Korean Journal of Human Ecology
2019. Vol. 28, No. 1, 21-32
http://dx.doi.org/10.5934/kjhe.2019.28.1.21
ISSN 1226-0851(Print)/ISSN 2234-3768(Online)

Associations of Dietary Patterns with Sarcopenic Obesity among Middle-Aged Women: the Korean National Health and Nutrition Examination Survey (KNHANES) (2008–2011)

중년 여성의 식사패턴과 근감소성 비만과의 연관성 : 국민건강영양조사 2008-2011년 자료를 이용하여

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Abstract

식사패턴과 근감소증 및 근감소성 비만과의 관련성에 대한 국내 연구가 미비한 실정이다. 이에 본 연구는 한국 중년 여성의 식사패턴과 근감소증 및 근감소성 비만과의 관련성을 분석하고자 하였다. 국민건강영양조사 (2008-2011) 자료를 이용하여 이중에너지방사선흡수법 측정을 통한 사지골격근량 (appendicular skeletal muscle, ASM) 자료가 있는 중년 여성 1,802명을 대상으로 분석을 실시하였다. 근감소증 진단기준은 젊은 성인 집단의 ASM을 체중으로 나눈 값의 표준편차 1 미만으로 하였으며, 비만 기준은 25 kg/m^2 이상으로 하였다. 식사 섭취 분석은 식사섭취빈도조사 자료의 63 가지 식품을 사용하였다. 요인 분석을 통해 3가지 요인의 식사패턴을 도출하였으며, 이를 건강식 패턴, 서양식 패턴 및 불균형식 패턴으로 명명하였다. 본 연구결과 불균형식 패턴은 허리둘레, 혈압, 총 콜레스테롤 및 중성지방과의 유의한 상관관계가 나타났으며 (*P* for trend<0.05), 요인점수가 증가할수록 ASM/wieght ratio 가 유의적으로 감소하였다 (*P* for trend<0.05). 또한 불균형식 패턴의 요인점수를 5분위로 나누어 분석한 결과 가장 높은 그룹이 가장 낮은 그룹보다 근감소성비만의 Odds Ratio 가 1.72배 높은 것으로 나타났다 (95% confidence interval: 1.050–2.801; *P* for trend<0.05). 건강식 패턴과 서양식 패턴은 근감소증 및 근감소성비만과의 관련성이 나타나지 않았다. 본 연구 결과 식사패턴이 불균형식 패턴을 보이는 경우 심혈관 질환 요인 위험률은 근감소성 비만과 관련성이 있는 것으로 나타났다.

주제어 : 식사패턴, 신체구성, 근감소증, 비만, 근감소성비만

Ⅰ. INTRODUCTION

The percentage of the elderly in Korea is increasing rapidly. It is expected to reach 40.0% by 2058 (Korea National Statistical Office, 2017). Among biological changes associated with aging, the elderly have higher

이 논문은 2017년 학년도 원광대학교의 교비지원에 의해 수행됨.
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risk of developing sarcopenia and sarcopenic obesity due to reduced muscle mass with increased body fats and intra-abdominal fats. In the elderly, sarcopenia is known to be a risk factor not only for main senile illnesses such as falls, osteoporosis, and dementia, but also for chronic diseases such as diabetes, cardiovascular disorders, and hypertension(Morley, 2008). In addition, sarcopenic obesity is more likely to trigger physical disabilities than sarcopenia. It is considered a risk factor of metabolic syndrome (Zamboni et al., 2008). Increasing prevalence of sarcopenia and sarcopenic obesity can lead to increase of socioeconomic burden. As the aging population in Korea is increasing, substantial efforts must be made to minimize changes in body composition due to physiological aging. Among Koreans aged > 65 years, the prevalence of sarcopenia has been reported to be 15.4%–33.6% in men and 22.3%–32.7% in women (Moon et al., 2015). Regarding the prevalence of sarcopenic obesity, it has been reported to be 5.1%–13.0% in men and 12.5%–17.0% in women(Kim et al., 2009; Lim et al., 2010). Women have remarkably higher prevalence of sarcopenia and sarcopenic obesity than men due to several reasons, including menopause-induced female hormone deficiency, reduced physical activities, changes in the nervous system, and nutritional imbalance(Janssen et al., 2002; Kim et al., 2013). Therefore, middle-aged women who undergo the aging process should prevent and manage sarcopenia and sarcopenic obesity by performing appropriate activities and receiving adequate nutrition.

Since food intake is a major factor that can either prevent or worsen the disease, nutritional assessment plays an important role in the management of patients with chronic diseases. It is difficult to evaluate the interaction of nutrients using a single nutrient-based assessment method as it only reflects patients' dietary habits from the time they consumed various foods. However, a dietary pattern can be established to identify patients' food intake and analyze the overall diet that is routinely consumed(Hu, 2002). Based on a dietary pattern, practical guidelines can be provided for nutrition management. For this reason, research on dietary patterns is actively conducted(Kant, 2004; Newby & Tucker, 2004). Regarding the association between dietary patterns and body composition, a study on 300 Iranian people aged > 55 years has reported that participants consuming Mediterranean diet consisting of olive oil, fruits, vegetables, fish, and nuts have lower risk of developing sarcopenia(Hashemi et al., 2015). A study on postmenopausal women has also reported that consumption of Mediterranean diet helps reduce the risk of sarcopenia(Mohseni et al., 2017). A study conducted on Chinese elderly people aged > 65 years has revealed that increase consumption of vegetables, fruits, and dairy products can help reduce the risk of sarcopenia(Chan et al., 2016). A cluster analysis of American elderly people to determine correlations between sarcopenia and dietary patterns has reported that individuals who consume large amounts of alcohol have higher risk of sarcopenia(Fanelli Kuczmarski et al., 2013). A study conducted on elderly Korean individuals aged > 65 years has reported that the risk of sarcopenia has a significant negative correlation with intake of fruits and vegetables(Kim et al., 2015). One such study has shown that dietary patterns are related to appendicular skeletal muscle (ASM) mass-weight ratio(Oh et al., 2014). These results of previous studies can serve as a basis to establish guidelines for nutritional management by presenting changes in body composition and their association with dietary patterns. However, only a few studies have examined the correlation between dietary patterns and body composition in Korean women aged > 50 years who have relatively high prevalence of sarcopenia and sarcopenic obesity.

The objective of the present study was to analyze correlations between dietary patterns and sarcopenic obesity in community-dwelling women aged > 50 years who needed preventive management of sarcopenia and obesity using the Korea National Health and Nutrition Examination Survey (KNHANES) data.

Ⅱ. MATERIALS AND METHODS

1. Selection of study participants

This study used data from the 4th and 5th KNHANES (2008-2011). Of 37,753 participants, 30,441 subjects aged < 50 years or > 65 years were excluded. Participants who had missing values in Dual energy X-ray densitometry, height, weight, body mass index (BMI), waist circumference, and food frequency questionnaire were also excluded (n = 2,949). Additionally, those with implausible calorie intake ranges (less than 500 kcal/day or more than 5,000 kcal/day; n = 1,160) and men (n = 1,401) were excluded. As a result, 1,802 women were analyzed as study participants. Before conducting this study, we received approval from our Institutional Review Board (WKIRB-201605-SB-028).

2. Data collection

1) Social demographic factors

Study participants' socioeconomic factors including level of income, education, occupation, marriage, smoking, drinking, and menopausal status were surveyed. Level of income was classified into low, mid-low, mid-high, and high according to the household equivalence scale based on monthly average income. It was calculated by dividing family income by the number of family members. Occupation was divided into seven categories: manager, specialist, office worker, service and sales worker, skillful workers in agriculture, forestry, and fishery, technician and device assembly worker, simple labor worker, and "unemployed (housewife, student, and so on). Education was classified into graduated from elementary school or lower, graduated from middle school, graduated from high school, and graduated from a university or higher. Marital status was divided into two categories: married and unmarried. Smoking status was divided into smoked and not smoked. Drinking status was divided into drank and not drank. With regard to menopausal status, those who had metrectomy were included. Regarding analysis of physical activities, data of the questionnaire designed according to the International Physical Activity Questionnaire criteria were utilized to calculate metabolic equivalent of task (MET)-minute per week.

2) Antheropometric and dietary intake survey

To evaluate participants' antheropometric and dietary intake, the KNHANES was conducted using the following methods. An extensometer (Seca 225, Seca, Hamburg, Germany) was used to measure height. For weight, a digital weight scale (GL-6000-20, G-tech, Gyeonggi-do, Korea) was used to examine up to 200 kg. For BMI, weight in kilogram was divided by height in meter squared. Waist circumference was measured using a measuring tape (Seca 200, Seca, Hamburg, Germany). A bone densitometry (Discovery W, Hologic, MA, USA), also known as dual energy X-ray densitometry, was used to measure ASM mass and body fat mass. Systolic blood pressure and diastolic blood pressure were measured three times in stable condition and mean values were obtained. Serum total cholesterol, triglyceride, and fasting blood sugar levels were evaluated using an enzymatic analyzer (Advia 1650, Siemens, IL, USA). Glycated hemoglobin level was analyzed by high-performance liquid chromatography (HPLC, Tosoh, Tokyo, Japan). Dietary intake was surveyed using a dietary intake frequency questionnaire on the basis of 63 food items and a 24-hour dietary recall.

3) Criteria of sarcopenia and obesity diagnosis

To diagnose sarcopenia, dual energy X-ray densitometry was used to measure appendicular muscle mass. The measured value was divided by participant's weight and then multiplied by 100. For the diagnostic criterion of sarcopenia, ASM mass of each healthy female adult aged 19–39 years in KNHANES (2008-2011) (n = 2,322) was divided by her weight and the mean mass value was calculated.

ASM mass/weight percentage of one standard deviation below the mean of young female adults (23.83%) was set as sarcopenic diagnosis criterion for women. BMI was used to screen for obesity which was defined as a BMI of ≥ 25 kg/m^2. Sarcopenia and sarcopenic obesity were distinguished using the above criteria.

3. Dietary patterns

1) Classification into food groups

A total of 63 food items in the food frequency questionnaire were reclassified into 33 food groups. Rice and cereals were classified as “grains”. Noodles were classified as “noodles”. Radish, radish tops, bean sprouts, spinach, cucumber, pepper, carrot, pumpkin, cabbage, and tomato were classified as “vegetables”. Chinese cabbage was classified as “cabbage kimchi”. Sea mustard and laver were classified as “seaweed”. Potato and sweet potato were classified as “tubers”. Tofu, soy, and soybean milk were classified as “beans”. Ham, bacon, and sausage were classified as “processed meat products”. Hamburger and pizza were classified as “instant food products”. Mandarin, persimmon, pear, watermelon, oriental melon, strawberry, grape, peach, apple, banana, and orange were “fruits”. Mackerel and tuna were “external blue colored fish”. Croaker and pollack were “external white-colored fish”. Makgeolli, Soju, and beer were classified as “alcohol” <Table 1>.

Regarding the intake frequency of each food item in the questionnaire, participants were asked to estimate the frequency of food consumption per day, week, month, and year. In this study, intake frequency was evaluated on a weekly basis. Hence, an intake frequency of once a week was counted as “1”. On this basis, the relative intake frequency value of each food product was corrected and calculated.

2) Extraction of dietary patterns

The intake frequency value of each of 33 reclassified food groups was divided by daily energy intake estimated by a 24-hour dietary recall. Different intake frequency scale of each food group can influence pattern analysis. Therefore, intake frequency was standardized into Z-score. Factor analysis was conducted using the standardized intake frequency value of each food group. As a factor extraction method, principal component analysis was utilized. To increase explanatory power, orthogonal factor rotation was conducted. Factor extraction was based on results of the scree test. Factors with eigenvalues > 1.3 were retained. Using food items with a factor loading absolute value > 0.30, three dietary patterns were extracted as factors. A name of dietary pattern was named reflecting characteristics of foods that belonged to that factor. After factor analysis, we calculated a factor score for each of other dietary patterns.

4. Statistical analysis

Using the 2008–2011 KNHANES data, a complex sample design-based analysis was conducted. Participants were divided into five groups based on their score of each dietary pattern extracted. To determine differences among these groups, frequency analysis and cross tabulation analysis were conducted. We analyzed level of income, occupation, education, marriage, smoking, and menopausal status according to each group of dietary patterns using Chi-square. Complex samples general linear model (CSGLM) was conducted to analyze correlations of each group of dietary patterns with anthropometrics, body composition indicators, and biochemical indicators. Results are expressed as mean ± standard error. Logistic regression analysis was conducted to draw the relative risk value of correlation of dietary patterns with sarcopenia and sarcopenic obesity. Demographic factors such as age, total MET score, education, smoking, and menopause factors showing a correlation with dietary pattern were considered as correction variables. All statistical analyses were performed using SPSS Program 21.0 (SPSS Inc., Chicago, IL, USA).

〈Table 1〉 Food groups and factor-loading matrix for dietary patterns

Food group	Food items	Healthy diet pattern	Western diet pattern	Unbalanced diet pattern
Cereal	Rice, barley			-0.702
Rice cake	Rice cake		0.397	
Bread	Bread		0.565	
Snack	Snack		0.541	
Noodles	Instant noodle, noodle			0.381
Vegetables	Radish, radish leaves, sprouts, spinach, cucumber, pepper, carrot, pumpkin, cabbage, tomato	0.680		
Kimchi	Napa cabbage			-0.333
Mushroom	Mushroom	0.552		
Seaweed	Seaweed, laver	0.585		
Potato	Potato, sweet potato	0.439	0.307	
Legumes	Bean curd, legume, soy milk			-0.623
Beef	Beef		0.561	
Pork	Pork		0.432	
Chicken	Chicken		0.594	
Processed meat	Ham, bacon, sausage		0.381	
Milk	Milk		0.398	
Yogurt	Yogurt		0.324	
Ice cream	Ice cream		0.370	
Eggs	Egg	0.380		
Fruits	Tangerine, persimmon, pear, watermelon, melon, strawberry, grape, peach, apple, banana, orange	0.485	0.380	
Oily fish	Mackerel, tuna	0.515		
Whitefish	Yellow fish, pollack	0.615		
Anchovy	Anchovy	0.478		
Fish ball	Fish ball	0.390		0.301
Cuttlefish	Squid	0.465		
Shellfish	Calm	0.541		
Salted fish	Salted fish	-	-	-
Instant food	Hamburger, pizza		0.470	
Fried food	Fried food		0.324	
Soft drink	Cola, soda, fruit juice soda			0.431
Coffee	Coffee	-	-	-
Tea	Green tea	-	-	-
Alcohol	Beer, soju, rice wine			0.432
Eigen value		2.562	2.160	1.962
Percentage of variances (%) Explained		∑20.256 %		

Values are factor loading: absolute values < ±0.30 are not shown for simplicity

Ⅲ. RESULTS

1. Dietary patterns

A factor analysis of the 33 food items was conducted to analyze participants' dietary patterns. Based on eigenvalue and explanatory power, three factors were extracted as shown in <Table 1>. Factor 1 was categorized as "healthy diet pattern" as it included a variety of food groups such as vegetables, tubers, eggs, fruits, and fish. Factor 2 was categorized as "western diet pattern". It involved high consumption of meat along with bread, dairy products, instant food, fried food, and carbonated beverages. Factor 3 was categorized as "unbalanced diet pattern". It involved high consumption of noodles (instant food included), fish paste, beverage, and alcohol with less consumption of vegetables and beans. Each eigen value was in the range of 1.962-2.562. These three dietary patterns accounted for 20.256% of total variables.

2. Dietary patterns and sociodemographic factors

Each factor was divided into five quintiles and participants' general characteristics were compared <Table 2>. The highest group of dietary pattern score showed the lowest age on all dietary pattern ($P < 0.001$). Regarding economic level of each pattern, higher "healthy diet pattern" and "western diet pattern" scores indicated higher income levels. In terms of educational level, those participants with "unbalanced diet pattern" who received university education or higher accounted for 9.6%. Those with "healthy diet pattern" and "western diet pattern" accounted for 11.5% and 17.5%, respectively, which were relatively high. There was no significant difference in smoking or drinking status between individuals with "healthy diet pattern" and those with "western diet patterm." Meanwhile, individuals with higher scores of "unbalanced diet pattern" had higher smoking ($P < 0.001$) and drinking rates ($P < 0.01$). For each dietary pattern, higher score group of "healthy diet pattern" and "western diet pattern" showed lower frequency of menopause ($P < 0.01$).

3. Dietary patterns, nutrient intake, and health risk indicator

Based on the score for each dietary pattern, differences in body composition indicator, blood pressure, and blood lipid indicator were compared <Table 3>. Participants with higher scores of "healthy diet pattern" showed higher height measurements (P for trend < 0.001), but lower waist circumference (P for trend < 0.01), glycated hemoglobin levels (P for trend < 0.05), and triglyceride levels (P for trend < 0.05). The group with higher score of "healthy dietary pattern" showed increased protein ratio per total calories ($P < 0.05$). With an increase in "western diet pattern" score, height measurements decreased (P for trend < 0.05). With an increase of "unbalanced diet pattern" score, the waist circumference (P for trend < 0.05), blood pressure levels (P for trend < 0.05), total cholesterol levels (P for trend < 0.05), and triglyceride levels (P for trend < 0.05) showed significant increases while values of ASM mass (P for trend < 0.05) and ASM mass-to-weight ratio (P for trend < 0.01) showed significant decreases. Also, as "healthy diet pattern" score increased, the percentage of energy from protein was significantly increased. However, when "unbalanced diet pattern" score increased, protein ratio per energy significantly decreased ($P < 0.05$).

4. Dietary patterns and body composition indicators

The risk of body composition (obesity, sarcopenia, and sarcopenic obesity) was analyzed based on the score of each dietary pattern. We used covariables such as age, education, smoking status, total MET score, and menopausal. Results are presented in <Table 4>. With an increase in "unbalanced diet pattern" score, the relative risk of sarcopenic obesity increased 1.715 times (95% confidence interval: 1.050 – 2.801) (P for trend < 0.05). However, "healthy diet pattern" or "western diet pattern" was not associated with obesity, sarcopenia, or sarcopenic obesity in adjusted models.

〈Table 2〉 Participants' characteristics by quintiles of food intake pattern score

Variable	Healthy diet pattern - quintile				Western diet pattern - quintile				Unbalanced diet pattern - quintile			
	Q1 (n=360)	Q3 (n=360)	Q5 (n=359)	P	Q1 (n=360)	Q3 (n=361)	Q5 (n=360)	P	Q1 (n=360)	Q3 (n=361)	Q5 (n=359)	P
Age[1)]	56.76±0.27	55.72±0.23	55.14±0.26	***	57.38±0.25	55.79±0.24	54.75±0.26	***	57.08±0.29	55.53±0.24	54.93±0.25	***
Income[2)]				***				***				
Low	137 (36.3)	77 (20.4)	54 (13.9)		135 (34.7)	76 (19.9)	55 (17.2)		90 (25.9)	87 (22.7)	107 (29.1)	
Medium-low	110 (31.1)	87 (22.7)	78 (26.9)		107 (31.2)	95 (26.3)	77 (23.6)		106 (28.3)	86 (24.8)	96 (27.3)	
Medium-high	62 (17.9)	107 (32.8)	104 (28.8)		70 (20.3)	99 (29.4)	99 (27.4)		89 (25.6)	94 (28.9)	75 (22.2)	
High	47 (14.6)	88 (24.1)	117 (30.5)		45 (13.9)	87 (24.3)	126 (31.7)		73 (20.3)	89 (23.7)	77 (21.3)	
Occupation[2)]				**				***				***
Manager, Professional	6 (2.6)	11 (2.7)	11 (2.6)		3 (1.0)	8 (1.9)	19 (4.5)		6 (1.4)	13 (3.8)	11 (3.2)	
office worker	2 (0.8)	4 (1.2)	6 (1.9)		4 (0.8)	2 (0.6)	12 (3.2)		3 (0.8)	8 (2.2)	5 (1.3)	
Service and Sale workers	43 (14.0)	56 (16.9)	74 (21.9)		37 (12.0)	46 (13.1)	75 (23.7)		33 (11.1)	49 (14.4)	96 (27.0)	
Forestry and Fishery Workers	75 (17.3)	54 (10.5)	21 (3.9)		80 (17.0)	53 (12.2)	21 (4.4)		55 (11.0)	56 (12.7)	34 (7.6)	
Craft and Related Trade Worker	15 (4.6)	18 (4.3)	12 (3.2)		10 (2.8)	21 (6.5)	14 (3.6)		11 (2.9)	10 (2.2)	12 (3.6)	
Simple laborer[2)]	61 (15.7)	60 (19.3)	49 (17.6)		60 (18.8)	65 (20.8)	45 (13.8)		56 (18.6)	68 (22.8)	54 (16.4)	
Unemployed	154 (45.1)	154 (45.1)	186 (49.0)		163 (47.4)	165 (45.0)	171 (46.8)		194 (54.3)	154 (41.9)	146 (41.0)	
Education[2)]				***				***				***
< Elementary school	259 (67.7)	173 (45.6)	117 (30.6)		264 (72.3)	188 (49.1)	106 (26.8)		199 (51.9)	157 (40.4)	180 (45.8)	
Middle school	61 (19.1)	82 (24.4)	82 (23.5)		58 (16.6)	80 (25.2)	68 (19.7)		74 (22.3)	78 (21.8)	81 (26.2)	
High school	28 (11.1)	77 (23.4)	121 (34.5)		30 (9.0)	73 (21.6)	118 (36.0)		70 (22.0)	84 (26.6)	64 (18.4)	
≥ University	9 (2.1)	25 (6.7)	39 (11.5)		6 (2.1)	19 (4.2)	65 (17.5)		16 (3.8)	39 (11.2)	33 (9.6)	
Marital status, Married[2)]	358 (99.4)	356 (99.5)	356 (99.4)		359 (99.9)	359 (99.7)	357 (99.2)		357 (99.5)	357 (99.5)	358 (99.5)	
Physical activity (MET-min/week)	2391±479.1	3579±514.2	2707±383.9		2767±446.5	2917±409.3	2621±440.2	*	2415±404.3	2969±415.0	2601±395.0	
Smoking, Yes[2)]	26 (7.3)	29 (10.5)	16 (4.6)		29 (8.8)	17 (4.8)	26 (9.7)		12 (2.9)	19 (5.6)	42 (13.6)	***
Alcohol drinking, Yes[2)]	267 (74.9)	262 (73.4)	263 (73.2)		245 (69.6)	268 (74.0)	282 (78.9)		240 (69.8)	266 (74.8)	298 (82.2)	**
Menopause, Yes[2)]	336 (93.2)	320 (87.9)	301 (81.9)	**	338 (94.0)	316 (86.9)	299 (81.9)	**	333 (92.7)	314 (86.4)	308 (84.8)	

[1)]Mean ± SE, significance as determined by GLM
[2)]N (%), significance as determined by Chi-square test
$^{*}P < 0.05$, $^{**}P < 0.01$, $^{***}P < 0.001$

〈Table 3〉 Anthropometric, biochemical, and dietary intakes of participants by quintiles of food intake pattern scores

Variable	Healthy diet pattern - quintile				Western diet pattern - quintile				Unbalanced diet pattern - quintile			
	Q1	Q3	Q5	*P* for trend	Q1	Q3	Q5	*P* for trend	Q1	Q3	Q5	*P* for trend
Height, cm[1)]	155.10±0.53	155.33 ± 0.49	156.33 ± 0.47	0.000	154.80 ± 0.51	155.64±0.51	156.08 ±0.48	0.004	156.30 ±0.52	155.36 ±0.48	154.99 ±0.49	0.012
Weight, kg	57.43±0.76	57.12 ± 0.63	57.88 ± 0.66	0.410	56.40 ± 0.69	58.26 ±0.77	57.32 ±0.62	0.212	57.31 ±0.67	56.35 ±0.66	57.27 ±0.66	0.911
WC, cm	80.52±0.82	80.11 ± 0.68	79.93 ± 0.76	0.005	80.12 ± 0.75	81.40 ±0.86	79.50 ±0.67	0.279	79.32 ±0.71	78.89 ±0.72	80.80 ±0.72	0.035
BMI, kg/m^2	23.91±0.29	23.73 ± 0.26	23.69 ± 0.25	0.243	23.56 ± 0.26	24.06 ±0.31	23.56 ±0.23	0.845	23.49 ±0.26	23.36 ±0.25	23.86 ±0.24	0.160
ASM, kg[1)]	14.34±0.17	14.09 ± 0.15	14.47 ± 0.16	0.213	14.00 ± 0.16	14.40 ±0.19	14.37 ±0.16	0.106	14.41 ±0.18	14.19 ±0.16	14.07 ±0.17	0.040
ASM/Wt, %	25.15±0.22	24.82 ± 0.21	25.12 ± 0.20	0.987	24.96 ± 0.21	24.85 ±0.21	25.21 ±0.21	0.717	25.25 ±0.19	25.26 ±0.23	24.71 ±0.20	0.005
BF, kg	19.15±0.44	19.20 ± 0.40	19.37 ± 0.40	0.448	18.86 ± 0.41	19.83 ±0.44	18.96 ±0.38	0.493	19.04 ±0.38	18.55 ±0.41	19.42 ±0.38	0.369
BFP, %	33.13±0.47	33.53 ± 0.45	33.42 ± 0.42	0.442	33.34 ± 0.42	33.95 ±0.46	32.96 ±0.42	0.916	33.22 ±0.42	32.96 ±0.46	33.78 ±0.39	0.251
SBP, mmHg[1)]	120.46±1.63	121.48 ± 1.45	120.04 ± 1.44	0.857	121.15 ± 1.56	120.94±1.39	120.19 ±1.38	0.330	118.99 ±1.58	119.16 ±1.41	122.32 ±1.50	0.015
DBP, mmHg	77.23±1.02	77.71 ± 0.93	77.47 ± 0.88	0.241	77.32 ± 1.02	77.55 ±0.90	77.01 ±0.85	0.711	77.15 ±1.03	76.10 ±0.87	77.85 ±0.88	0.384
FBG, mg/dL	95.97±2.40	94.76 ± 1.41	93.45 ± 1.31	0.078	96.52 ± 1.99	95.56 ±1.81	94.63 ±1.41	0.844	94.66 ±1.62	94.95 ±1.74	95.02 ±1.33	0.796
HbA1c, %	6.17±0.27	6.08 ± 0.20	5.83 ± 0.17	0.049	6.24 ± 0.24	6.33 ±0.26	5.99 ±0.18	0.740	6.16 ±0.18	6.07 ±0.20	6.21 ±0.19	0.292
TC, mg/dL	200.46±3.00	201.99 ± 2.95	201.60 ± 2.73	0.386	200.53 ± 3.20	199.56±3.08	201.73 ±2.62	0.802	198.35 ±2.92	202.14 ±2.81	205.89 ±3.04	0.046
TG, mg/dL	136.39±0.855	133.77 ± 7.81	118.62 ± 6.52	0.028	131.62 ± 7.75	133.25±7.43	118.73 ±6.84	0.106	119.16 ±6.84	113.10 ±6.99	134.23 ±7.60	0.038
Dietary intake												
Daily energy intake, kcal/day	1240.4	1828.9	1616.2		1222.8	1900.1	1678.7		1497.7	1942	1449.7	
Proteins, % energy intake	13.5	14.0	14.8*		13.9	13.8	14.2		14.9	14.2	13.9*	
Fat, % energy intake	15.5	17.0	16.8		14.5	15.5	17.6		16.3	16.7	16.8	
Carbohydrates, % energy intake	69.3	68.7	68.2		70.4	69.8	68.0		69.0	69.6	67.0	

All model was adjusted for age, education, smoking status, and menopausal status

1) Mean ± SE, significance as determined by GLM *$P < 0.05$

〈Table 4〉 Multivariate adjusted odds ratios (95% confidence intervals) for sarcopenia, obesity, and sarcopenic obesity by quintiles of food intake pattern scores

Variable	Healthy diet pattern - quintile Q1	(95% CI)	Q5	P for trend	Western diet pattern - quintile Q1	(95% CI)	Q5	P for trend	Unbalanced diet pattern - quintile Q1	(95% CI)	Q5	P for trend
Sarcopenia[1)]	1	(0.674 - 2.114)	1.194	0.278	1	(0.395 - 1.294)	0.715	0.340	1	(0.730 - 2.381)	1.319	0.216
obesity	1	(0.539 - 1.568)	0.919	0.987	1	(0.556 - 1.638)	0.954	0.426	1	(0.711 - 1.821)	1.138	0.939
Sarcopenic obesity	1	(0.584 - 1.600)	0.966	0.658	1	(0.533 - 1.467)	0.884	0.985	1	(1.050 - 2.801)	1.715	0.036

Q5 = the highest quintile of dietary pattern, Q1 = the lowest quintile of dietary pattern (reference)

[1)]All analyses were adjusted for age, education, smoking status, total MET score, and menopausal status

Ⅳ. DISCUSSION

Based on the data from food frequency questionnaire of the KNHANES, a factor analysis was conducted to determine the main dietary patterns of community-dwelling middle-aged women in Korea and their correlations with sarcopenia and sarcopenic obesity. In this analysis, three factors were extracted: “healthy diet pattern,” “western diet pattern,” and “unbalanced diet pattern.” With an increase in “unbalanced diet pattern” score, the prevalence of sarcopenic obesity increased.

In a previous study, a factor analysis of female adults aged > 40 years was conducted using data from the food frequency questionnaire of the 2001 KNHANES(Lee et al., 2008). In that analysis, three diet patterns were also extracted: healthy diet pattern, convenient food pattern, and alcohol pattern. Their results were similar to our results. In another Korean study, a traditional diet pattern mainly comprised of rice and Kimchi was extracted(Ahn et al., 2007). However, this type of dietary pattern was not extracted in our study. Instead, a dietary pattern that involved high consumption of alcohol was extracted. Therefore, women’s drinking habit might reflect their dietary pattern and changes in social phenomena.

In the present study, according to analysis on demographic and socioeconomic indicators, individuals with higher education levels with higher income were more likely to adhere to healthy diet patterns. This finding was consistent with results of several previous studies reporting that participants who adhered to healthy diet pattern attained a higher level of education, had higher income, and had more professional jobs(Hiza et al., 2013; Kamphuis et al., 2015). In the present study, the group with a higher western diet pattern score had higher income level, higher education, and more professional jobs. Therefore, appropriate nutritional education is needed regarding healthy eating habit in women with high level of social economic status.

Regarding calorie component ratio of three major nutrients in each dietary pattern, the percentage of calories obtained from proteins decreased with an increase in “unbalanced diet pattern” score. In addition, ASM mass and skeletal muscle-to-weight ratio decreased with an increase in “unbalanced diet pattern” score. To prevent aging-induced decrease in muscle mass, proper amounts of quality proteins should be consumed (Paddon-Jones et al., 2008; Paddon-Jones & Rasmussen, 2009). This study showed that inadequate intake of proteins can increase the risk of fat-free mass loss and physical function disorders. Unbalanced diet pattern featuring less intake of vegetables, fish, and meat, with high intake of alcohol and instant noodles was considered an inappropriate diet as it could not help preserve muscle mass due to deficiency of absolute intake of quality proteins. According to a study on the correlation between Korean female adults’ instant noodle intake and diseases, instant noodle intake had a positive correlation with the prevalence of abdominal obesity and metabolic syndrome(Shin et al., 2014). In addition, since the diet pattern comprised of “meat and alcohol” could increase calorie intake, the risk of metabolic syndrome was high. Accordingly, to maintain muscle mass and prevent obesity, it is necessary to consume less noodles and alcohol and follow a “healthy diet pattern”.

Regarding correlations between chronic diseases and dietary intake based on individual’s lifestyle, several studies have analyzed different food items included in each dietary pattern and their influence on the individual’s eating habits rather than simply determining the individual’s intake of each nutrient. According to a previous study on correlations between dietary patterns and chronic diseases, individuals who had high adherence to “healthy diet pattern” featuring high intake of fish, grains, fruits, and vegetables had lower risk of hypertriglyceridemia and cardiovascular disorders(Whitton et al., 2018; Neale et al., 2016). A previous study has reported that individuals with higher consumption of alcohol have lower diet quality and higher triglyceride levels(Song & Joung, 2012). The present study analyzed dietary patterns and health risk indicators. Results showed that “healthy diet pattern” had negative correlations with waist circumference, glycated hemoglobin, and triglyceride. However, with an increase in “unbalanced diet pattern” score, values of waist circumference, blood pressure, total cholesterol, and triglyceride increased. Therefore, to prevent chronic diseases, it is necessary to decrease alcohol consumption and eat a well-balanced diet that includes fish, eggs, vegetables, and fruits.

A decrease in skeletal muscle mass is among typical biological changes associated with aging. People’s skeletal muscles are reduced by approximately 8% annually at the age of 40. This reduction rate increases up to 15% when they reach the age of 70(Grimby & Saltin, 1983). Decreased muscle mass and muscle strength will decrease an individual’s ability to perform physical activities and total energy consumption that can trigger obesity. For this reason, the prevalence of sarcopenic obesity increases as people age. In individuals with sarcopenic obesity, high amounts of adipose tissues can increase the secretion of inflammatory factors by fat cells and insulin resistance. Therefore, these individuals have higher risk of metabolic diseases like metabolic syndrome compared with those who are considered healthy(Zamboni et al., 2008). In the present study, the risk of sarcopenic obesity increased in individuals with high “unbalanced diet pattern” scores. The accumulation of reactive oxygen species caused by oxidative stress has a high correlation with sarcopenia and sarcopenic obesity. To reduce oxidative stress, it is necessary to control dietary intake. Given that the intake of antioxidants such as carotenoid, vitamin E, and selenium has an inverse correlation with sarcopenia(Robinson et al., 2018), it is necessary to eat a variety of food products that can provide such nutrients to prevent and treat sarcopenia.

Ⅴ. SUMMARY AND CONCLUSION

This study had the following limitations. First, this study was a cross-sectional research using the KNHANES data. For this reason, it was difficult to establish the cause and effect relationship of dietary patterns with sarcopenia and sarcopenic obesity. To date, in order to diagnose sarcopenia, factors other than low muscle mass such as physical performance and grip strength are also taken into account. However, these factors were not included in this study. Second, in the analysis of dietary patterns, this study made use of the frequency of food intake based on of limited number of food items used in the food frequency questionnaire in order to extract factors. For this reason, this study failed to include more food products to analyze study participants’ dietary patterns. Third, this study was only conducted in women. Hence, it was difficult to apply results of this study in men who had different socioeconomic conditions or living habits from women. Nevertheless, this study is considered significant as it reveals correlations between middle-aged women’s sarcopenic obesity and their dietary patterns using representative data of Korean people.

Keywords : Dietary pattern, Body composition, Sarcopenia, Obesity, Sarcopenic obesity

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Received 10 December 2018;
Accepted 18 January 2019