Original Article

Sarcopenic Obesity in Elderly Korean Women: A Nationwide Cross-sectional Study

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Background: Sarcopenia causes loss of muscle mass in the elderly and is associated with development of metabolic syndrome in those with obesity. This study evaluated the prevalence of sarcopenic obesity (SO) in healthy Korean elderly women. **Methods:** This study was based on data from the Korea National Health and Nutrition Examination Survey IV and V, 2008-2011. Whole body dual energy X-ray absorptiometry and body mass index measurement were performed for all patients. Women aged 65 years or older were included in this study. Total appendicular extremity muscle mass was used to determine the skeletal muscle mass index. **Results:** Of 2,396 women aged 65 years or older, a total of 1,491 (62.2%) were underweight, normal weight, or overweight, while 905 (37.8%) were obese. The prevalence of sarcopenia using a cut-off value of 5.4 kg/m^2 was 64.9% (63/97) in underweight women, 38.2% (320/838) in normal weight women, 17.1% (95/556) in overweight women, and 6.1% (55/905) in obese women. **Conclusions:** The prevalence of sarcopenia was different among groups. The prevalence rate in obese women was lower than that in non-obese women. SO is a new category of obesity in older adults with high adiposity coupled with low muscle mass. The prevalence of SO was lower than that in previous studies because of differences in the definition. A consensus definition of SO needs to be established.

Key Words: Body mass index, Korea, Obesity, Sarcopenia, Women

INTRODUCTION

Loss of muscle mass is a predominant change of body composition in elderly people. Rosenberg [1] defined age-related reduction of muscle mass as sarcopenia. Sarcopenia is characterized by decline in skeletal muscle mass and function that may result in reduced physical capability and poorer quality of life.[2,3] In recent years, the population of obesity is rapidly increasing. Aging and physical disability are also related to an increase in fat mass, particularly visceral fat,[4] an important factor in the development of metabolic syndrome and cardiovascular disease.

The concurrence of both obesity and sarcopenia, also known as sarcopenic obesity (SO), was first defined by Baumgartner [5]. It has been reported that SO can increase the risk of metabolic syndrome, physical disability, morbidity, and mortality compared to either sarcopenia or obesity alone.[6] The complex interplay of

common pathophysiological mechanisms (such as increased proinflammatory cytokines, oxidative stress, insulin resistance, and hormonal changes) and decreased physical activity underlies the close relationship between sarcopenia and obesity.[7] Sarcopenia can reduce physical activity and total energy expenditure, thus increasing the risk of obesity.[8] In contrast, an increase in visceral fat induces inflammation which contributes to the development of sarcopenia.[9] The association between sarcopenia and obesity likely sets up a vicious cycle, resulting in further loss of muscle mass and mobility, insulin resistance, and risk of metabolic syndrome development.[10] For this reason, SO and its relation with other metabolic disease are important issues in elderly population. Furthermore, we hypothesized that there would be higher prevalence rate of sarcopenia within obesity due to that vicious cycle.

Korea is one of the most rapidly aging countries in the world.[11] Several studies have focused on the prevalence, etiology, and clinical issues of SO in Korea. However, the prevalence rates of SO were quiet different among studies. The objective of this study was to evaluate the prevalence of SO in large number of healthy Korean elderly women based on data of the Korea National Health and Nutrition Examination Survey (KNHANES) IV and V conducted in 2008 to 2011. We also compared prevalence rates of SO according to their obesity status.

METHODS

1. Study population

This study was based on data obtained from the KNHANES IV and V. The KNHANES is a nationally-representative survey conducted by the Korean Ministry of Health and Welfare. These surveys have been conducted periodically since 1998, using a rolling sampling design involving a complex, stratified, multistage, probability-cluster survey of a representative sample of the non-institutionalized civilian population in order to assess the health and nutritional status of the Korean population. Whole body dual energy X-ray absorptiometry (DXA) scan and body mass index (BMI) measurement were performed for individuals of ≥10 years old from July 2008 to May 2011(excluding pregnant women), individuals with a height of ≥196 cm or a weight of ≥136 kg were excluded in accord with the KNHANES survey protocol. In addition, test results were treated as missing value

in participants with implanted radio-opaque material (e.g., a prosthetic device, implant or other radio-opaque object) that could affect DXA results. Postmenopausal women aged 65 years or more were included in this study. Written informed consent was obtained from all participants. Protocols for the KNHANES IV and V were approved by the Institutional Review Board of the Korean Center for Disease Control and Prevention.

2. Definition of sarcopenia and SO

Whole-body DXA examinations for the KNHANES study were conducted with a QDR4500A apparatus (Hologic Inc., Bedford, MA, USA). Data included values for bone mineral content (g), bone mineral density (g/cm^2), fat mass (g), lean mass, bone mineral content (g), and fat percentage of the whole body and that of specific anatomical region. Appendicular skeletal muscle mass (ASM) was obtained by adding muscle masses of the four limbs by assuming that non-fat and non-bone masses were skeletal muscles. Skeletal mass index (SMI) was defined as ASM/height^2. Asian Working Group for Sarcopenia (AWGS) suggested a classical approach to determine the cut-off value by using the value of two standard deviations below the mean for a young reference group which was 5.4 kg/m^2 for women.[12] We used 5.4 kg/m^2 as the cut-off value to determine the prevalence for sarcopenia among elderly Korean women.

BMI is commonly used to classify overweight and obesity in adults. According to the International Obesity Task Force recommendation, BMI categories were as follows: normal (between 18.5 and 23 kg/m^2), underweight (<18.5 kg/m^2), overweight (between 23 and 25 kg/m^2), and obese (between 25 and 30 kg/m^2).[13]

3. Statistical analysis

The χ^2 test was used to compare categorical measures between groups defined by BMI. Odds ratios (ORs) and 95% confidence intervals (CIs) were estimated for the associations between obesity and sarcopenia using logistic regression analyses. All P-values of less than 0.05 were considered statistically significant. All analyses were conducted using SPSS software version 20.0 (SPSS Inc., Chicago, IL, USA).

RESULTS

In the elderly women, age was significantly higher in the

Table 1. Characteristics of elderly women older than 65 years by presence of sarcopenia

Variables	All (n=2,396)	Non-sarcopenia (n=1,863)	Sarcopenia (n=533)	P-value*
Age (year)	72.5±5.5	72.3±5.4	74.2±6.3	<0.001
BMI (kg/m^2)[a]	24.1±3.4	24.5±3.3	20.9±2.5	<0.001
Waist circumference (cm)	83.1±9.7	84.0±9.5	76.1±8.8	<0.001
Appendicular SMI (kg/m^2)	6.4±1.1	6.5±1.0	5.0±0.3	<0.001
Education (%)				0.499
<Elementary school	86.7	87.0	84.2	
Elementary school	6.3	6.2	7.5	
Middle school	5.4	5.2	7.1	
>Middle school	1.6	1.6	1.2	
Cigarette smoking status (%)				0.245
Never	89.6	89.9	86.6	
Former	1.6	1.5	2.4	
Current	8.8	8.6	10.9	
Moderate physical activity (%)[b]	12.3	12.8	8.6	0.064
Walking physical activity (%)[c]	39.7	40.0	38.0	0.561
Income (%)				0.711
Quartile 1 (lowest)	24.4	24.5	23.8	
Quartile 2	25.5	25.9	22.9	
Quartile 3	24.4	24.3	25.8	
Quartile 4 (highest)	25.6	25.4	27.5	
Energy intake (kcal/day)	1,420.6±534.5	1,437.6±540.7	1,276.1±454.0	<0.001
Protein intake (g/day)	44.7±22.9	45.3±23.2	40.0±19.5	0.001
Comorbidity (%)				
Diabetes	17.7	17.8	17.0	0.352
Chronic obstructive pulmonary disease	0.5	0.5	0.0	0.892
Chronic renal failure	0.7	0.7	0.8	0.053
Malignancy	5.7	5.6	6.4	0.641

The data is presented as the mean±standard deviation or percentage distribution of participants, as appropriate: BMI, SMI, and bone mass density. [a]The unweighted sample size was presented in the table, but the results presented reflect the weighted sample. [b]Moderate physical activity was 5 or more days of moderate-intensity activity for at least 30 min per day. [c]Walking physical activity was 5 or more days of walking of at least 30 min per day. *Significance was compared between non-sarcopenia and sarcopenia groups using Student's t-test or Pearson χ^2 test.
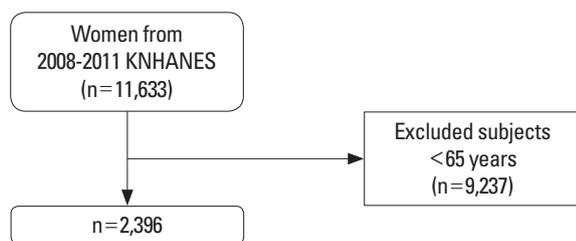BMI, body mass index; SMI, skeletal muscle mass index.

Fig. 1. Flow chart of included participants. KNHANES, Korea National Health and Nutrition Examination Survey.

Table 2. Distribution of sarcopenia by obesity status

BMI	Sarcopenia, n (%)	Non-sarcopenia, n (%)	Total
Non-obesity	478 (19.9)	1,013 (42.3)	1,491 (62.2)
Obesity	55 (2.3)	850 (35.5)	905 (37.8)
Total	533 (22.2)	1,863 (77.8)	2,396 (100.0)

The data is presented as number (%).
BMI, body mass index.

sarcopenia group than the non-sarcopenia group (P<0.001). However, BMI (P<0.001), waist circumference (P<0.001), appendicular SMI (P<0.001), energy intake (P<0.001), and protein intake (P=0.001) were significantly lower in the sarcopenia group than the non-sarcopenia group (Table 1).

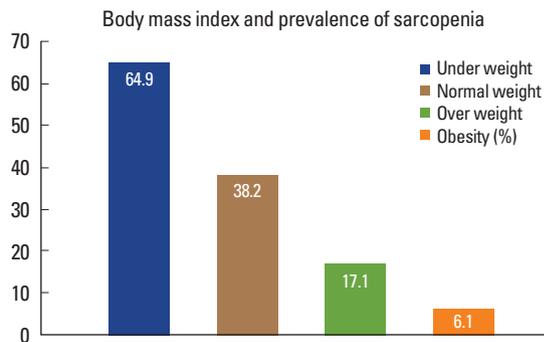The 2008 to 2011 the KNHANES included 2,396 women ≥65 years (Fig. 1). Regarding age distribution, 1,611 were

Fig. 2. Prevalence rate of sarcopenia according to the degree of body mass index.

65 to 74 years old, 706 were 75 to 84 years, and 79 were over 85 years. Among women over 65 years, 1,491 (62.2%) were underweight, normal weight, or overweight while 905 (37.8%) were obese (Table 2).

The prevalence of sarcopenia was 64.9% (63/97) in underweight women, 38.2% (320/838) in normal weight women, 17.1% (95/556) in overweight women, and 6.1% (55/905) in obese women (Fig. 2). The overall prevalence of sarcopenia among women ≥65 years was 22.2%. The prevalence of SO was 2.3% among elderly women ≥65 years (Table 2). Participants with BMI of 25 or above had lower odds of having sarcopenia (OR, 0.14; 95% CI, 0.10-0.18; $P<0.01$) than those with BMI <25.

DISCUSSION

This study evaluated the prevalence of SO in healthy elderly women in Korea. The results showed that the overall prevalence of SO was 2.3% in women of 65 years or older. The prevalence of sarcopenia was different among groups according to BMI. The prevalence rate of sarcopenia in obese women was lower than that in non-obese women.

To clarify the definition of sarcopenia, various working groups have published consensus papers. We addressed the prevalence of sarcopenia using 5.4 kg/m^2 as recommended value by the AWGS. We also defined obesity as BMI ≥25 according to the International Obesity Task Force recommendation.

The prevalence of SO significantly differed from those of previous studies,[6,14-24] ranging from 0% to 48% depending on the background of the studied population, parameters, and cut-off values used for muscle volume quantification. Furthermore, methods and cut-off values used to de-

fine obesity were different among these studies. In this study, the prevalence rate of SO was lower than other previous studies. In general, SO prevalence is lower using height adjusted SMI compared to weight or BMI adjusted SMI. This phenomenon is prominent in Korea because differences in height between age groups are greater among Koreans compared to those in other countries.[25] Moreover, SO prevalence is higher using % body fat compared to that using BMI as a parameter of obesity.[26] In this study, we used height adjusted SMI and BMI as a parameter of SO. This might have resulted in lower prevalence of SO compared to that in other previous studies.

Patients with obesity were at decreased risk of prevalent sarcopenia in this study. This finding is consistent with findings of others. In a previous cohort study, low BMI was a risk factor for both current and future sarcopenia in very old age. The prevalence and incidence of sarcopenia were high in the underweight group in the present study. Low BMI might be a reasonable proxy for low lean mass.[27] Previously, BMI has been found to be the only predictor of skeletal muscle mass for women.[27] It is strongly and negatively correlated with the prevalence of sarcopenia.[28]

Although BMI is commonly used as a surrogate parameter for obesity, it indicates weight-for-height without considering differences in body composition or contribution of body fat to overall body weight. The mass of muscle is reduced while that of fat tissues is increased in the elderly. Thus, BMI might be a poor marker of body fat because it does not distinguish between fat and lean body mass, especially in old ages. This is a kind of "Obesity Paradox" commonly mentioned in heart failure, cardiovascular disease, and other chronic diseases.[29]

SO is a novel concept that has become more important in the elderly population. However, different definitions of sarcopenia and SO limit the discovery of clinical application of this disease with regard to other metabolic diseases and cardiovascular diseases. Therefore, consensus definition needs to be established for SO to promote standardized diagnosis and management for this disease in future study.

This study has several limitations. First, we only considered low muscle mass when defining sarcopenia regardless of muscle function. Second, we did not specifically exclude women with metabolic diseases such as hyperthyroidism or diabetes mellitus that might influence lean body

mass.

This study has several powerful strengths. A large number of participants were included and analyzed by using data obtained from the KNHANES. Furthermore, the data of the KNHANES are representative of the entire Korean population. To the best of our knowledge, this is the first study addressing the prevalence of sarcopenia using 5.4 kg/m^2 as recommended value by the AWGS in Korea.

In conclusion, the prevalence rate of sarcopenia in obese women was lower than that in non-obese women. We examined the prevalence of SO in Korean elderly women by using AWGS recommendation. The prevalence of SO was lower compared to other previous studies because of different method to define it. A consensus definition of SO needs to be established.

REFERENCES

1. Rosenberg IH. Sarcopenia: origins and clinical relevance. J Nutr 1997;127:990s-1s.

2. Visser M, Goodpaster BH, Kritchevsky SB, et al. Muscle mass, muscle strength, and muscle fat infiltration as predictors of incident mobility limitations in well-functioning older persons. J Gerontol A Biol Sci Med Sci 2005;60:324-33.

3. Xue QL, Walston JD, Fried LP, et al. Prediction of risk of falling, physical disability, and frailty by rate of decline in grip strength: the women's health and aging study. Arch Intern Med 2011;171:1119-21.

4. Riechman SE, Schoen RE, Weissfeld JL, et al. Association of physical activity and visceral adipose tissue in older women and men. Obes Res 2002;10:1065-73.

5. Baumgartner RN. Body composition in healthy aging. Ann N Y Acad Sci 2000;904:437-48.

6. Lim S, Kim JH, Yoon JW, et al. Sarcopenic obesity: prevalence and association with metabolic syndrome in the Korean Longitudinal Study on Health and Aging (KLoSHA). Diabetes Care 2010;33:1652-4.

7. Choi KM. Sarcopenia and sarcopenic obesity. Korean J Intern Med 2016;31:1054-60.

8. Zamboni M, Mazzali G, Fantin F, et al. Sarcopenic obesity: a new category of obesity in the elderly. Nutr Metab Cardiovasc Dis 2008;18:388-95.

9. Gregor MF, Hotamisligil GS. Inflammatory mechanisms in obesity. Annu Rev Immunol 2011;29:415-45.

10. Roubenoff R. Sarcopenic obesity: the confluence of two epidemics. Obes Res 2004;12:887-8.

11. Statistics Korea. Complete enumeration results of the 2016 population and housing census. 2017 [cited by 2017 Aug 31]. Available from: http://kostat.go.kr/portal/eng/press-Releases/8/7/index.board?bmode＝read&bSeq＝&aSeq＝363132&pageNo＝1&rowNum＝10&navCount＝10&currPg＝&sTarget＝title&sTxt＝

12. Chen LK, Liu LK, Woo J, et al. Sarcopenia in Asia: consensus report of the Asian Working Group for Sarcopenia. J Am Med Dir Assoc 2014;15:95-101.

13. International Obesity TaskForce, World Health Organization. The Asian-Pacific perspective: redefining obesity and its treatment. Geneva, CH: World Health Organization Western Pacific Region; 2000.

14. Kim TN, Yang SJ, Yoo HJ, et al. Prevalence of sarcopenia and sarcopenic obesity in Korean adults: the Korean sarcopenic obesity study. Int J Obes (Lond) 2009;33:885-92.

15. Hwang B, Lim JY, Lee J, et al. Prevalence rate and associated factors of sarcopenic obesity in korean elderly population. J Korean Med Sci 2012;27:748-55.

16. Kim YS, Lee Y, Chung YS, et al. Prevalence of sarcopenia and sarcopenic obesity in the Korean population based on the Fourth Korean National Health and Nutritional Examination Surveys. J Gerontol A Biol Sci Med Sci 2012;67:1107-13.

17. Ryu M, Jo J, Lee Y, et al. Association of physical activity with sarcopenia and sarcopenic obesity in community-dwelling older adults: the Fourth Korea National Health and Nutrition Examination Survey. Age Ageing 2013;42:734-40.

18. Bouchard DR, Dionne IJ, Brochu M. Sarcopenic/obesity and physical capacity in older men and women: data from the Nutrition as a Determinant of Successful Aging (NuAge)-the Quebec longitudinal Study. Obesity (Silver Spring) 2009;17:2082-8.

19. Monteiro MA, Gabriel RC, Sousa MF, et al. Temporal parameters of the foot roll-over during walking: influence of obesity and sarcopenic obesity on postmenopausal women. Maturitas 2010;67:178-85.

20. Lu CW, Yang KC, Chang HH, et al. Sarcopenic obesity is closely associated with metabolic syndrome. Obes Res Clin Pract 2013;7:e301-7.

21. Silva AO, Karnikowski MG, Funghetto SS, et al. Association of body composition with sarcopenic obesity in elderly women. Int J Gen Med 2013;6:25-9.

22. dos Santos EP, Gadelha AB, Safons MP, et al. Sarcopenia and sarcopenic obesity classifications and cardiometabolic risks in older women. Arch Gerontol Geriatr 2014;59:56-61.

23. Batsis JA, Mackenzie TA, Lopez-Jimenez F, et al. Sarcopenia, sarcopenic obesity, and functional impairments in older adults: National Health and Nutrition Examination Surveys 1999-2004. Nutr Res 2015;35:1031-9.

24. Aggio DA, Sartini C, Papacosta O, et al. Cross-sectional associations of objectively measured physical activity and sedentary time with sarcopenia and sarcopenic obesity in older men. Prev Med 2016;91:264-72.

25. Kwon HJ, Ha YC, Park HM. The Reference Value of Skeletal Muscle Mass Index for Defining the Sarcopenia of Women in Korea. J Bone Metab 2015;22:71-5.

26. Lee DC, Shook RP, Drenowatz C, et al. Physical activity and sarcopenic obesity: definition, assessment, prevalence and mechanism. Future Sci OA 2016;2:Fso127.

27. Dodds RM, Granic A, Davies K, et al. Prevalence and incidence of sarcopenia in the very old: findings from the Newcastle 85+ Study. J Cachexia Sarcopenia Muscle 2017;8:229-37.

28. Iannuzzi-Sucich M, Prestwood KM, Kenny AM. Prevalence of sarcopenia and predictors of skeletal muscle mass in healthy, older men and women. J Gerontol A Biol Sci Med Sci 2002;57:M772-7.

29. Lainscak M, von Haehling S, Doehner W, et al. The obesity paradox in chronic disease: facts and numbers. J Cachexia Sarcopenia Muscle 2012;3:1-4.