{m}^{2}\right)$ | $7.58(0.06)$ | $6.18(0.04)$ |
| ASM/weight | $33.2(0.2)$ | $26.1(0.1)$ |
| Past history (\%) |  |  |
| Hypertension | $38.3(3.3)$ | $50.1(2.5)$ |
| Stroke | $9.9(1.8)$ | $5.3(1.0)$ |
| Coronary artery disease | $7.2(1.9)$ | $4.1(1.2)$ |
| Diabetes mellitus | $15.3(1.8)$ | $15.8(2.1)$ |
| Any cancer | $5.5(1.3)$ | $5.2(1.2)$ |
| Drinking (\%) |  |  |
| Less than once a month | $41.1(3.6)$ | $84.7(1.9)$ |
| Once a week or less frequent | $24.3(3.5)$ | $10.5(1.7)$ |
| More than once a week | $34.6(3.3)$ | $4.7(0.9)$ |
| Smoking (\%) |  |  |
| Current smoker | $32.0(2.8)$ | $7.6(1.7)$ |
| Ex-smoker | $51.6(3.3)$ | $6.6(1.0)$ |
| Nonsmoker | $16.3(2.3)$ | $85.8(1.7)$ |
| Exercise (\%) |  |  |
| None or no response | $58(3.6)$ | $67.3(2.4)$ |
| Less than three times a week | $9.5(2.0)$ | $7.4(1.5)$ |
| Three times a week or more | $32.6(3.3)$ | $25.2(2.4)$ |
| Prevalence (\%) |  |  |
| Height-adjusted definition | $30.8(2.7)$ | $10.2(1.5)$ |
| Class I sarcopenia | $12.4(1.7)$ | $0.1(0.1)$ |
| Class II sarcopenia | $0.2(0.2)$ | 0.0 |
| Sarcopenic obesity | $29.5(3.4)$ | $30.3(2.5)$ |
| Weight-adjusted definition | $7.6(2.0)$ | $11.8(1.9)$ |
| $\quad$ Class I sarcopenia |  | $9.1(1.7)$ |
| Class II sarcopenia |  |  |
| Sarcopenic obesity |  |  |
|  |  |  |

Note: Results are calculated from complex sample analysis and standardized by direct method. Results are expressed as means or proportion (SE). Participants with Class I sarcopenia are those whose height- or weight-adjusted ASM is between mean $-1 S D$ and mean $-2 S D$ for gender-specific young reference group. Participants with Class II sarcopenia are those whose height- or weightadjusted ASM is below mean - 2SD for gender-specific young reference group. Participants with obesity are those whose waist circumference is more than or equal to 90 cm for men and more than or equal to 85 cm for women. Participants with sarcopenic obesity are those who have both Class II sarcopenia and obesity. ASM = appendicular skeletal muscle mass.
men increased with age (Table 3). For men, the prevalence of Class II sarcopenia in those aged 40-49 years was $1.8 \%$ by the height-adjusted definition and $1.6 \%$ by the weightadjusted definition. The prevalence increased to $18.0 \%$ and $25.6 \%$ by the height-adjusted and weight-adjusted definition, respectively, in participants aged 80 years or older. For women, the prevalence of Class II sarcopenia by the weightadjusted definition increased steeply at ages 50-59 years; the prevalence did not change much between the age groups 50 years or older. The prevalence in all age groups was nearly zero by the height-adjusted definition (Table 3).

ASM was strongly correlated with height and body weight in men and women (Data not shown). The correlation coefficient between ASM and height was .685 for men, .591 for women, respectively, and the coefficient between ASM and body weight was .843 for men and .789 for women.


Figure 1. Changes of height- and weight-adjusted appendicular muscle mass for age; (A) Height-adjusted ASM, $p$ for trend < . 001 (in men) and .249 (in women). (B) Weight-adjusted ASM, $p$ for trend $<0.001$ (in men and women). $*$ Means that there is significant difference from the mean of reference group ( $p<.05$ ). $* *$ Means that there is significant difference from the mean of reference group ( $p<.01$ ). $\mathrm{ASM}=$ appendicular skeletal muscle mass; $\mathrm{Ht}=$ height; Wt $=$ body weight.

ASM and height- and weight-adjusted ASM were analyzed by linear and quadratic model with age. Weightadjusted ASM decreased linearly with age in both genders (Figure 2). ASM and height-adjusted ASM were fit for quadratic model with age in both genders; based on the derived equations, the age at the highest height-adjusted ASM was 34 for men and 51 for women, respectively.

## Discussion

Presently, the prevalence of sarcopenia and SO was quite different according to gender and definitions. The prevalence of sarcopenia increased with age generally in KNHANES IV.

In our study, sarcopenic men and women according to the height-adjusted definition were rarely accompanied by obesity. This result reflects the tendency of Koreans with lower body weight to have lower fat mass as well as lower muscle mass. In a previous study, few of the overweight and none of the obese population were classified as sarcopenic using this definition (5). Most sarcopenic individuals, however, had accompanying obesity using the weight-adjusted definition in our study. This result could have reflected the agerelated increases in body weight and fatness and decrease in fat-free mass shown in other studies $(17,18)$.

For women, unlike for men, the prevalence was extremely different by the definitions used in our study. Height-adjusted

Table 3. Prevalence of Sarcopenia for Korean Population Aged 40 Years or Older According to Age Group

| Definition |  | \% of Adults (SE) |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | Height-Adjusted ASM |  | Weight-Adjusted ASM |  |  |
| Class | Number of Samples | Class I | Class II | Class I |  | Class II |
| Men |  |  |  |  |  |  |
| 40-49 | 909 | 11.5 (2.1) | 1.8 (0.8) | 15.4 (2.3) |  | 1.6 (0.7) |
| 50-59 | 776 | 18.5 (3.0) | 2.1 (0.7) | 14.8 (2.4) |  | 3.7 (1.5) |
| 60-69 | 743 | 26.5 (3.7) | 6.1 (1.9) | 29.4 (4.7) |  | 5.5 (1.6) |
| 70-79 | 501 | 29.6 (3.6) | 18.2 (3.4) | 30.4 (4.8) |  | 10.3 (3.2) |
| $\geq 80$ | 97 | 41.0 (10.2) | 18.0 (7.0) | 30.5 (11.0) |  | 25.6 (10.6) |
| $p$ for trend |  |  |  |  |  |  |
| Class I + II |  |  |  |  | <0.001 |  |
| Class II only |  |  |  |  | <0.001 |  |
| Women |  |  |  |  |  |  |
| 40-49 | 1,228 | 4.8 (1.3) | 0.0 | 17.5 (2.5) |  | 1.7 (0.6) |
| 50-59 | 1,029 | 4.6 (1.6) | 0.2 (0.2) | 22.8 (2.6) |  | 7.0 (1.5) |
| 60-69 | 975 | 4.1 (1.2) | 0.0 | 32.4 (3.0) |  | 7.7 (2.0) |
| 70-79 | 700 | 14.0 (3.3) | 0.0 | 35.6 (4.0) |  | 12.4 (2.7) |
| $\geq 80$ | 163 | 12.0 (4.2) | 0.7 (0.7) | 15.4 (4.3) |  | 9.4 (4.2) |
| $p$ for trend |  |  |  |  |  |  |
| Class I + II |  |  |  |  | <0.001 |  |
| Class II only |  |  |  |  | <0.001 |  |

Note: Results are expressed as proportion (SE) derived from complex sample analysis. $p$ for trend was estimated by the linear regression test. Participants with Class I sarcopenia are those whose height- or weight-adjusted ASM is between mean - $1 S D$ and mean $-2 S D$ for gender-specific young reference group. Participants with Class II sarcopenia are those whose height- or weight-adjusted ASM is below mean $-2 S D$ for gender-specific young reference group. ASM = appendicular skeletal muscle mass.

ASM did not have a peak at age of 20-39 years but was slightly elevated at ages 40-49 years, and the value of height-adjusted ASM in the elderly population was almost the same as in the young reference group. Also, a weak positive correlation was found between age and height-adjusted ASM. Originally, to
define sarcopenia, Baumgartner and colleagues (3) needed to consider the relative muscle mass because absolute muscle mass is correlated with height. The height-adjusted ASM has been regarded as a good index of relative skeletal muscle mass (3). In our study, however, the height-adjusted


Figure 2. Scatter plots between age versus ASM, ASM divided by height squared, and ASM divided by body weight according to gender; $R^{2}$ is a model fitness derived from general linear model. $\mathrm{ASM}=$ appendicular skeletal muscle mass; $\mathrm{Ht}=$ height; $\mathrm{Wt}=$ body weight.

ASM showed poor correlation with age-related muscle mass loss. A recent study involving the Chinese elderly population also reported similar findings, leading the authors to conclude that height-adjusted ASM criteria may not be suitable for diagnosing sarcopenia in the Chinese population (19). One explanation could be that the slope for the decline in height with age was much steeper for women than for men (data not shown) while ASM with age showed steeper decline in men than in women. The difference in the mean height between women with 20 s and 80 years or older was about 14.5 cm , which is much more than the amount that the height of an individual may decrease with aging. In this reason, height-adjusted ASM had a peak at middle age instead of young age. This was opposed to the assumption that the reference is healthier and more abundant in muscle. In contrast, the values of weight-adjusted ASM decreased with age in our study. Other research emphasized that height-adjusted definition should be interpreted carefully because the important role of body fat is not incorporated (20). Another study of a Korean population reported that SO defined by weight-adjusted definition was more closely associated with metabolic syndrome (13). There were studies that investigated the association between muscle mass and physical performance $(14,21,22)$. Janssen and colleagues showed reduced skeletal muscle mass evaluated by weightadjusted definition is associated with functional impairment and disability (14). Another study reported sarcopenic participants evaluated by height-adjusted definition have not had lower muscle performance with adjustment for body fat mass (22). These suggest that ASM adjusted by body weight may be a more appropriate method in defining sarcopenia, especially in the Korean population.

A study from New Mexico (3) reported that the prevalence of sarcopenia in the participants aged 80 years or older was more than $40 \%$, which is a higher prevalence than presently determined. In another study, the prevalence of sarcopenia in participants in their 70 s (23) was $7.8 \%-16 \%$ in various method; this prevalence is similar to the prevalence by both definitions in Korean men and to the prevalence by the weight-adjusted definition in women in our study. A study conducted in a Chinese population (24) reported that the prevalence of sarcopenia by height-adjusted definition in those aged 70 years or older was $12.3 \%$ for men and $7.2 \%$ for women. For men, the prevalence is almost the same as the presently reported prevalence in the Korean male elderly population.

There are some Korean studies that showed the prevalence of sarcopenia in the elderly population $(12,13)$. They measured skeletal muscle mass by DXA; the prevalence was estimated by height- and weight-adjusted definition. In one of these studies (12), the prevalence of sarcopenia in those aged 60 years or older was considerably lower than the presently determined Korean prevalence, even though the cutoff value was much higher than our data. Lim and colleagues (13) defined sarcopenia as $1 S D$ below mean of ASM/height ${ }^{2}$ and ASM/
weight instead of $2 S D$. Their cutoff values were very similar to our values of Class I sarcopenia in both definitions and both genders. However, the prevalence in their sample was lower than the present Korean data in either definitions and in either gender. It could also have been caused by the difference of the samples. The participants in both studies enrolled voluntarily; it is possible that the participants in those studies were comparably healthier than average Korean population.

Our study has some limitations. First, the young population was assigned as a reference group. The age-related change occurs in each individual, not between generations. However, the past data of the older participants could not be collected in our study. Due to the limitation of the crosssectional study like ours, many studies investigating sarcopenia have also regarded the young group as the reference $(3,14,23,25)$. Second, this study could not evaluate the function of muscle. The function of skeletal muscle as well as muscle mass is important for sarcopenia in the elderly population $(26,27)$. The European Working Group on Sarcopenia in Older People suggested conceptual stages of sarcopenia considering both muscle function and mass (28). The muscle function needs to be evaluated in later studies. Third, we did not use a more precise method to measure the skeletal muscle mass. More precise measurement techniques, such as computed tomography and magnetic resonance imaging, are themselves limited by their high cost of equipment acquisition and use, limited access to the equipment, and radiation exposure during the procedures (29). Most prior studies used DXA and bioelectrical impedance analysis to estimate the skeletal muscle mass; the present DXA data are comparable with these studies. Fourth, we could not use a more precise method to evaluate obesity. A Korean study (13) used computed tomography for the examination of abdominal obesity. Early studies $(30,31)$ used the fat proportion to evaluate obesity. However, waist circumference is a good surrogate marker for central obesity, and the cut value is well established by international criteria (32).

This study has powerful strengths. The data are representative of the entire Korean population. Because we analyzed the data considering sampling weight by complex sample design, the results represent population estimates. Also, to calculate the prevalence in the elderly population, direct standardization was used. Because we could analyze large sample of young population, those who had the possible history of illness to affect skeletal muscle could be excluded for calculation of the cut values.

In conclusion, the prevalence of Class II sarcopenia in the Korean elderly population is $12.4 \%$ for men and $0.1 \%$ for women by the height-adjusted definition and $9.7 \%$ for men and $11.8 \%$ for women by the weight-adjusted definition. The prevalence of SO is very low by the heightadjusted definition and high among sarcopenic participants by the weight-adjusted definition. Because the heightadjusted definition, especially in women, does not seem to reflect the real status of the Korean elderly population,
alternative definitions like the weight-adjusted definition should be applied for the studies of sarcopenia. Moreover, the epidemiological status of sarcopenia should be described including the muscle function as well as the muscle mass.

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