Austin Journal of Obesity & Metabolic Syndrome

Open Access

Austin Publishing Group

Research Article

Association between Sarcopenia and Metabolic Syndrome on the Obese Status in Korean Elderly: KNHANES 2010–2010

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Received: June 15, 2020; **Accepted:** July 07, 2020; **Published:** July 14, 2020

Abstract

Background: The aim of this study was to determine relationship between sarcopenia and the risk of Metabolic Syndrome (MS) on the obese status in Korean elderly and to compare the general characteristics include METs (Metabolic Equivalent), and dietary patterns among subjects for better understand to prevent strategy of MS.

Methods: The collected subjects (n=4,452) were ≥60 years and included 1,929 males and 2,523 females who was completed using dual energy X-Ray Absorptiometry (DXA) and both health condition and dietary intake data. MET was used to express Physical Activity (PA) intensity and the three dietary patterns using cluster analysis were identified.

Results: The Non-Obese Sarcopenic Group (NOS) showed a significantly increased MS risk than with obese sarcopenic group. The MS risk in non-obese group, NOS showed a 3.21% increased of abdominal obesity (2.525-4.212, P=0.000), 1.285 % increased of Hypertriglyceridemia (1.012-1.632, P=0.040), 1.314% increased of Low-HDL-cholesterol (1.054-1.638, P=0.015), 1.439 % increased of High fasting blood glucose (1.164-1,780, P=0.001). There is 2.269% increased MS risk in with sarcopenia group (1.430-3.600, p=0.001) in non- obese group and increased a 1.463% (0.999-2.142, p=0.050) in obese group comparing without sarcopenia group.

Conclusions: In Korea, old people-onset MS may be considering toward more sarcopenia status than obese status. We should consider obese include sarcopenia or not when we understand the general strategy for the MS in the Korean elderly.

Keywords: Sarcopenia; Obese; MS; Exercise; Dietary Patterns; Elderly

Introduction

In aging, the prevalence of Metabolic Syndrome (MS) referred to the previous stage of geriatric disease is increased rapidly in Korean elderly [1]. It is a cluster of independent factors such as Insulin Resistance (IR), abdominal obesity, dyslipidemia, and hypertension [2]. According to a research by Oh, there have been the association between body composition such as obese or sarcopenia phenomenon of aging and increased risk of the MS in the Korean elderly [3].

In general, obese is one of worldwide health problems as a cause of chronic disease as well as MS among all age people. However, just obese status can't be the indicator of healthy aging. Recent studies have reported the risk of disease among non-obese elderly individuals [4]. There are associations between body composition changes and IR and/or inflammations are fundamental to MS [5,6]. Specially with aging, less producing cytokines and myokines by skeletal muscle is caused IR and increased fat mass [5].

As muscle functions are revealed, sarcopenia status might be most important factor when defining obesity in the elderly. There is report that Non-Obese with Sarcopenia (NOS) elderly has been clearly demonstrated to have an adverse effect on physical performance due to frailty syndrome [7]. Furthermore, it should be different the way of approaching on the strategy of MS for the elderly, compared with the young people. Insufficient understanding of obesity for the elderly leads to body composition degradation and accelerates body function for the elderly. Therefore, it is not appropriate to apply knowledge that non-obese is to be healthy in the elderly without considering sarcopenia status.

Life style could control muscle synthesis in epigenetic perspective [2,8]. Their unbalanced diet status and physical activity behaviors are reflected in leading to obesity include sarcopenia [9-12]. Up to this date, many studies have focused on the MS and obese or sarcopenia but a few studies have investigated focused on the non-obese sarcopenia. [3,13,14]. This study assessed and compared the risk of MS and the general characteristics include METs and dietary patterns on sarcopenia and obese status in Korean elderly. The principal objective of this study is to elucidate that sarcopenia might be a specific intervention for the improvement of MS than obese for the Korean elderly.

Citation: Cho Rong Oh. Association between Sarcopenia and Metabolic Syndrome on the Obese Status in Korean Elderly: KNHANES 2010–2010. Austin J Obes & Metab Synd. 2020; 4(2): 1019.

Table 1: The socio-demographic factors of subjects according to sarcopenic status within the obese and non-obese groups.

Variable	Group	Non-obese			Obese		
		Non-Sarcopenia	Sarcopenia	P¥	Non-Sarcopenia	Sarcopenia	p
Gender (%)	Male	47.0(75.5%)	44.5(24.5%)	0.316	41.7(40.8%)	33.7(59.2%)	0.01
	Female	53.0(73.6%)	55.5(26.4%)		58.3(32.9%)	66.3(67.1%)	
Education (%)	Elementary	64.2	66.9	0.093	62	66.5	0.38
	Middle school	13.7	15.3		17.3	13.6	
	High school	15	10.8		14.1	14.2	
	≥College	7	6.9		6.6	5.8	
Income (%)	Low	25.6	23.1	0.621	25.8	19.8	0.075
	Low-Middle	24	23.4		29	27.7	
	Middle-High	25.6	26.7		22.2	24	
	High	24.8	26.8		31	69	
Smoking (%)	Yes	30.4	27.4	0.22	19.2	18.8	0.886
	No	69.6	72.6		80.8	81.2	
Diabetes (%)†	Normal	62.9	50.5	0	47.7	45.2	0.094
	Pre-Diabetes	21.7	26.3		29.7	26.4	
	Diabetes	15.4	23.2		22.6	29.4	

¥p from a chi-square test.
†Prediabetes: fasting glucose 100–125 mg/dl; diabetes: diagnosed with diabetes or a fasting glucose ≥126 mg/dl. Statistical significance was accepted at < 0.05.

Methods

Study population

Data for this cross-sectional studies was obtained from the Korean National Health and Nutrition Examination Survey 2009 to 2011 (KNHANES) by using a stratified, complex multistage, cluster random survey method of a representative sample of the non-institutionalized civilian Korean population. In brief, the KNHANES consisted of the following four sections: the first section is a health interview survey, the second section is a health behaviors survey, the third section is a health examination survey and the fourth section is a nutrition examination survey. Total population of 1,929 men and 2,523 women (aged≥60 y of age or older) participated in body composition measuring by using bone densitometry, DXA and completed both the health and dietary surveys. Everyone who participated in this survey signed a consent form. All collected blood sample tested in 24 hours. Height, weight, and waist circumference related anthropometric predictors were measured.9 VV [15].

Assessment for obese and the non- obese with sarcopenia or not

We used Appendicular Skeletal Muscle mass (ASM) after weight adjusted ASM, ASM/Wt % more than 1 Standard Deviations (1 SDs) below the mean for the gender-age based reference group this research, because (ASM/Wt) (%) is more applicable than ASM/Height2 for Korean populations [13,14,16]. The reference group included 2,824 men and 3,732 women, who were all healthy adulthood aged of 20 to 40 age. We used BMI (kg/m^2) calculator=Weight (kg) /Height (m^2) to classify obesity; BMI ≥ 25 kg/m^2 was considered obese [17].

Assessment for the Metabolic Equivalent Task (MET score)

The International Physical Activity Questionnaire (IPAQ) has been measured for epidemiological study and for physical health. It was defined as moderate-intense activity for five days per week or walks for 30 min a day; vigorous PA, defined as three days of vigorous exercise over 20 min per day; and inactivity within a previous 7-day reference period [18,19]. An average MET score was calculated for measuring IPAQ data: Walking score=3.3, Moderate PA score=4.0, Vigorous PA score=8.0. There are 4 different METs defined as Walking METs, Moderate METs, Vigorous METs and total PA METs=sum of Walking + Moderate + Vigorous METs [20].

Assessment of dietary patterns

The 24 h dietary recall (24HR) was used to express the foods and beverages consumed yesterday by trained staff with food models, bowls, cups and spoons to estimating. The food data were grouped into 20 food items based on the Korean Nutrient Data, and total energy intake (%) was calculated from every food groups. Kimchi was grouped into a Korean traditional side dish. The die intake patterns were grouped by efficient K-mean cluster analysis. We classified three patterns (the Mix group, White rice group, and Meat group) with the based on the central food groups. 'White rice group' was showed by an increased consumption of white rice and kimchi. The other subjects were applied to a 'Meat group' because they had a high intake of meat and alcohol.

Statistical analysis

Statistics were carried out with SPSS 20.0 (SPSS, IBM, NY, USA). Chi-square test was used to examine difference in the socio-demographic factors according to non-obese and obese groups with or without sarcopenia. The diet intake was grouped by k-means cluster analysis. A generalized linear was tested for physical activity according to non-obese and obese groups with or without sarcopenia and a logistic regression model was calculated as odds ratios (95% CI) for association between sarcopenia within obese status and metabolic syndrome risk factors. All data were adjusted for ages, sexes, and diabetes. Statistical significances were accepted at $P< 0.05$.

Table 2: Physical activity of the subjects according to sarcopenic status within the obese and non-obese groups.

	Non-obese			Obese		
	Non-sarcopenia	Sarcopenia	p¥	Non-Sarcopenia	Sarcopenia	P
Walking MET†	1161.38±59.74¶	949.69±62.12	0.013	1020.91±62.50	840.46±48.66	0.014
Moderate MET†	636.97±54.27	300.29±43.82	0	783.43±133.09	463.67±51.82	0.021
Vigorous MET†	789.35±89.40	408.25±78.45	0	1051.27±216.08	529.90±77.61	0.023
Total MET§	2790.33±138.12	1743.64±128.27	0	3167.88±361.26	1969.82±144.12	0.002

¥Obtained from generalized linear models that were adjusted for age, sex, and diabetes.

†Vigorous PA was defined as three or more days of vigorous activity for at least 20 minutes per day. Moderate PA or walking PA was defined as five or more days of moderate-intense activity or walking for at least 30 minutes per day. An average Metabolic Equivalent (MET) score was derived for the analysis of IPAQ data (Walking PA=3.3 METs, Moderate PA=4.0 METs and Vigorous PA=8.0 METs). Using these values, MET scores were defined as: Walking MET-minutes/week=3.3-walking minutes-walking days; Moderate MET-minutes/week=4.0 -moderate-intensity activity minutes-moderate days; Vigorous MET-minutes/week = 8.0-vigorous-intensity activity minutes_ vigorous-intensity days.

§total MET-minutes/week=sum of Walking + Moderate + Vigorous MET-minutes/week scores

¶Means ± SDs are shown. Statistical significance was accepted at *P* < 0.05.

Ethics statement

The study methods were confirmed by the Korea Centers for Disease Control and Prevention (IRB No: 2012-02 CON-06-C).

Results

The socio-demographic factors of obese and the non- obese group with sarcopenia or not.

In Table 1, the significant difference between gender and sarcopenia in the obese group and the prevalence of sarcopenia is shown to be higher in female than male (male, 59.2%; female, 67.1%. (p=0.01)). There is no significant difference between gender and sarcopenia in the non-obese group and the prevalence of sarcopenia is shown to be lower in both gender in the non-obese group (male, 24.5%; female, 25.4%). In the non-obsess group, subjects with sarcopenia had significantly higher precursor signs of diabetes and diabetes than subjects with non-sarcopenia. There is no significant difference between diabetes status and sarcopenia in the obese group.

PA levels in non-obese and obese groups with or without sarcopenia.

PA levels by sarcopenia status and obesity categories are detailed in Table 2. First of all, regardless of obese or not, there were significantly different between PA levels and sarcopenia. Every modes of exercise had been higher in non-sarcopenia than in sarcopenia among obese or non-obese. Especially, in the non-sarcopenia in obese group, levels of moderate and vigorous exercise, and total MET except walking, were higher than non-sarcopenia in non-obese group. In the obese group, moderate or vigorous exercise are more positive for maintain muscle than walking.

Dietary patterns by sarcopenic status within obese or not

The dietary patterns weren't significantly associated with sarcopenic status in the obese or obese group. More subjects were in the 'White rice group' (4 6.1%, 44.5% in the non-obese group; 42.7% 40.6% in the obese group), but few subjects were in the "Meat group' (16.4%, 17.6% in the non-obese group; 17.6%, 20.4% in the obese group), as shown in Table 3.

The risk factors of metabolic syndrome by sarcopenic status within the obese and non-obese groups

The odds ratios (95% CI) for MS and sarcopenia in non-obese and obese group are associate with are shown in Table 4. Sarcopenia had a significantly increasing prevalence of MS risk in group of obese or not. NOS group had significantly more likely to be increased MS risk than with obese group.

The MS risk in non-obese group, the sarcopenia group showed a 3.21% increased of abdominal obesity (2.525-4.212, P=0.000), 1.285% increased of Hypertriglyceridemia (1.012-1.632, P=0.040), 1.314% increased of Low-HDL-cholesterol (1.054-1.638, P=0.015), 1.439% increased of High fasting blood glucose (1.164-1,780, P=0.001). MS is associated with sarcopenia in both groups. In the non-obese group showed a 2.269% increased MS in sarcopenia group (1.430-3.600, p=0.001). There is increased a 1.463% (0.999-2.142, p=0.050) in obese group.

Discussion

Among the elderly, their excess body weight can't be an indicator of unhealthy. Furthermore, we should consider obese include sarcopenia or not when we understand the general strategy for the MS in the elderly. In this national large sample research, we explored the association of sarcopenic status and risk of MS and socio-

Table 3: The dietary patterns of subjects according to sarcopenic status within the obese and non-obese groups.

	Non-obese			Obese		
	Non-sarcopenia	Sarcopenia	p¥	Non-Sarcopenia	Sarcopenia	P
Walking MET†	1161.38±59.74¶	949.69±62.12	0.013	1020.91±62.50	840.46±48.66	0.014
Moderate MET†	636.97±54.27	300.29±43.82	0	783.43±133.09	463.67±51.82	0.021
Vigorous MET†	789.35±89.40	408.25±78.45	0	1051.27±216.08	529.90±77.61	0.023
Total MET§	2790.33±138.12	1743.64±128.27	0	3167.88±361.26	1969.82±144.12	0.002

¥p from a chi-square test.

†Food group (% energy); There were three dietary patterns derived by cluster analysis among the Korean elderly. Statistical significance was accepted at *P* <0.05.

Table 4: The Odds Ratios (OR) for metabolic risk by sarcopenic status within the obese and non-obese groups[a].

	Non-obese				Obese			
	Non-Sarcopenia	Sarcopenia			Non-Sarcopenia	Sarcopenia		
		OR	95% CI	P¥		OR	95% CI	P
Abdominal obesity M>90,F>80†	1	3.261	(2.525-4.212)	0	1	1.912	(1.342-2.726)	0
Hypertriglyceridemia ≥150 mg/dl	1	1.285	(1.012-1.632)	0.04	1	1.089	(0.840-1.412)	0.52
Low-HDL-cholesterol M<40, F<50 mg/dl§	1	1.314	(1.054-1.638)	0.015	1	1.031	(0.793-1.342)	0.818
Elevated blood pressure ≥130/85 mmHg	1	1.127	(0.863-1.470)	0.38	1	1.109	(0.831-1.480)	0.481
High fasting blood glucose >100 mg/dl	1	1.439	(1.164-1,780)	0.001	1	1.159	(0.912-1.472)	0.228
Metabolic syndrome3 or More	1	2.269	(1.430-3.600)	0.001	1	1.463	(0.999-2.142)	0.05

¥The logistical regression models used to obtain the ORs were adjusted for age, sex, and diabetes.
†Abdominal obesity: WC >90 cm in males, >80 cm in females.
§Low HDL cholesterol: <40 mg/dl in males, <50 mg/dl in females. Statistical significance was accepted at P <0.05.

demographic factors include METs and dietary patterns in obese and non-obese groups.

We found that the NOS elderly showed a significantly increased MS risk more than with obese group. Obese or sarcopenia should be prescribed differently for the strategy for the prevention of MS. Is non - obese subject healthy? There is report that depending on the degree of muscle mass can lead to metabolic risk in normal weight [4,11]. Even though it is right to control excess weight but muscle strengthening and maintenance strategy is needed in the elderly. Recently, in several studies, most elderly who lost weight more had an increased relative mortal disability compared to those who had a stable weight which is not considered muscle mass [4,21]. Moreover, weight loss has a negative impact on some aspects of mental health, including markers of Alzheimer disease [22]. The results of present study indicated that the NOS are more likely to have unhealthy levels for all MS risk factors. We need to pay special attention to geriatric non-obesity group.

We found that sarcopenia may be important early predictor for the risk of MS, which is consistent with a previous report by Lim [14]. In the past, Sarcopenia is not well known as disease but it has its own International Classification of Disease code - M 62.84 - October 1, 2016 [23]. In spite of this clinical importance of sarcopenia in the elderly, the criteria for its definition and clinical diagnosis are not yet clear-cut and vary among studies and experts [24,25]. According to study by Buchmann, definition of MS is expanded to include body composition changes such as sarcopenia and obese as well as the cardiovascular risk factors [26] Oh & No [27], suggested that the prevalence of sarcopenia was significantly higher in MS than in normal group. This consistent with a previous study with 65 years or older Korean elderly [9].

The decreased skeletal muscle mass could cause the risk of cardiovascular, diabetics, some cancers among the elder [28]. Therefore, maintaining muscle mass from adolescence, similar to savings, is very important because changes in anthropometric indices may serve as warning criteria. There are studies found that muscle plays critical roles in influencing hormonal glands, carbohydrate metabolism, insulin metabolism and MS in aging populations [29-31]. Increased muscle mass has a positive effect on improving IR and reducing mild inflammation. We found that in the NOS had significantly higher precursor signs of diabetes and diabetes than subjects with non-sarcopenia. It showed a significant decrease in blood IL-6 and TNF-α levels corresponding to HOMA-IR, C-peptide, and mild inflammation-related indicators [29]. Muscle loss in aging process, there is a greater relative increase abdominal fat than subcutaneous fat by the muscle loss [32]. This finding indicates the likely influence of inflammatory cytokines such as TNF-a, IL-8 from adipose tissue on the obese individual include non-obese with sarcopenia [12]. The loss of muscle mass resulting from fat infiltration may lead to IR. Body fat itself is not the problem, but these vicious cycles led by inflammatory cytokines cause muscle catabolism and lead to the accumulation of body fat [29]. In other words, the weight change or weight range is normal, but there is continuously the muscle mass loss and the increased fat mass, causing metabolic abnormalities.

What is the best strategy to prevent to MS to maintain proper body composition? lifestyle change like more sedentary behaviors as well as malnutrition for the elderly, which are contributing to sarcopenia accompanied by an increase of fat mass in aging [33,34]. We found that activity is significantly associated with sarcopenia in both obese group but dietary patterns are not. Several treatments have been suggested to prevent muscle mass loss among the elderly, and there is no doubt that exercise is the most important approach for reversing or modifying the treatment of sarcopenia [12,35]. There are evidences that moderate exercise, including walking, gives good effect on reduction of CHD, and updated the ACSM recommendations for moderate-intensity aerobic activities, muscle-strengthening activities, balance exercises and reducing sedentary behavior [36,37]. Activities in the elderly may be important way for preventing the risk of MS, which is consistent with our finding [38,39].

There are some strengths and limitations to this study. First, it was done with a large number of representative Korean elderly. Second, there have been few epidemiological studies that have focused on sarcopenia and obese status on MS for the elderly. Design of study such as divided obese status with sarcopenia status has become primary key to understand obese should be include sarcopenia for the elderly. It could provide useful new understanding on the strategy of MS among Korean elderly and the considering sarcopenia can be used in early interventions for MS risk. There are some limitations. First, the prevalence of sarcopenia may have not been clearly estimated due to no consensus for sarcopenia has yet been reached. Second, there was a lack of a way to define obese for the elderly. Body Mass Index (BMI) as obesity criteria in the elderly is not appropriate and started to consider new approaching reflected the body composition change. So it is needed more research to make early systematic evaluations of sarcopenia and obese for MS in Korean elderly.

To summarize, We found that the NOS elderly showed a significantly increased MS risk more than with obese group. Also, activity is significantly associated with sarcopenia in both obese group but dietary patterns are not. Finally, we should consider obese include sarcopenia or not when we understand the general strategy for the MS in the elderly.

Acknowledgment

CRO designed, analysing the data and carried out the study and approved the final manuscript.

This research was supported by Kyungsung University in 2020, Busan, Korea.

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