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Research Article

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Comprehensive Investigation on the Prevalence and Risk Factors of Coexistence of Age-related Loss of Skeletal Muscle Mass and Obesity among Males in Their 40s

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| Abstract |

PURPOSE: This study examined the prevalence and specific risk factors in males aged 40–49 years with the coexistence of age-related loss of skeletal muscle mass and obesity (CALSMO).

METHODS: The current study analyzed the data obtained from a cross-sectional study involving a sample of 1,218 men who resided in the community and fell within the age range of 40 to 49 years. Multiple risk factors were examined: age, height, weight, body mass index, waist circumference, skeletal muscle mass index, smoking and drinking habits, systolic and diastolic blood pressure, fasting glucose levels, and triglyceride and cholesterol levels. All data were analyzed via complex sampling analysis.

RESULTS: The coexistence of age-related loss of skeletal muscle mass and obesity in males was 2.94% (95% CI: 2.06–4.17). The clinical risk factors were low height, high weight, body mass index, waist circumference, skeletal muscle index, systolic blood pressure, diastolic blood pressure, and fast glucose ($p < .05$).

CONCLUSION: The study identifies the prevalence and risk factors for CALSMO among adults in the community. These findings contribute to the existing literature on CALSMO and highlight potential risk factors associated with CALSMO development in males aged 40–49 years.

Key Words: Age-related, Muscle Loss, Obesity, Prevalence, Risk factor

Ⅰ. Introduction

The coexistence of age-related loss of skeletal muscle mass and obesity (CALSMO) is a medical condition where an individual experience the simultaneous occurrence of age-related loss of skeletal muscle mass and obesity [1]. The age-related loss of skeletal muscle mass refers to the age-related reduction in muscle mass, strength, and physical functionality, while obesity is characterized by the accumulation of excessive fat mass, which has adverse health effects. CALSMO affects individuals with both age-related losses of skeletal muscle mass and obesity,

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which can lead to a range of health issues [2].

The elderly population in Asia is growing rapidly. Korea is among the countries with the highest proportion of older adults in Asia. By 2050, the elderly population in Korea will increase to 40% from 15% in 2022, with the number of older individuals rising from five to 19 million [3]. Consequently, age-related complications, such as age-related loss of skeletal muscle mass, pose a potential threat to Korean society. In addition, the prevalence of obesity in Korea has increased continuously from 2009 to 2019, particularly among males and females in their 70s and 80s [4]. This increase in the obese population among the elderly, coupled with the growing elderly population, suggests that the potential risk factors for CALSMO in Korean society are also increasing. Therefore, there is an urgent need to prioritize the prevention of CALSMO in Korean society.

The coexistence of obesity and low muscle mass can adversely affect health, exacerbate chronic degenerative diseases and disability, and prolong hospital stays, posing a challenge to healthcare sustainability and efficiency in primary and secondary care, social support, public health, and policymaking [5]. Various studies have shown that individuals with this condition have worse morbidity, disability, and mortality rates than those with either low muscle mass or obesity alone [6,7]. Moreover, obesity impedes the production or retention of muscle mass, making it difficult to diagnose and identify its clinical consequences [8].

Males have a higher incidence of age-related loss of skeletal muscle mass than females [9,10]. Bouchard et al. [9] examined a group of 904 Canadians. They concluded that the incidence of CALSMO in men and women was 19% and 11%, respectively. Defour et al. [10] carried out a study on a cohort of 767 individuals in the US as part of the Framingham study. They reported that the prevalence rate of CALSMO was 8% and 4% among men and women, respectively. In other words, men are more prone to experiencing CALSMO associated with aging than women. Identifying the risk factors and managing CALSMO among older adults, with a particular emphasis on the significant proportion of affected males, is a challenge. These challenges are evident when comparing the existing research on CALSMO in males to the well-researched studies focused on CALSMO in females [11-13].

In addition, most research studies on CALSMO have concentrated primarily on individuals 50 years and older [7,14-16], despite emerging evidence indicating age-related muscle loss and obesity commence as early as the 40s [17-22]. The significance of implementing early prevention strategies for age-related muscle loss highlights the need to identify risk factors, specifically in middle-aged women ranging from 40 to 49 years old.

Despite the crucial implications of CALSMO, healthcare professionals and primary care clinicians often lack the necessary diagnostic tools and knowledge to diagnose it. The average general practitioner, who spends less than 10 minutes per patient visit, must first recognize the likelihood that a patient may have CALSMO before considering a referral for diagnosis and treatment. Furthermore, the lack of understanding of CALSMO as a disease among clinicians increases the likelihood of missing the diagnosis [23]. Therefore, knowledge of the key risk factors for early detection and prevention is essential. The early diagnosis of CALSMO is critical to identify symptomatic patients as early as possible [24]. Delayed or missed CALSMO diagnosis and intervention can result in poor functional recovery treatment, reduced quality of life, and waste of government healthcare resources.

This study examined the prevalence and risk factors of CALSMO in the community-dwelling middle-aged male population aged 40 to 49 years. The research posited two hypotheses. First, the specific prevalence of CALSMO exists among the male community-dwelling population. Second, there are specific risk factors for CALSMO in middle-aged men.

Ⅱ. Methods

1. Study Population

The research conducted in this study utilized the data obtained from the Korea National Health and Nutrition Examination Surveys. The Centers for Disease Control and Prevention carried out these surveys. The data collection process employed a complex sampling design called stratified, clustered, multistage probability sampling.

During the survey period spanning from 2008 to 2011, 37,753 individuals participated. On the other hand, 34,123 individuals were excluded because they did not fall within the age range of 40 to 49 years old. The final sample size consisted of 3,630 participants. The analysis included a specific subset of the sample, comprising 1,218 men aged between 40 and 49 years old. The participants were divided into two distinct groups based on their skeletal muscle mass index score. The CALSMO group consisted of 35 individuals. The remaining 1,183 individuals were assigned to the normal group. The study received approval from the institutional review board of the Center for Disease Control and Prevention, and all participants provided informed written consent to participate in the research.

2. CALSMO Criteria

The two constituents of CALSMO, the coexistence of age-related loss of skeletal muscle mass and obesity, are defined as follows. One is age-related loss of skeletal muscle mass measured by the appendicular skeletal muscle mass. The appendicular skeletal muscle mass was evaluated by dual X-ray absorptiometry (DEXA, QDR4500A, Hologic, Inc., Bedford, MA, USA). The skeletal muscle mass index (SMI) was calculated by measuring the appendicular skeletal muscle mass (ASM) measured by DEXA divided by the body mass index (BMI) expressed in kilograms per square meter (kg/m^2). The Foundation for the National Institutes of Health Age-related loss of skeletal muscle mass project established the criteria for diagnosing age-related loss of skeletal muscle mass. In men, age-related loss of skeletal muscle mass was defined as having an SMI of less than .521 in men [25]. This methodology was employed to diagnose age-related loss of skeletal muscle mass within the study population.

The other one is obesity. Obesity is the abnormal or excessive accumulation of body fat, which can adversely affect the overall health. The condition was identified based on A BMI equal to or greater than 25 kg/m^2. Central obesity was characterized by a waist circumference (WC) exceeding 90 cm among the Asian population [26].

3. Variables

1) Anthropometric Variables

The anthropometric variables were assessed in the study through a standardized procedure. All study participants were requested to remove their shoes, socks, hats, and hairpins and wear lightweight clothing. The height and weight measurements were obtained using precise automated body measurement equipment, with recorded values rounded to the nearest tenth of a centimeter or kilogram. The BMI was then calculated. The waist circumference (WC) was measured accurately to the nearest tenth of a centimeter in a horizontal plane at the midpoint between the last rib and the iliac crest at the end of a normal expiration.

2) Blood Pressure and Blood Lab Tests Variables

A trained practitioner utilized a mercury sphygmomanometer to measure systolic blood pressure (SBP) and diastolic blood pressure (DBP). The blood pressure cuff was positioned at the heart level while the subjects were seated, following a minimum rest period of five minutes.

As for the blood lab tests, the fasting glucose (FG), triglyceride, and total cholesterol (TC) levels were analyzed using the LABOSPECT 008AS platform developed by Hitachi High-Tech Co. in Tokyo, Japan. The blood samples were collected from the non-dominant arm after an overnight fast of at least eight hours. Immediate mixing of the collected blood with a coagulation promoter occurred, followed by centrifugation within a mobile examination vehicle. All tests were conducted within 24 hours of sample collection to ensure accurate analysis.

3) Alcohol Consumption and Tobacco Use

The survey collected data regarding alcohol consumption and tobacco use. The participants were categorized into three domains based on their cigarette smoking and alcohol consumption: non-user, ex-user, or current user. These measurements and variables are important in evaluating diverse facets of health and assessing the potential risks of different diseases within the study population.

4. Data Analysis

The mean and standard deviation were used to present the statistical values for each measurement. The analysis employed complex sampling analysis, which accounted for the nationwide representation by incorporating the individual weights provided by KNHANES (Korean National Health and Nutrition Examination Survey). SPSS 22.0 window version (IBM Corporation, Armonk, NY, USA) was utilized for data analysis.

The data in the study followed a stratified, clustered, multistage probability sampling design. To compare the chemical parameters between participants with CALSMO and those without CALSMO, independent t-tests, and chi-square analyses were conducted. In addition, multiple logistic regression analysis was used to calculate the odds ratio of CALSMO. The statistical significance level was set to p = .05.

Ⅲ. Results

1. Prevalence

The prevalence of CALSMO, considering the weighted values, was determined to be 2.94% (95% CI: 2.06–4.17). When considering the unweighted prevalence, the occurrence of CALSMO was 2.87%, and the prevalence of a normal muscle mass was 97.13% (Table 1).

Table 1. Prevalence of CALSMO

	CALSMO (N = 35)	Normal (N = 1,183)	Total (N = 1,218)
Un-weighted (%)	2.87	97.13	100
Weighted (%)	2.94 (2.06 - 4.17)	97.06 (95.83 - 97.94)	100

Weighed values present the 95% confidence interval.
CALSMO, coexistence of age-related loss of skeletal muscle mass and obesity.

2. Risk factor

1) Anthropometric Variables

The present study revealed risk factors, including height, weight, BMI, and WC, with a significant difference between the two groups (p < .01)(Table 2).

2) Blood Pressure and Blood Lab Tests Variables

Significant differences in SBP, DBP, and fasting glucose were observed between the two groups (p < .05). On the other hand, no statistically significant differences in triglyceride and total cholesterol levels were noted (p > .05)(Table 3).

3) Alcohol Consumption and Tobacco Use

Alcohol consumption and tobacco use between the two groups did not show significant differences, as listed in Table 4 (p > .05).

3. Odd Ratios for Risk Factors

Table 5 lists the odd ratio for risk factors. Significant increases in age, height, weight, BMI, WC, SMI, and FG were noted between the two groups (p < .01). The corresponding values were as follows: age, 1.42 (95% CI:

Table 2. Age, anthropometric variables, and skeletal muscle mass index

	CALSMO (N = 35)	Normal (N = 1,183)	p
Age (years)	45.28 ± 2.72	44.22 ± 2.93	.034
Height (cm)	164.89 ± 3.67	171.18 ± 5.47	.000
Weight (kg)	78.42 ± 8.30	70.45 ± 10.78	.000
BMI (kg/m^2)	28.79 ± 2.36	23.99 ± 3.16	.000
WC (cm)	96.86 ± 5.64	84.15 ± 9.15	.000
SMI (kg/m^2)	0.74 ± 0.03	0.95 ± 0.09	.000

The values are expressed as the mean ± standard deviation. The independent t-test was exploited.
CALSMO, Coexistence of age-related loss of skeletal muscle mass and obesity; BMI, body mass index; WC, waist circumference; SMI, skeletal muscle mass index

Table 3. Blood lab tests and blood pressure tests

	CALSMO (N = 35)	Normal (N = 1,183)	p
FG (mg/dL)	112.08 ± 33.36	99.41 ± 23.06	.002
Triglyceride (mg/dL)	211.26 ± 93.24	172.75 ± 150.14	.137
TC (mg/dL)	189.00 ± 37.83	193.63 ± 34.51	.441
SBP (mmHg)	123.97 ± 18.36	118.65 ± 14.42	.033
DBP (mmHg)	85.94 ± 13.39	81.51 ± 10.79	.018

The values are expressed as the mean ± standard deviation. The independent t-test was exploited.
CALSMO, Coexistence of age-related loss of skeletal muscle mass and obesity; FG, fasting glucose; TC, total cholesterol; SBP, systolic blood pressure; DBP, diastolic blood pressure.

Table 4. Alcohol consumption and tobacco use

	CALSMO (N =35)	Normal (N =1,183)	p
Alcohol consumption (%) (current-/ex-/non-)	78.65 / 13.75 / 7.58	89.60 / 7.03 / 3.362	.156
Tobacco use (%) (current-/ex-/non-)	72.30 / 12.71 / 14.98	73.86 / 18.78 / 7.35	.350

Chi-square test was used to compare the two groups.
CALSMO, Coexistence of age-related loss of skeletal muscle mass and obesity.

Table 5. Multiple logistic regression for odds ratios of CALSMO

Variables	Odd ratios (95% of CI)	p
Age	1.42 (1.04–2.58)	.000
Height	.01 (.00–.02)	.000
Weight	132.92 (55.9–316.06)	.000
BMI	1.72 (1.44–2.06)	.000
WC	2.20 (1.45–3.34)	.000
SMI	0.66 (0.58–0.73)	.000
FG	1.20 (1.14–1.28)	.000

Odds ratio values are present as the 95% confidence interval (CI).
Multiple logistic regression was exploited.
CALSMO, Coexistence of age-related loss of skeletal muscle mass and obesity; BMI, body mass index; WC, waist circumference; SMI, skeletal muscle mass index; FG, fasting glucose.

1.04–2.58); height, .01 (95% CI: .00–.02); weight, 132.92 (95% CI: 55.9–316.06); BMI, 1.72 (95% CI: .1.44–2.06); WC, 2.20 (95% CI: 1.45–3.34); SMI, 0.66 (95% CI: 0.58–0.73); and FG, 1.20 (95% CI: 1.14–1.28).

Ⅳ. Discussion

This study examined the CALSMO prevalence and risk factors in community-dwelling people aged 40–49 years. Healthcare professionals, such as physical therapists and occupational therapists, and primary clinicians encounter difficulties in accurately diagnosing CALSMO because of limited knowledge and diagnostic tools. This lack of resources can result in missed diagnoses and complications because of the potential negative consequences of CALSMO. This study assessed variables, including anthropometric measures, blood pressure, blood lab tests, alcohol consumption, and tobacco use, to mitigate the problem because they are convenient and easily accessible methods for detecting potential CALSMO patients. The risk factors identified were fast glucose, systolic and diastolic blood pressure, fasting glucose, triglyceride levels, and total cholesterol levels.

The first risk factor for CALSMO was age. This outcome was parallel to previous research [27,28]. Atkins et al. examined the risk factors among 917 males in the U.K. and concluded that age is a risk factor [27]. Sanade et al. examined 2,309 Japanese men and reported a significant difference between the CALSMO group and the normal group [28]. Possible underlying rationales are age-related shifts in hormonal levels and metabolism alteration. First, age-related shifts in hormonal levels, such as a decline in growth hormone and testosterone, play a role in CALSMO. These hormonal changes affect muscle protein synthesis and metabolism, increasing the likelihood of muscle loss and the accumulation of excess body fat [29]. Moreover, age-related changes in metabolism, including a decrease in basal metabolic rate and changes in body composition, contribute to the development of CALSMO. As individuals age, their metabolic rate slows down, resulting in fewer calories burned at rest. This can make weight management more challenging. Furthermore, there is often an increase in visceral fat and a decrease in subcutaneous fat with age, which further contributes to CALSMO [30].

Fasting glucose is a risk factor for CALSMO. This finding is consistent with several previous studies [31-33]. Perna et al. [32] examined 639 patients with higher glycemia levels in the CALSMO group. Lu et al. [31] examined 600 individuals living in the community. The CALSMO group exhibited elevated fasting blood glucose levels compared to the normal and pure age-related with skeletal muscle loss groups. Du et al. [33] conducted a study involving 631 community-dwelling individuals in East China and found that individuals with CALSMO had significantly higher blood glucose levels than the normal population.

One potential underlying mechanism pertains to the crucial role of skeletal muscle in regulating postprandial glucose levels. After food is absorbed from the gastrointestinal tract, approximately 80% of the glucose uptake that relies on insulin occurs within the muscles. This process involves the transportation of glucose from the circulation to the muscle, facilitated by insulin-dependent and insulin-independent mechanisms. During exercise, insulin is released, prompting the translocation of glucose to the cell membrane, facilitating its entry into the muscle. The glucose uptake is facilitated by glucose transporters, regulated by intracellular glucose metabolism. After meal ingestion, impaired skeletal muscle glucose uptake is associated with abnormal carbohydrate metabolism, resulting in elevated blood glucose levels [34].

Hypertension, including SBP and DBP, is a risk factor for CALSMO. This outcome concurs with past studies [31,27,35]. Yin et al. examined 14,928 Chinese adults and reported a higher SBP in the male CALSMO group (139.39 mmHg) compared to the normal male group (131.77

mmHg). Furthermore, the DBP among men in the CALSMO group was also higher than that of the normal group, with respective values of 86.95 mmHg and 81.21 mmHg [35]. The Taiwan community CALSMO dwelling study [31] reported that the CALSMO group had SBP levels of 132.3 mmHg or above, whereas the normal population exhibited SBP levels of 125.7 mmHg. The diastolic blood pressure (DBP) was higher in the CALSMO group (80.6 mmHg) than in the normal group (76.2 mmHg). A representative sample of a 7,735 British male cohort study found a significantly higher DBP in the CALSMO group than in the normal group [27].

Several underlying rationales for such increased SBP and DBP are as follows. One is an interdependence between muscle loss and metabolic alterations, which can lead to a decline in energy expenditure and physical inactivity. These factors contribute to insulin resistance and arterial stiffness [36-38]. The other is that an increase in visceral fat mass triggers an inflammatory response, thickens the blood vessel walls, obstructs blood flow, and narrows vascular passages [39]. A lower skeletal muscle mass and higher adipose tissue compared to males render them more susceptible to hypertension [40]. The reduced muscle mass and adipose tissue accumulation in the visceral region may contribute to hypertension in men with CALSMO.

This study presents significant findings, shedding light on the prevalence and specific risk factors of CALSMO among community-dwelling middle-aged men. The data used in this study are representative of the Korean population and employ the widely accepted DEXA measurement technique to diagnose CALSMO. Nevertheless, the present study has a limitation that should be addressed in future research. This study could not establish a causal relationship conclusively because of its cross-sectional design. To bolster the research credibility, a longitudinal design that involves measuring the same individuals at different time points would benefit the causal relationship.

Ⅴ. Conclusion

This study examined the prevalence and first clinical risk factors in the Korean CALSMO among Middle-Aged Males in Their 40s. The prevalence of CALSMO in males was 2.94% (95% CI: 2.06–4.17). The clinical risk factors for CALSMO in males were low height, high weight, body mass index, waist circumference, skeletal muscle index, systolic blood pressure, diastolic blood pressure, and fast glucose. The credibility of the research can be enhanced using a longitudinal design that includes measuring the same participants at multiple time points. This approach would contribute to establishing a causal relationship between the variables under investigation.

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