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Research Article

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Unraveling the Contributing Factors of Sarcopenia in Young Korean Male Adults: A Study of Occurrence, Somatometric, Biochemical, and Behavioral Characteristics

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| Abstract |

PURPOSE: The present study evaluated the occurrence, somatometric, biochemical, and behavioral characteristics of young Korean sarcopenic males aged between 30 to 39 years.
METHODS: The study involved a total of 1,546 participants. These individuals were divided into two distinct groups based on their skeletal muscle mass index. Of these, 49 participants were categorized into the sarcopenia group, while the remaining 1,497 individuals were placed in the normal group. The researchers analyzed the occurrence of sarcopenia, somatometric, biochemical, and behavioral characteristics such as height, weight, body mass index (BMI), waist circumference (WC), skeletal muscle mass index, fasting glucose (FG), triglyceride and total cholesterol (TC) levels, systolic (SBP) and diastolic blood pressure (DBP), and the drinking and smoking status. A complex sampling data analysis was performed.
RESULTS: The weighted occurrence of sarcopenia was found to be 3.24%, (95% confidence interval (CI) of 2.39% to 4.36%). The somatometric contributing factors were height, BMI, and WC ($p < .05$). Triglyceride and TC levels exhibited statistically significant differences in the biochemical variables ($p < .05$). The behavioral characteristics, including the drinking and smoking status, had no statistical significance ($p > .05$).
CONCLUSION: This study identified specific occurrences of sarcopenia and contributing factors in young Korean men.

Key Words: Contributing factors, Occurrence, Sarcopenia, Younger adult

Ⅰ. Introduction

Global advances in applied science and healthcare technology, along with improvements in socioeconomic conditions, have led to a notable increase in the human lifespan. According to estimates from 2019, the worldwide population of individuals aged 65 years and older was approximately 703 million, and this number is projected to reach 1.5 billion by 2050 [1]. Life expectancy has risen in all countries, resulting in a significant increase in the proportion of the elderly in the population [2]. Consequently, healthcare services are facing a strain due to the growing

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burden of caring for the elderly. To address age-related chronic illnesses and alleviate the pressure on healthcare systems, it is imperative to gain a better understanding of these conditions and develop innovative approaches to address aging-related diseases.

Sarcopenia is a condition characterized by the gradual and widespread decline in muscle mass and function as people age [3]. It is closely associated with frailty, a state in which elderly individuals become more susceptible to stressors that can lead to adverse health outcomes, and increase the chances of disability and mortality [4]. Understanding and addressing sarcopenia is crucial in improving the health and well-being of aging individuals, as these conditions can put a significant strain on healthcare systems and affect the quality of life of older adults. Developing interventions to prevent or manage sarcopenia and frailty can help alleviate the burden on healthcare services and promote healthy aging.

Sarcopenia exhibits a greater prevalence in men when compared to women, as evidenced by several studies. For instance, Brown et al. [5] conducted a study involving 4,425 adults in the US, revealing that the prevalence of sarcopenia was higher in males (44.8%) than in females (30.24%). Similarly, Liu et al. [6] investigated 4,500 Chinese individuals in an urban community and reported a prevalence of 22.1% in men and 17.8% in women. In addition, Hai et al. [7], in their assessment of 834 community-dwelling Chinese individuals, found that the incidence of sarcopenia was 11.3% in men and 9.8% in women. Likewise, Chan et al. [8] observed a prevalence of 9.30% in males and 5.30% in females among a group of 3,957 people in Hong Kong. These collective findings consistently suggest that sarcopenia is more commonly found in males than females. Notwithstanding the notable prevalence of this condition among males, identifying contributing factors and effectively addressing sarcopenia in this specific population pose considerable challenges, particularly when compared to the well-explored research on sarcopenia in females [9-12].

Most existing research on sarcopenia has focused on individuals aged 40 years and older [20-28]. Nonetheless, emerging evidence suggests that age-related muscle decline may commence in younger adult males as early as in the 30s [29-31]. Sarcopenia in young adults can be attributed to a combination of multiple lifestyle-related and other physiological factors [13,14]. Among these, lifestyle choices play a pivotal role—sedentary habits, insufficient physical activity, and suboptimal dietary patterns can all precipitate muscle weakening and atrophy even in individuals of a younger age [15]. The hormonal decline after the 20s constitutes another significant facet; disruptions in the growth hormone, testosterone, and insulin-like growth factor-1 (IGF-1) levels can have an intricate effect on the maintenance and development of muscle mass [16,17]. Furthermore, young adults prefer instant foods that offer only limited nutrition [18]. The deficiency of crucial nutrients such as proteins, vitamins, and essential minerals [19], which are fundamental for nurturing muscle health, also significantly contributes to the early onset of sarcopenia among young adults.

It is important to evaluate the factors contributing to sarcopenia in young men between 30 and 39 years old, as this can lead to the development of early prevention strategies against age-related muscle loss. Consequently, the present study aimed to investigate the occurrence, somatometric, biochemical, and behavioral characteristics of young Korean sarcopenic men aged 30 to 39 years.

Ⅱ. Methods

1. Data Sampling

The current investigation utilized data from the Korea National Health and Nutrition Examination Survey (KNHANES), an initiative by the Centers for Disease Control and Prevention aimed at monitoring the health-contributing behaviors of the population. The survey

Table 1. General characteristics of participants in the study

	Sarcopenia group (n =49)	Normal group (*n* = 1,497)	p (N = 1,546)
Age (years)	35.49 ± 2.9	35.00 ± 2.78	.235
Height (cm)	164.29 ± 6.343	173.23 ± 5.61	.000
Weight (kg)	72.92 ± 13.76	72.68 ± 10.89	.879
SMI (g/m^2)	743.204 ± 46.5	988.53 ± 102.76	.000

SMI, skeletal muscle mass index. An independent *t*-test test was performed.

employed a stratified, clustered, multistage probability sampling design, involving a total of 35,737 individuals surveyed between 2008 and 2011. After excluding 33,339 participants outside the age range of 30 to 39 years, the dataset comprised 2,398 men. Subsequently, 1,004 subjects were further excluded due to the unavailability of data from their health surveys and the absence of dual X-ray absorptiometry (DEXA) measurements. Eventually, only data from 1,546 male participants between the ages of 30 and 39 years were considered for the final analysis. The inclusion criteria stipulated individuals within the age range of 30 to 39 years, while the exclusion criteria included individuals who did not undergo DEXA measurements and with incomplete health survey data. Among these participants, 49 individuals were classified into the sarcopenia group based on their skeletal muscle mass index score, and the remaining 1,497 individuals were assigned to the normal group. The study received approval from the institutional review board of the KDCA (approval numbers 2008-04EXP-01-C, 2009-01CON-03-2C, 2010-02CON-21-C, and 2011-02CON-06-C), and informed written consent was obtained from all participants. Table 1 describes the general characteristic of the participants in the study.

2. Diagnosis of Sarcopenia

Sarcopenia, a medical condition categorized under the ICD-10-CM code M62.84 by the World Health Organization (WHO) [32], is diagnosed through the measurement of appendicular skeletal muscle mass. In this study, DEXA was employed to assess the appendicular skeletal muscle mass (ASM). The skeletal muscle mass index (SMI) was calculated as the ratio of ASM (in kg) to BMI (in kg/m^2). The definition of sarcopenia in this study was based on the criteria established by the Foundation for the National Institutes of Health (FNIH) Sarcopenia Project wherein sarcopenia in men was defined as an SMI of less than 0.789 [33].

3. Variables

1) Somatometric Variables

The somatometric variables data were collected from all study participants. To ensure accurate measurements, individuals were requested to remove their shoes, socks, hats, and hairpins, and were instructed to wear light clothing. Height and weight were measured using calibrated automatic body measurement equipment, with precision recorded to the nearest .1 cm or kg. Subsequently, the body mass index (BMI) was calculated by dividing the weight (in kg) by the square of height (in m^2). Additionally, waist circumference (WC) was measured to the nearest .1 cm in a horizontal plane at the midline between the last rib and the iliac crest, following a normal expiration [34].

2) Biochemical and Blood Pressure Variables

The biochemical variables including fasting glucose (FG), triglyceride, and total cholesterol (TC) levels were analyzed using the LABOSPECT 008AS platform (Hitachi High-Tech Co., Tokyo, Japan). Blood samples were collected from the non-dominant arm after an overnight fast of at least eight hours. Immediately after collection, the blood was mixed with a coagulation promoter and centrifuged within a mobile examination vehicle. All tests were conducted within 24 hours of blood sample collection. A trained practitioner conducted the measurement of systolic blood pressure (SBP) and diastolic blood pressure (DBP) using a mercury sphygmomanometer. The blood pressure cuff was positioned at the heart level with participants in a seated position after a minimum of five minutes of rest [35,34].

3) Behavioral Habits

Data pertaining to behavioral habits including the smoking and drinking status of the participants were obtained through a survey. Based on their cigarette smoking and alcohol drinking habits, individuals were categorized into three groups: non-users, ex-users, or current users. These measured variables play a crucial role in evaluating various aspects of health and the potential contribution to diseases within the study population [34].

4. Statistical Analysis

This study conducted a comprehensive analysis of data, providing statistical values such as mean and standard deviation for each measurement. The complex sampling method involved a nationwide analysis incorporating individual weights provided by the KNHANES. The researchers used SPSS 22.0 Windows version (IBM Corporation, Armonk, NY, USA) for their statistical analysis. The data utilized a stratified, clustered, multistage probability sampling design. The researchers employed independent t-tests and Chi-square analyses to compare the variables between participants with and without sarcopenia. Additionally, multiple logistic regression was utilized to calculate the odds ratio of sarcopenia. The researchers established a statistical significance level of α = .05 for the study.

Ⅲ. Results

1. Occurrence of Sarcopenia

The weighted occurrence of sarcopenia was reported as 3.24% (with a 95% confidence interval of 2.39% to 4.36%). These values were calculated by complex sampling analysis, after applying adjusted weights to individuals. The unweighted prevalence of sarcopenia was found to be 3.17% (Table 2).

2. Contributing Factors

1) Somatometric Factors

The contributing factors analyzed in this study included height, BMI, and WC and they exhibited statistically significant differences between the two groups ($p < .05$). However, there was no statistically significant difference ($p > .05$) in the weight between the groups. Table 3 provides a comprehensive overview of these contributing factors and their associations with the studied outcomes (Table 3).

2) Biochemical and Blood Pressure Variables

Triglyceride and TC levels exhibited statistically significant differences between the two groups ($p < .05$), indicating that these variables are important distinguishing factors between the studied groups. On the other hand, FG, SBP, and DBP did not show statistically significant

Table 2. Prevalence of sarcopenia

	Sarcopenia group (n = 49)	Normal group (*n* = 1,497)	Total
Un-weighted (%)	3.17	96.83	100
Weighted (%)	3.24 (2.39-4.36)	96.76 (95.64-97.61)	100

Weighed values present the 95% confidence interval.

Table 3. Analysis of somatometric factors in the study population

	Sarcopenia group (N = 49)	Normal group (*n* = 1,497)	p
Height (cm)	164.29 ± 6.343	173.23 ± 5.61	.000
Weight (kg)	72.92 ± 13.76	72.68 ± 10.89	.879
BMI (kg/m^2)	26.92 ± 4.24	24.18 ± 3.19	.000
WC (cm)	89.60 ± 10.20	83.56 ± 8.91	.000

BMI, body mass index; WC, waist circumference. An independent *t*-test was performed.

Table 4. Biochemical and blood pressure variables of study participants

	Sarcopenia group (N = 49)	Normal group (*n* = 1,497)	p
FG (mg/dL)	99.22 ± 17.74	94.35 ± 18.8	.077
Triglycerides (mg/dL)	236.56 ± 249.32	162.39 ± 131.84	.000
TC (mg/dL)	200.89 ± 28.84	189.68 ± 34.15	.025
SBP (mmHg)	117.75± 13.05	116.27 ± 12.65	420
DBP (mmHg)	80.735 ± 10.72	79.45 ± 10.62	.407

FG, fasting glucose; TC, total cholesterol; SBP, systolic blood pressure; DBP, diastolic blood pressure. An independent *t*-test was performed.

Table 5. Behavioral habits of study participants

	Sarcopenia group (N = 49)	Normal group (*n* = 1,497)	p
Drinking status (%) (current-/ex-/non-drinker)	93.30 / 4.84 / 1.85	92.49 / 5.03 / 2.47	.957
Smoking status (%) (current-/ex-/non-smoker)	71.84 / 11.06 / 17.08	70.23 / 12.14 / 17.62	.971

A Chi-square test was performed.

differences ($p > .05$) between the two groups. These results highlight the relevance of triglyceride and TC levels in sarcopenia, while FG, SBP, and DBP did not demonstrate significant associations with the studied outcomes (Table 4).

3) Behavioral Habits

The drinking and smoking status had no statistical significance ($p > .05$) (Table 5).

3. Odd Ratios (ORs) for Contributing Factors

The variables of height, BMI, WC, SMI, triglyceride, and TC demonstrated statistically significant differences between the two groups ($p < .05$). The corresponding values were .00 (.00–.00), 7.66 (1.27–46.19), 1.78 (1.24-2.56), 42.68 (36.62–56.93), 1.00 (1.00–1.00), 1.08 (1.05-1.10) (Table 6).

Table 6. Odds ratio (OR) for male sarcopenia

	Odds ratio (95% CI)	p
Height	.00 (.00– .00)	.000
BMI	7.66 (1.27–46.19)	.000
WC	1.78 (1.24–2.56)	.002
SMI	42.68 (36.62–56.93)	.000
Triglycerides	1.00 (1.00–1.00)	.001
TC	1.08 (1.05-1.10)	.000

BMI, body mass index; WC, waist circumference; SMI, skeletal muscle mass index; TC, Total cholesterol.
Odds ratio values are present in the 95% confidence interval (CI).
Multiple logistic regression in complex sampling was performed.

Ⅳ. Discussion

This study aimed to explore the occurrence and contributing factors associated with sarcopenia among young men aged 30 to 39 residing in the community. The aging population in Korea and Asia is increasing rapidly, leading to a higher occurrence of sarcopenia, especially among males. Unfortunately, healthcare professionals, including physical and occupational therapists, often face challenges in accurately diagnosing the disease due to limited knowledge and diagnostic tools, resulting in missed diagnoses and potential complications. To address this issue, this study focused on easily accessible and cost-effective variables, such as somatometric, biochemical variables, and behavioral characteristics, which are useful for detecting potential sarcopenia patients. Early detection and prevention of sarcopenia are crucial for managing its potential negative consequences. The study identified several contributing factors associated with sarcopenia, including height, BMI, WC, and triglyceride and TC levels. Understanding these contributing factors provides valuable insights that can help healthcare professionals intervene at an early stage and implement effective measures to prevent sarcopenia in community-dwelling younger men.

The WC has been identified as a contributing factor for sarcopenia. Numerous studies have consistently shown an association between WC and an increased incidence of sarcopenia in men [36,5,37]. For instance, Brown et al. conducted a study on a US cohort and reported an OR of 1.39 (95% CI [1.05,1.84]) for WC as a contributing factor for sarcopenia in men [5]. Similarly, a cohort study in Brazil among individuals with sarcopenia found a significant OR of 17.90 (95% CI [1.48, 201.16]) for waist circumference [37]. Another study in Japan, focusing on community-dwelling individuals, also revealed that those with sarcopenia had a larger WC compared to individuals without sarcopenia [36]. The underlying reason for the higher WC in adults with sarcopenia can be attributed to the intricate relationship between increased fat mass and decreased muscle mass [38]. Individuals with sarcopenia often experience difficulties in muscle power and function due to muscle loss, leading to reduced levels of physical activity, including challenges in activities such as sitting-to-stand and walking long distances indoors and outdoors [39]. This decreased physical activity is closely linked to reduced total daily energy expenditure and an increase in fat deposits, especially in the visceral and abdominal areas, thereby contributing to increased waist volume [39]. Conversely, higher fat volume, particularly visceral fat, produces pro-inflammatory cytokines such as interleukin (IL)-6 and C-reactive protein (CRP), which can hinder the anabolic response of muscle tissue [40].

Consequently, the relationship between decreased muscle mass and increased fat mass in individuals with sarcopenia is bidirectional and mutually reinforcing [41]. In summary, the WC has been consistently identified as a significant contributing factor for sarcopenia in men, with the interplay between decreased muscle mass and increased fat mass playing a pivotal role in this relationship.

Triglyceride levels were identified as another significant contributing factor for men, with an average level of 231.74 mg/dL in the sarcopenia group and 178.14 mg/dL in the normal group. These findings are consistent with previous research on sarcopenia [42-44]. For instance, Lu et al. [32] examined 600 elderly individuals in northern Taiwan and reported that the sarcopenic group had significantly higher triglyceride levels of 1.9 mmol/L compared to the normal group with 1.3 mmol/L [42]. Similarly, Buchmann et al. [43] investigated 1420 elderly individuals living in Berlin and concluded that participants with sarcopenia had higher triglyceride levels (108.7 mg/dL) compared to the non-sarcopenia group (92.1 mg/dL). Additionally, Du et al. [44] conducted a cross-sectional study on community-dwelling elderly people in East China and found that the male sarcopenia group had increased serum triglyceride levels. An underlying mechanism for the higher triglyceride and total cholesterol levels in sarcopenia may be related to insulin resistance [45] and elevated levels of inflammatory cytokines [52]. These factors could contribute to alterations in lipid metabolism, ultimately leading to higher triglyceride levels in individuals with sarcopenia. In short, the study highlights triglyceride levels as an important contributing factor for men with sarcopenia, consistent with previous studies. The association between increased triglyceride levels and sarcopenia could be attributed to insulin resistance and inflammation. Understanding these connections is crucial for managing and preventing the incidence of age-related low skeletal muscle mass in the population [46].

Research findings have consistently indicated that TC levels act as a contributing factor for sarcopenia in men, which is in line with previous studies [29,33]. For instance, a study by Du et al. [33] revealed that men in the sarcopenic group had higher TC levels compared to those in the normal group. Similarly, in a study conducted by Sanada and colleagues involving 1488 Japanese individuals, it was observed that TC levels were significantly elevated in individuals with sarcopenia when compared to the normal group [29]. The potential underlying mechanism for the higher triglyceride and TC levels in sarcopenia could be associated with factors such as insulin resistance [34] and an increased presence of inflammatory cytokines [35]. These factors can disturb lipid metabolism, leading to elevated triglyceride and total cholesterol levels in individuals with sarcopenia. To sum up, research consistently highlights the significance of higher total cholesterol levels as a contributing factor for sarcopenia in men, corroborating findings from earlier studies. The connection between elevated triglyceride and total cholesterol levels in sarcopenia may be influenced by factors like insulin resistance and increased inflammatory cytokines. Gaining a deeper understanding of these associations is vital for effectively managing and preventing sarcopenia among men.

One crucial aspect of this study is the investigation of male-specific contributing factors in a representative population of Korean individuals in their 30s, a critical age when the loss of skeletal muscles typically begins. Unlike most studies that combine both sexes into a single group, this study focused specifically on men, providing valuable insights into the gender-specific factors contributing to sarcopenia [5,21,47].

However, it is essential to acknowledge a couple of limitations of this study that should be considered for undertaking future research. The cross-sectional design utilized in this study, despite incorporating a large sample size of participants representative of the entire population through statistical weighting, may present limitations in establishing causal relationships for the identified contributing factors. Cross-sectional studies only capture data at a single point in time, making it challenging to infer causality between variables. Hence, to strengthen the findings, future studies should consider employing a longitudinal or randomized case-control study design, allowing for a better understanding of the temporal relationships and causative factors for sarcopenia among the male population. Secondly, the current study did not investigate the issue of sarcopenic obesity which presents with reduced muscle mass and being overweight. To enhance comprehension of the observed heightened levels of triglycerides and total cholesterol, it would have been advantageous to examine sarcopenic obesity. Third, at the time of selecting study subjects, patients with underlying diseases such as cardiovascular disease, chronic heart disease, and chronic respiratory disease were not excluded. The study could not rule out the possibility that these diseases could have affected muscle mass. Finally, the study did not include standardized measures of physical activity or exercise as part of the surveyed behavioral habits. The inclusion of such measures would have enhanced the robustness of the study's findings. It is recommended that forthcoming research should investigate deeper into physical activity or the exercise-related habits of the participants to bolster the comprehensiveness and reliability of the study results.

Ⅴ. Conclusion

This paper presents a pioneering investigation focusing on the clinical contributing factors which raise the risk of sarcopenia in young Korean males in their 30s. The study's objective was to shed light on this condition by providing valuable insights into its prevalence and associated contributing factors. According to the results, the estimated prevalence of sarcopenia in this specific demographic population was 3.24% (95%CI [2.39,4.36]) The study identified several significant contributing factors related to sarcopenia. These factors included height, BMI, SMI, WC, triglyceride levels, and TC levels. By recognizing and considering these contributing factors, healthcare professionals can identify and detect potential sarcopenia patients, thereby promoting early intervention and treatment. Despite the valuable findings presented in this study, the relationship between the identified predictors and sarcopenia requires further exploration. Therefore, additional research is warranted to deepen our understanding of this condition. Specifically, longitudinal or randomized case-control study designs should be employed to strengthen the reliability and validity of the study's conclusions. Such efforts will contribute significantly to the advancement of knowledge in the field of sarcopenia and its management in males in their 30s.

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