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Research Article

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Comprehensive Cross-sectional Study of Sarcopenia in Young Korean Women: Assessing Body Dimensions, Clinical Indicators, and Behavioral Traits for Hazardous Components and Proportional Analysis

Jongseok Hwang, PT, Ph.D · Na-Hyung Kim, Ph.D[1†]

Institute of Human Ecology, Yeungnam University
[1]Wonkwang University

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| Abstract |

PURPOSE: This research investigated clinical hazardous components and analyzed the proportion of sarcopenia among young Korean women.

METHODS: The cross-sectional study included 1,236 women aged 20 to 29 years, categorized into two groups according to their skeletal muscle mass index (SMI). Of these, 20 participants were placed in the sarcopenia group, while 1,216 were included in the normal group. The analysis involved hazardous components including body dimensions, clinical indicators, and behavioral trait variables: height, weight, body mass index, waist circumference, skeletal muscle mass index, systolic and diastolic blood pressure, blood laboratory tests assessing fasting glucose, triglycerides, total cholesterol, as well as smoking habits and alcohol consumption. Complex sampling analysis was used to analyze the proportion and hazardous components of sarcopenia.

RESULTS: The proportion of sarcopenia was at 1.76% (95% of CI: 1.08-2.83). Anthropometric measurements, such as height, BMI, and WC, exhibited significant differences between the groups ($p < .05$). However, there was no significant difference in weight ($p > .05$) between the two groups. Among the clinical indicators, SBP, DBP, FBG, serum triglycerides, and total TC found to be significant hazardous components for sarcopenia within both groups ($p < .05$). Smoking status as a behavioral trait was significant as well ($p < .05$), unlike alcohol consumption ($p > .05$).

CONCLUSION: This study discerned both the proportion of sarcopenia and the hazardous components associated with it among community-dwelling women of a young age.

Key Words: Body dimension, Hazardous component, Proportional analysis, Sarcopenia, Young women

Ⅰ. Introduction

Sarcopenia is a medical condition characterized by an age-related decrease in skeletal muscle mass, reduced

†Corresponding Author : Na-Hyung Kim
knahyu@yu.ac.kr, https://orcid.org/0000-0003-1595-5558

muscle strength, and functionality, and a diminished quality of life [1]. While the precise mechanisms leading to sarcopenia remain incompletely understood, several studies have suggested that hormonal shifts, reduced physical activity, age-associated muscle alterations, nutritional factors, and neurodegenerative elements may contribute to its onset [2]. Skeletal muscle decline commences around the age of 35 years with an annual decrease of 1–2% and accelerates to 3% per year after reaching 65 years.

The aging population in Asia, with Korea at the forefront, is expanding rapidly. Approximately 16.5% of Korea's population was aged 65 years or older in 2021, a proportion set to surge to almost 40% by 2050 [3]. This demographic shift is projected to substantially amplify the impact of age-related conditions, such as sarcopenia, particularly in Korea and Asia, in comparison with other nations across the world [3].

Several investigations have identified a higher occurrence of sarcopenia in females compared to males. Dam et al. screened 10,063 individuals and noted a proportion of 11.80% in women and 5.10% in men [4,5]. Similarly, Hunt et al. studied 1,921 Japanese individuals residing in the community and found a sarcopenia proportion of 16.56% in females and 10.34% in males [5].

Despite a significantly higher proportion of female sarcopenia patients compared to their male counterparts, detecting sarcopenia in female patients at an early stage remains a challenge. This is because of a dearth of studies on the identification of hazardous components in females with sarcopenia, compared to the extensive research focusing on sarcopenia in males [6-9]. This underscores the necessity for research on gender-specific sarcopenia- associated hazardous components. Despite the potential negative consequences associated with sarcopenia and the increase in the number of elderly women, healthcare professionals, including physical therapists and primary care clinicians, encounter problems in diagnosing sarcopenia due to limited knowledge and diagnostic tools. Healthcare professionals are constrained by the limited time per patient visit and the need to assess the likelihood of sarcopenia before considering referrals for diagnosis and treatment. Moreover, the lack of knowledge regarding sarcopenia among clinicians is often the reason for missed diagnoses [10]. Understanding the key hazardous components associated with sarcopenia is crucial in effectively addressing this challenge and enabling early detection and prevention [11]. Timely recognition of the individuals displaying symptoms is crucial for prompt diagnosis and intervention. Late or overlooked diagnoses can lead to complications, including limited functional recovery, reduced quality of life, and an unnecessary strain on government healthcare resources.

However, the primary focus of most studies on sarcopenia has been on individuals aged 30 years and above [12-20], disregarding the fact that age-related muscle loss can potentially start in the 30s [21-25]. It is crucial to identify the factors associated with muscle loss at an earlier stage to effectively prevent and treat this condition. This study, therefore, investigated the proportion of sarcopenia in the general Korean population and examined the hazardous components among young women aged between 20 and 29 years. The hypothesis underlying this study was that this specific age group would display distinct and unique factors that could raise their risk of developing sarcopenia later in life.

Ⅱ. Methods

1. Research Participants

The study relied on data collected from the Korea National Health and Nutrition Examination Surveys, a program conducted by the Centers for Disease Control and Prevention to monitor health-risk behaviors among the population. This survey was structured with a stratified, clustered, multistage probability sampling design and involved 37,753 participants between 2008 and 2011. Of these, 34,123 individuals comprising males and females

aged below 20 or above 29 years were excluded, leaving 1,945 participants. Among these, 709 subjects were further excluded due to a lack of available health survey data and information on dual X-ray absorptiometry (DEXA). The final set of subjects for the analysis comprised 1,236 women aged between 20 and 29 years. These subjects were then segregated into two groups based on their skeletal muscle mass index (SMI): 20 individuals were included in the sarcopenia group and 1216 individuals in the normal group. The study used health survey data including body dimensions, clinical indicators, and behavioral trait variables: height, weight, body mass index (BMI), waist circumference (WC), SMI, systolic and diastolic blood pressure (SBP and DBP), blood laboratory tests assessing fasting blood glucose (FBG), triglycerides, total cholesterol (TC), as well as lifestyle factors such as smoking status and alcohol consumption. The experimental design was approved by the institutional review board of the KDCA, and all participants provided informed written consent.

2. Criteria of Sarcopenia

Sarcopenia, identified by the ICD-10-CM code M62.84, was diagnosed by evaluating the appendicular skeletal muscle mass. DEXA, using the QDR4500A equipment from Hologic, Inc. in Bedford, MA, USA, was employed to measure the appendicular skeletal muscle mass (ASM). The Skeletal Muscle Mass Index (SMI) was calculated as the ratio of ASM (kg) to BMI (kg/m^2). Sarcopenia was defined as having an SMI of below .521 in women, as per the criteria set by the Foundation for the National Institutes of Health (FNIH) Sarcopenia Project [20]. This criterion was applied for diagnosing sarcopenia within the study population.

3. Research Variables

1) Body Dimensions

Body dimensional measurements were gathered from the study subjects. This included the measurement of height, weight, BMI, and WC.

2) Clinical Risk Indicators

Clinical Indicators assessed included blood pressure and data from blood laboratory tests. Skilled professionals conducted the measurement of SBP and DBP using a mercury sphygmomanometer, positioning the blood pressure cuff at heart level while individuals were seated following a rest period of at least five minutes. The blood laboratory analysis included fasting blood glucose (FBG), triglycerides, and TC levels, which were assessed and quantified using a LABOSPECT 008AS platform (Hitachi High-Tech Co., Tokyo, Japan). Blood samples were drawn from the non-dominant arm after an overnight fast lasting at least eight hours. The collected blood was immediately mixed with an agent promoting coagulation and subsequently centrifuged in a mobile examination facility. All tests were conducted within 24 hours of the blood sample collection.

3) Behavioral Traits

Information regarding smoking and alcohol consumption status was gathered through a survey. Both cigarette smoking and alcohol consumption were classified into three categories: non-users, ex-users, or current users. Current users refer to participants who are actively consuming or using alcohol or tobacco products at present. Ex-users include those who used to consume alcohol or tobacco products but have since stopped. Non-users comprise those who have never engaged in the consumption of alcohol or tobacco products. These recorded measurements and variables play a crucial role in assessing diverse health factors and the risk of disease within the study population.

4. Data Analysis

The research study displayed statistical measurements using the mean and standard deviation for each parameter. A complex sampling analysis was conducted, presenting a comprehensive nationwide analysis for Korea by integrating individual weights provided by the KNHANES.

Statistical analysis was carried out using the SPSS 22.0 Windows version (IBM Corporation Armonk, NY, USA). The data adopted a stratified, clustered, multistage probability sampling design. In proportional analysis, weighted values are employed to account for the complexities of the survey design and ensure a more accurate representation of the proportion in the broader population. Unlike unweighted values, where each observation is treated equally, weighted values adjust for potential biases introduced by the sampling process. To compare the clinical parameters between participants with and without sarcopenia, independent t-tests, and Chi-square analyses were applied, and the odds ratio (OR) of sarcopenia was calculated using multiple logistic regression. An alpha level of .05 was chosen as the threshold for statistical significance.

Ⅲ. Results

1. Proportional Analysis

The proportion of sarcopenia, calculated as a weighted value, was 1.76% (95% CI: 1.08-2.83), as shown in Table 1. The unweighted sarcopenia proportion was 1.62%.

2. Hazardous Components

1) Body Dimension Variables

The groups displayed statistically significant differences in height, BMI, and WC ($p < .05$). No differences were noted in the weight ($p > .05$). Table 2 outlines the hazardous components within the body dimensional measurements.

2) Clinical Indicators

SBP, DBP, FBG, triglycerides, and TC exhibited statistically significant differences between the two groups ($p < .05$) (Table 3).

Table 1. Analysis of the proportion of sarcopenia

	Sarcopenia (n = 20)	Normal (n = 1,216)	Total (N = 1,236)
Un-weighted (%)	1.62	98.92	100
Weighted (%)	1.76 (1.08-2.83)	98.24 (97.17-97.17)	100

Weighed values present the 95% confidence interval (CI).

Table 2. Anthropometric measurements and the skeletal muscle mass index (SMI) in young Korean women

	Sarcopenia (n = 20)	Normal (n = 1,216)	p
Age (years)	24.20 ± 2.72	24.86 ± 2.82	.294
Height (cm)	151.12 ± 5.31	161.61 ± 5.42	.000
Weight (kg)	59.19 ± 14.71	55.88 ± 9.76	.138
BMI (kg/m^2)	25.719 ± 4.91	21.37 ± 3.42	.000
WC (cm)	78.21 ± 12.65	71.37 ± 9.11	.001
SMI (g/m^2)	481.45 ± 54.86	695.04 ± 83.03	.000

Values are expressed as the mean ± standard deviation. An independent t-test was conducted.
BMI, body mass index; WC, waist circumference; SMI, skeletal muscle mass index.

Table 3. Clinical Indicators associated with sarcopenia in young Korean women

	Sarcopenia (n = 20)	Normal (n = 1,216)	p
SBP (mmHg)	118.817 ± 15.09	112.23 ± 14.59	.000
DBP (mmHg)	77.437 ± 10.15	74.30 ± 10.03	.001
FBG (mg/dL)	101.55 ± 35.75	94.11 ± 18.87	.000
Triglycerides (mg/dL)	120.79 ± 70.01	105.96 ± 77.94	.039
TC (mg/dL)	192.84 ± 35.17	185.65 ± 32.17	.017

Values are expressed as the mean ± standard deviation. An independent t-test was conducted.
SBP, systolic blood pressure; DBP, diastolic blood pressure; FBG, fasting blood glucose; TC, total cholesterol.

Table 4. Lifestyle factors associated with sarcopenia among young Korean women

	Sarcopenia (n = 20)	Normal (n = 1,216)	p
Alcohol consumption (%) (current-/ex-/non-users)	81.66 / 15.29 / 3.04	84.47 / 11.03/ 4.48	.776
Smoking status (%) (current-/ex-/non-users)	23.18 / 23.87 / 52.93	17.42 / 5.89 / 76.68	.014

A Chi-square analysis was employed to compare the two groups.

3) Behavioral Traits

The statistical evaluation indicated that the factors linked to smoking status demonstrated significance ($p < .05$), while the variables associated with alcohol consumption did not demonstrate statistical significance ($p > .05$) (Table 4).

3. Odds Ratio (OR)

The variables of height, BMI, WC, SMI, SBP, DBP, FBG, triglycerides, and TC revealed statistically significant differences between the two groups ($p < .05$). The corresponding values of OR (95% of CI) were .829 (.738–.994), 2.932 (1.345–4.378), 1.197 (1.010–1.434), .511 (.353–.734), 1.148 (1.068–1.262), 1.017 (1.000–1.155), 1.311 (1.003–1.563), 1.009 (1.002–1.012), and 1.007 (1.003–1.009), respectively.

Table 5. Multiple logistic regression for computing the odds ratios of sarcopenia

Variables	Odd ratios (95% of CI)	p
Height	.829 (.738–.994)	.026
BMI	2.932 (1.345–4.378)	.013
WC	1.197 (1.010–1.434)	.036
SMI	.511 (.353–.734)	.000
SBP	1.148 (1.068–1.262)	.037
DBP	1.017 (1.000–1.155)	.046
FBG	1.311 (1.003–1.563)	.015
Triglycerides	1.009 (1.002–1.012)	.022
TC	1.007 (1.003–1.009)	.037

Odd ratio values are present as the 95% confidence interval (CI). BMI, body mass index; WC, waist circumference; SMI, skeletal muscle mass index SBP, systolic blood pressure; DBP, diastolic blood pressure; FBG, fasting blood glucose; TC, total cholesterol.
Multiple logistic regression was conducted.

Ⅳ. Discussion

This research investigated the proportion and hazardous components of sarcopenia in community-dwelling young women. The rapidly growing elderly population in Korea and other Asian countries has led to a heightened proportion of sarcopenia, particularly among females. Despite the adverse effects associated with sarcopenia, healthcare practitioners, such as physical and occupational therapists, encounter difficulties in diagnosing this condition due to insufficient knowledge and diagnostic resources, resulting in missed diagnoses and associated long-term complications. The variables affecting the proportion of sarcopenia were body dimension measurements (e.g., WC), clinical indicators such as blood pressure, FBG, triglycerides, and TC levels in the blood, and lifestyle factors such as alcohol consumption and smoking habits. The tests to identify these potential hazardous components associated with sarcopenia are cost-effective, convenient, and can be readily conducted. Understanding the risk elements is critical for the early identification and prevention of sarcopenia in the susceptible population. The recognized hazardous components for sarcopenia in the population included WC, SBP, DBP, fasting glucose, triglycerides and TC, and smoking status.

Anthropometric measurements, particularly WC, have consistently emerged as a significant hazardous component

associated with sarcopenia in both men and women in numerous studies [26-28]. A cohort study based on the US National Health and Nutrition Survey identified a greater waist circumference in adults affected by sarcopenia [27]. Similarly, a separate cohort study conducted among individuals with sarcopenia in Brazil revealed a notably larger waist circumference compared to the normal population [28]. Moreover, research in Japan focusing on community-dwelling individuals suggested that those with sarcopenia exhibited larger waist circumferences than those without [26].

The potential theoretical explanation for the association between increased WC in adults and sarcopenia is the mutually interdependent relationship between elevated fat mass and reduced muscle mass [29]. Individuals with sarcopenia commonly experience symptoms such as muscle weakness due to muscle loss with decreased muscle function, leading to reduced engagement in physical activities, such as in tasks like sitting-to-standing and walking extended distances indoors and outdoors [30]. This decline in physical activity is strongly linked to reduced overall daily energy expenditure and an accumulation of fat stores, particularly in the visceral and abdominal regions, resulting in an expansion of the waist circumference [30]. Conversely, the relationship between reduced muscle mass and increased fat mass in sarcopenia operates bidirectionally and is mutually reinforcing [31].

The research outcomes of this study affirm the hypothesis that SBP and DBP are hazardous components for women and are consistent with earlier studies. Lu et al. documented higher SBP and DBP in the sarcopenia group in Taiwan compared to the normal group [32]. A British cohort study comprising 4252 participants identified significantly higher SBP and DBP in the sarcopenia group in contrast to the normal group [33]. Additionally, Androga et al. reported a higher proportion of hypertension in the sarcopenia group compared to the normal group [34]. The higher levels of SBP and DBP in individuals with sarcopenia might be rooted in skeletal muscle loss due to metabolic changes and a reduction in muscle mass. These factors contribute to diminished energy expenditure, lower physical activity, insulin resistance, and arterial stiffness in adults [36-38]. Moreover, the accumulation of excess visceral fat may initiate an inflammatory response, resulting in thickening of blood vessel walls, constriction of the vascular pathways, and impediments to blood flow [35].

Previous investigations have identified higher FBG levels as a hazardous component for sarcopenia in females, which aligns with the current study's outcomes [36-39]. In a cohort study conducted by Bersemi et al., 157 community-dwelling individuals with sarcopenia displayed elevated fasting blood glucose levels compared to the normal group [39]. Ozturk's examination involving 147 participants revealed that individuals with sarcopenia encountered challenges in regulating their blood glucose levels to remain within the normal range [36].

The possible explanation for the correlation observed between sarcopenia and increased FBG levels lies in the role of muscle mass in regulating post-meal glucose metabolism. Skeletal muscle serves as a significant reservoir, storing about 80% of the ingested glucose after meals to prevent excessive glucose levels in the bloodstream [23]. Conversely, the reduced skeletal muscle mass in individuals with sarcopenia tends to lead to lower insulin sensitivity among females. This diminished sensitivity results in decreased glucose uptake by the skeletal muscles due to the lower proportion of type I muscle fibers and reduced capillary density both of which leads to reduced insulin action [40]. Consequently, the decreased muscle mass and compromised insulin sensitivity in females with sarcopenia may contribute to the reduced uptake of blood glucose by muscles, consequently leading to hyperglycemia in females affected by sarcopenia.

Our finding that elevated triglyceride levels serve as a hazardous component for sarcopenia is consistent with previous research [32,41,42]. In a cross-sectional study by Yanping Du et al. [32] conducted in East China, findings

revealed that females diagnosed with sarcopenia exhibited higher serum triglyceride levels. Similarly, Lu et al., exploring a population in northern Taiwan, noted significantly elevated triglyceride levels in the sarcopenia group. Buchmann et al. [41], examining a Berlin-based population, also affirmed higher triglyceride levels in the group with sarcopenia compared to the non-sarcopenic group. Additionally, TC also emerged as a hazardous component associated with sarcopenia, consistent with earlier research [26,42]. Sanada et al. [26], assessing a Japanese population, similarly reported significantly elevated TC levels in individuals affected by sarcopenia compared with those in the normal group. Yanping Du et al. [42] reported that females with sarcopenia showed higher TC levels compared with females in the normal group. The heightened triglyceride and TC levels observed in individuals with sarcopenia could be linked to underlying mechanisms such as insulin resistance [43] and increased inflammatory cytokines [44].

Smoking status has been identified as an additional hazardous component for sarcopenia, and this outcome was consistent with previous investigations [33,34]. A study on sarcopenia in the United States encompassing 11,616 adult participants from the National Health and Nutrition Examination Survey (NHANES) indicated that a higher proportion of individuals in the sarcopenia group had a history of tobacco use compared to the normal population [34]. In a British cohort study focusing on older adults with sarcopenia, a relationship between smoking and the risk of sarcopenia was demonstrated, which was in contrast to healthy older adults [33]. The theoretical reasoning behind smoking as a hazardous component for sarcopenia is elucidated as follows: Cigarette smoking exacerbates the decline in skeletal muscle mass by impeding muscle protein synthesis and promoting muscle breakdown. Smoking is associated with a reduction in the fractional synthesis rate of muscles and alterations in genes related to muscle atrophy and the inhibition of muscle growth, such as the E3 ubiquitin ligase muscle atrophy [45]. Smokers have been noted to experience a loss of type I muscle fibers, an increase in glycolytic capacity, and reduced expression of constitutive nitric oxide synthases, all contributing to a decrease in skeletal muscle volume [46].

The primary strength of the present study lies in its exploration of the hazardous components of sarcopenia in a representative Korean female population. These findings are valuable as they facilitate the early identification and treatment of sarcopenia. However, the study also carries several limitations that need consideration in future research. First, due to the nature of the cross-sectional design, even the significant sample size of 1,236 participants, chosen to be representative of the entire population using statistical weighting, might have limited the ability to establish causal relationships for the identified hazardous components. Further research is essential to comprehend the relationship between these predictors and sarcopenia. Subsequent studies could explore longitudinal or randomized case-control study designs to strengthen the reliability of the findings. Additionally, the study did not consider sarcopenic obesity, a condition wherein individuals experience both low muscle mass and high body fat. After further research was conducted on sarcopenic obesity, the interpreted variables, particularly fasting glucose, total cholesterol levels, and triglyceride levels, became clearer. Finally, the study did not address the possible relationship between sarcopenia in young women and other underlying health conditions. Future research incorporating additional aspects on the associations between sarcopenia in women and diseases such as cancer, cardiovascular disease, or other underlying conditions could enhance our understanding of sarcopenia among women.

Ⅴ. Conclusion

This study conducted a pioneering investigation, and the results shed light on the clinically relevant hazardous components associated with sarcopenia among young

female adults. The estimated proportion of sarcopenia in this group was 1.76%, 95%CI (1.08, 2.83). Significant hazardous components identified for sarcopenia included height, BMI, WC, SBP, DBP, FBG levels, triglycerides, TC levels, and smoking status. Recognizing both the proportion and the specific hazardous components could aid healthcare professionals in better identifying potential sarcopenia patients. Further research is required to thoroughly grasp the relationship between these predictors and sarcopenia. Additionally, employing longitudinal or randomized case-control study designs would be essential to strengthen the robustness of the findings.

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