Lower dietary variety is associated with worse sleep quality in community-dwelling elderly Japanese women

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ABSTRACT

Background and Objectives: Sleep disturbance is a common health problem in the elderly population. We examined the association between dietary variety and subjective sleep quality in community-dwelling elderly Japanese women. **Methods and Study Design:** This cross-sectional study recruited 160 community-dwelling elderly women aged ≥65 years. Subjective sleep quality and dietary variety were assessed by Pittsburg Sleep Quality Index (PSQI) and dietary variety score (DVS), respectively. DVS was calculated from the eating frequency of 10 food groups. Sleep disturbance was defined as PSQI score of ≥6. **Results:** The DVS in subjects with sleep disturbance was significantly lower than that of those without the disturbance (4.1±2.1 vs 5.3±2.1, $p<0.01$). In the multivariable regression model, the PSQI score was negatively correlated with the DVS score in age-adjusted model (standardized coefficient; −0.234, $p<0.01$). In the further adjusted model that included depression levels, the negative association between PSQI score and DVS score was retained (standardized coefficient; −0.211, $p<0.05$). Among 10 food groups comprising DVS, the eating frequency of soybean and soybean products was the determinant of sleep disturbance in the stepwise liner regression analysis. In the further model that contained DVS, DVS was the independent determinant of sleep disturbance, while the eating frequency of soybean and soybean products was excluded. **Conclusions:** A worse sleep quality was associated with lower DVS in elderly Japanese women. Diet comprising various food groups was better for sleep quality than consuming only a particular food in the elderly.

Key Words: dietary variety, dietary quality, elderly people, sleep disturbance, sleep quality

INTRODUCTION

In the 2019 Annual Report on the Aging Society, which was reported by Japan Cabinet Office, 28.1% of the population aged ≥65 years in 2018 in Japan, of which the population of ≥75 years (14.2%) is larger than that of 65-75 years (13.9%). In 2015, population of ≥80 years reached more than 10 million, and approximately 16 million is estimated by 2035. In fact, Japan now has a super-aged society.

Sleep disturbance in the elderly significantly increased the risks of cognitive decline and dementia,[1] cardiovascular diseases,[2] and all-cause mortality.[3] Furthermore, sleep quality has a huge influence on the quality of life in the elderly.[4]

Dietary variety refers to the number of foods or food groups consumed.[5] It is one of the key determinants of dietary quality. It is also associated with nutrient adequacies, especially energy, protein, and micronutrient adequacies.[6] In elderly women, a higher dietary variety score (DVS) is positively associated with body mass index (BMI).[7] Furthermore, a poor dietary variety can be a risk factor for poor physical performance, declined cognitive function and frailty in the elderly.[8-11] Taken together, dietary variety may be an important factor in elderly people's diets for their health preservation. Meanwhile, Kwon et al. reported that dietary variety declined in approximately 40% of the elderly people during an 8-year follow-up period, suggesting that aging not only decreases the amount of food intake but also worsens the dietary variety.[12]

Previous studies have demonstrated that poor sleep quality is associated with low protein intake[13,14] and high fat intake.[15,16] The association between sleep quality and carbohydrate intake, however, is controversial.[13,15,17,18] Higher sugar intake is related to poor sleep quality, whereas higher intake of fruits and vegetable and dairy products is demonstrated to be related to good sleep quality.[16,17,19] Healthy eating patterns, including adherence to the Mediterranean diet, and higher diet quality index have also been associated with good sleep quality.[20,21]

However, the association between sleep quality and dietary variety in the elderly is poorly understood. Hence, we examined the association between dietary variety and subjective sleep quality in community-dwelling elderly Japanese women in this cross-sectional study.

MATERIALS AND METHODS

Study participants

This study was conducted in a suburban area of the metropolis in western Japan. The study subjects participated in an annual health examination which we conducted in seven community-centers from September 2017 to October 2017. The participants were community-dwelling elderly people living alone and volunteers who attended voluntary lunch events in the community. Inclusion criteria of this study were female gender and an age of ≥65 years. Of 182 participants in the examination, a total of 170 female participants who were ≥65 years old were recruited. However, 10 participants were excluded: 6 due to incomplete questionnaires and 4 due to lack of blood pressure data. Thus 160 subjects were included in this study analysis. They provided information on age; sex, present illness status; smoking status; habitual alcohol use; and habitual outing. The study protocol for this cross-sectional study was approved by the Ethics Committees of Mukogawa Women's University (No.11-7).

All of them individually provided a written informed consent before study participation. The number of participants who received the health examination determined the sample size.

Anthropometric and laboratory measurements

The anthropometric measurements were conducted in the morning. The measurements included height, weight, skeletal muscle mass, and blood pressure. To measure weight and skeletal muscle mass, the InBody 430 body composition analyzer (BioSpace Inc., Cerritos, CA, USA) was used. The BMI was calculated as weight (in kilograms) divided by height (in meters) squared. The skeletal muscle mass index (SMI) was calculated as skeletal muscle mass (in kilograms) divided by height (in meters) squared. An automatic device (HBP-203RV, Omron Colin Co., Kyoto, Japan) was used to measure blood pressure once in one arm while the participant was sitting. Well-trained staff of our institution recorded the anthropometric data. Blood samples were drawn before the anthropometric assessments in the morning (from 10:00 AM to 11:00 AM), with or without overnight fasting. In addition, serum biochemical data were evaluated using standard laboratory methods in a fasting or nonfasting state (LSI Medience Corp., Tokyo, Japan).

Subjective sleep quality measurements

We assessed the subjective sleep quality using the Pittsburgh Sleep Quality Index (PSQI).[22,23] Participants described the time when they regularly went to bed, when they needed to fall into sleep, when they usually got up, and the actual sleep duration. Sleep duration, sleep efficiency, and sleep latency were calculated with these four questions. Subjects marked the frequencies of sleeping difficulty due to various reasons, sleep medication, and daytime sleepiness. In addition, we evaluated their subjective sleep quality and daytime dysfunction. Using all these questions, we calculated the global PSQI score.

Depression measurements

To assess the level of depression, we asked the participants to complete the Japanese version of the 15-item Geriatric Depression Scale (GDS15).

Dietary variety assessments

We assessed the habitual dietary variety according the DVS developed for the general elderly Japanese people by Kumagai et al.[24] Subjects reported the intake frequencies of 10 food groups during the preceding week, namely fish and seafood, meats, eggs, daily products, soybean and soybean products, green and yellow vegetables, seaweed, potatoes, fruits, and fat or oils. The frequency of intake for each food group was divided into the following four choices: “eat almost every day,” “eat once every 2 days,” “eat 1 or 2 days a week,” and “hardly eat at all.” DVS was calculated as follows: “eat almost every day” was scored 1, and other choices were scored 0; then, DVS was expressed as the sum of the 10 food groups’ scores. The higher the DVS score, the higher the dietary variety. None of the participants abstained from eating all animal foodstuffs including fish/shellfish, meats, eggs, or milk in this study.

Statistical analysis

We divided the subjects into two groups: those with or without sleep disturbance, which was referred as a PSQI score of ≥6.[22,23] For the characteristics of study participants, quantitative variables are expressed as the mean ± standard deviation (SD) (median). Categorical variables are expressed as numbers (percentage). The subjects with or without sleep disturbance were compared using the Mann–Whitney U test for the quantitative variables and chi-squared test for the categorical variables. Age-adjusted and multivariable-adjusted correlations between the PSQI score and DVS score were analyzed by multivariable linear regression analysis. The covariates of multivariable-adjusted correlations were age (increased by 5 years), lower BMI (<21.5 kg/m^2), lower SMI (<5.7 kg/m^2), higher systolic blood pressure (≥140 mmHg), higher diastolic blood pressure (≥90 mmHg), lower serum albumin (<4.3 mg/dl, the median value), current smoking status (yes or no), habitual alcohol drinking (yes or no), habitual outing (yes or no), morbidities (diabetes, hypertension, and dyslipidemia), lower serum albumin (<3.5 g/dl), tertile of estimated glomerular filtration rate and GDS score (continuous variable). Morbidities, such as diabetes, hypertension, and dyslipidemia were assessed with the question about present illness status. Low BMI was defined as <21.5 kg/m^2 in this study because the recommended BMI range for older people has been established as 21.5–24.9 kg/m^2 to prevent frailty, according to the Dietary Reference Intakes for Japanese (2020).[25] “Habitual outing” was defined in this study as going out for more than 30 min every day. Habitual outing included a combination of outdoor social activities and physical activity. Eating frequencies of 10 food groups between the two groups were compared using the chi-squared test. Finally, we used the stepwise multiple liner regression analysis to analyze the determinants of sleep disturbance. All statistical data were analyzed using the IBM SPSS Statistics 22.0 (IBM Corp., Armonk, NY, USA). Two-tailed p values of <0.05 were considered statistically significant.

RESULTS

Profile of study participants

The characteristics of the overall participants and of participants with or without sleep disturbance are shown in Table 1. In overall participants, the averages ± SDs (medians) of age, BMI, and SMI were 80.4±5.7 (81) years, 22.7±3.1 (22.4) kg/m^2 and 5.60±0.70 (5.57) kg/m^2, respectively. The average PSQI score was 5.2±3.5, and the number of sleep disturbance, which was defined as subjects with PSQI score ≥6, was 59 (36.9%). Age, anthropometric parameters, hematological data, and ratios of morbidities were not different between the non-sleep disturbance and sleep disturbance group. Furthermore, the GDS score in the sleep disturbance group was significantly higher than that in the non-sleep disturbance group (4.6±3.3 (4.0) vs 3.5±2.6 (3.0), $p<0.05$). In addition, the frequency of scores of ≥5 on the GDS, which indicate depression, was significantly higher in the participants with sleep disturbance group than those without sleep disturbance (44.1% vs 27.7%, $p<0.05$).

Among the overall participants, the average±SD of the DVS was 4.9±2.2. Interestingly, the DVS score in the sleep disturbance group was significantly lower than that in the non-sleep disturbance group (4.1±2.1 (4.0) vs 5.3±2.1 (5.0), $p<0.01$). Moreover, the ratio of subjects with lower DVS defied as <4 point24 in the sleep disturbance group was significantly higher than that in the non-sleep disturbance group (62.7% vs 36.6%, $p<0.01$). Thus, dietary variety was worse in subjects with sleep disturbance than those without the disturbance.

Association between the PSQI score and DVS score

Table 2 presents the associations between the PSQI score and DVS in the multivariate linear regression analysis. The PSQI score negatively correlated with the DVS score in age-adjusted model (standardized coefficient, −0.373; $p<0.01$). This negative association between the PSQI score and DVS remained significant after adjustment for relevant variates, including age, BMI, SMI, blood pressure, current smoking status, habitual alcohol drinking, habitual of going out, morbidities of diabetes, hypertension and dyslipidemia, and estimated renal function (standardized coefficient, −0.388; $p<0.01$). Moreover, the association between the PSQI score and DVS remained unchanged after additional adjustment was made with GDS score, which reported as strong covariate for sleep quality[26] (standardized coefficient; −0.388, $p<0.01$). Therefore, a higher DVS score was related to a lower PSQI score in community-dwelling elderly Japanese women.

Differences of eating frequencies of 10 food groups between non-sleep disturbance and sleep disturbance group

We analyzed the differences in the eating frequencies of 10 food groups. As shown in Table 3, the eating frequencies of eggs, soybean and soybean products, green and yellow vegetables, and fruits in the sleep disturbance group were significantly lower than those in the non-sleep disturbance group. The eating frequencies of fish and seafood, meats, daily products, seaweed, potatoes, and fat and oil showed no difference between the two groups.

Stepwise multiple linear regression analysis of PSQI score

We conducted stepwise multiple linear regression analysis to examine the independent determinants of PSQI score in elderly Japanese women. We constructed model 1, which included input variables including age, BMI, SMI, systolic blood pressure, diastolic blood pressure, serum albumin, current smoking status, habitual alcohol drinking, habitual going out, morbidities, renal function, GDS score, and the eating frequency of 10 food groups. As shown in Table 4, the eating frequency of soybean and soybean products (standardized coefficient; −0.178, $p<0.05$) and GDS score (standardized coefficient; 0.171, $p<0.05$) remained as the independent determinants of PSQI score in this model. Further analysis was conducted using model 1 plus DVS score. Intriguingly, DVS score (standardized coefficient; −0.212, $p<0.01$) and GDS score (standardized coefficient; 0.210, $p<0.01$) remained as the independent determinants, whereas the eating frequency of soybean and soybean products was excluded from this model. Therefore, soybean and soybean products may have the largest influence on the sleep quality of the 10 food groups. However, dietary variety which refers to eating various food groups may have an impact greater than eating a particular food group.

DISCUSSION

In this study, the PSQI score, which assessed the subjective sleep quality, was negatively associated with the DVS score in community-dwelling elderly Japanese women. Importantly, this association remained after adjustment with the GDS score, which evaluated the level of depression. To the best of our knowledge, this is the first study to show that the subjective sleep quality is associated with the dietary variety in community-dwelling elderly people. Among 10 food groups, the eating frequency of soybean and soybean products was the independent determinant of subjective sleep quality. Interestingly, the DVS score had greater impact on subjective sleep quality than soybean and soybean products, suggesting that diet comprising various food groups was better for sleep quality than consuming only a particular food in this study population.

Dietary variety has been reported to be associated with physical performance, cognitive function, BMI, and frailty in elderly people.[8-12] It was considered that higher DVS contributes to better nutritional status due to higher intakes of energy and protein in these reports. In addition, many nutrients interact with other nutrients in various metabolic processes. Then, the diet with multiple foods together might be considered to have the greater positive effect on health outcomes.[27]

In our study, we used the DVS, developed to assess the habitual dietary variety of elderly Japanese people in general.[24] The 10 food groups in the DVS include foods frequently included in Japanese meals, except for rice and other grains. Narita et al analyzed the DVS and nutrient intakes with dietary records in older Japanese adults.[28] They found that DVS was positively associated with energy and amount of total protein intake and negatively associated with amount of carbohydrate intake. Lower DVS was related to diets with a lower ratio of protein and a higher ratio of carbohydrate. Several reports have shown the association between sleep quality and intake of dietary protein and carbohydrate. Low protein intake was related to difficulty in falling asleep and poor quality of sleep in Japanese workers. In experimental studies, a high-protein diet was associated with shorter wakeful episodes, and a diet with a higher ratio of protein improved sleep quality.[14] Although the association between sleep quality and carbohydrate intake has been controversial in observational studies, sleep restriction was associated with increasing appetite for calorie-dense foods with high carbohydrate content, including starchy foods and confectionery foods, in an experimental study. Going to bed earlier increased intake of food with a low glycemic index in adolescents with late bedtimes.[29] Therefore, a lower DVS in association with poor sleep quality might reflect undesirable ratios of protein and carbohydrate in the diet.

Of interest was that the DVS was positively associated with magnesium intake in older Japanese adults.[28] Magnesium is the modulator of N-Methyl-D-aspartic acid receptor, which mediates sleep regulation.[30,31] Magnesium supplementation alone was also found to ameliorate insomnia severity, sleep onset latency, and sleep efficacy, along with increased serum melatonin and decreased serum cortisol, in the elderly in a randomized experimental study.[32] In our study, daily consumption of soybeans and soybean products, which contain considerable amounts of magnesium, showed the strongest interaction with sleep disturbance, with a PSQI score of ≥ 6 (Table 3). Therefore, lower DVS in association with poor sleep quality might reflect lower magnesium intake.

While the eating frequency of soybean and soybean products was the independent determinant of PSQI score in a stepwise multiple linear regression analysis, the DVS was a stronger determinant than soybean and soybean products (Table 4). This result suggested that diet comprising various food groups was better for sleep quality than consuming a particular food in this study population. Together, our findings indicate that a high-variety diet might enhance sleep quality in elderly women.

Meanwhile, this study has several limitations. First, the DVS does not account for quantitative dietary intake. Although the associations between dietary variety and nutritional intake have already been studied,[6,33-35] we did not examine them in our study. In our study population, almost all participants were in preferred nutritional status; only one participant had <3.5 g/dL of serum albumin level. Therefore, we could not discuss the effect of inadequate nutrition quantity on the association between DVS and sleep quality. Second, this study could not reveal the causal relationship between sleep quality and dietary variety, given the cross-sectional design. This association should be verified by a future randomized experimental study using diet intervention with a high dietary variety planned by a dietitian. Third, the study was limited by the sample size (n=160). The study subjects were the participants of our annual health examination, suggesting that the study relatively included many subjects having health awareness. Fourth, the objective data of sleep were not measured. However, the PSQI is clearly reliable and valid,[36] and subjective sleep quality has a clinical significance.

In conclusion, this study showed that a lower DVS was associated with sleep disturbance in community-dwelling elderly Japanese women. Maintaining a high dietary quality, which is the diet with more variety, would be important to not only to the elderly's sleep quality but also to their health and quality of life. Considering that selecting food from the food group is easier than thinking of diet in the nutritional level in general population, dietary variety might be an excellent educational tool to improve one's nutritional balance and sleep quality.

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AUTHOR DISCLOSURE

The authors declare no conflict of interest.

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Table 1. Characteristics of the study participants (n=160)

	Overall subjects (n=160) Mean±SD (median) or number (%)	Subjects without sleep disturbance PSQI score <6 (n=101) Mean±SD (median) or number (%)	Subjects with sleep disturbance PSQI score ≥6 (n=59) Mean±SD (median) or number (%)	*p*
Age, years†	80.4±5.7 (81)	80.3±6.0 (81.0)	80.6±5.4 (81.0)	0.996
Height, m†	1.49±0.58 (1.49)	1.49±0.58 (1.49)	1.50±0.59 (1.50)	0.516
Weight, kg†	50.5±7.8 (51.0)	50.0±7.9 (49.6)	51.4±7.5 (51.2)	0.361
BMI, kg/m^2†	22.7±3.1 (22.4)	22.6±3.3 (22.2)	22.9±2.7 (22.9)	0.464
<21.5 kg/m^2‡§	53 (33.1)	36 (35.6)	17 (28.8)	0.636
21.5–24.9 kg/m^2	77 (48.1)	46 (45.5)	31 (52.5)	
≥25 kg/m^2	30 (18.8)	19 (18.8)	11 (18.6)	
Lower BMI, <21.5 kg/m^2‡	53 (33.1)	36 (35.6)	17 (28.8)	0.391
SMI, kg/m^2†	5.60±0.70 (5.57)	5.60±0.71 (5.61)	5.59±0.70 (5.54)	0.670
Lower SMI, <5.7 kg/m^2‡	93 (58.1)	56 (55.4)	37 (62.7)	0.409
SBP, mmHg†	148.0±20.5 (146.5)	149.0±22.1 (146.0)	146.1±17.2 (148.0)	0.779
High SBP, ≥140 mmHg‡	106 (66.3)	65 (64.4)	41 (69.5)	0.604
DBP, mmHg†	85.0±13.0 (84.0)	85.9±14.2 (86.0)	83.4±10.6 (83.0)	0.331
High DBP, ≥90 mmHg‡	56 (35.0)	41 (40.6)	15 (25.4)	0.060
Current smoker‡	5 (3.1)	3 (3.0)	2 (3.4)	1.000
Habitual alcohol drinker‡	17 (10.6)	12 (11.9)	5 (8.5)	0.601
Habitual outing‡	78 (48.8)	46 (45.5)	32 (54.2)	0.327
Morbidity				
Diabetes‡	13 (8.1)	7 (6.9)	6 (10.2)	0.552
Hypertension‡	57 (35.6)	33 (32.7)	24 (40.7)	0.311
Dyslipidemia‡	21 (13.1)	13 (12.9)	8 (13.6)	1.000
Serum total protein, g/dl‡	7.4±0.4 (7.3)	7.3±0.4 (7.3)	7.4±0.4 (7.4)	0.447
Serum albumin, g/dl†	4.3±0.3 (4.3)	4.3±0.3 (4.3)	4.3±0.3 (4.3)	0.546
Serum creatinine, mg/dl†	0.74±0.21 (0.70)	0.72±0.19 (0.70)	0.76±0.23 (0.70)	0.522
eGFR, ml/min/1.73 m^2†	61.3±16.1 (60.6)	62.0±15.4 (60.7)	60.2±17.3 (60.2)	0.538
Blood urea nitrogen level, mg/dl†	16.9±4.8 (16.5)	16.9±4.8 (16.1)	16.9±4.8 (17.2)	0.889
GDS score†	3.9±3.0 (3.0)	3.5±2.6 (3.0)	4.6±3.3 (4.0)	<0.05
GDS score ≥5‡	54 (33.8)	28 (27.7)	26 (44.1)	<0.05
Dietary variety score†	4.9±2.2 (5.0)	5.3±2.1 (5.0)	4.1±2.1 (4.0)	<0.01
Lower dietary variety score, <4 point‡	74 (46.3)	37 (36.6)	37 (62.7)	<0.01
Sleep latency, minutes†	22.2±27.9 (15.0)	12.0±9.8 (10.0)	39.8±38.3 (30.0)	<0.01
Sleep duration, hour:minutes†	6:27±1:21 (6:27)	6:52±1:08 (7:00)	5:45±1:25 (6:00)	<0.01
PSQI score†	5. 2± 3.5 (5.0)	3.1±1.5 (3.0)	8.9±2.8 (8.0)	<0.01

BMI: body mass index; DBP: diastolic blood pressure; eGFR: estimated glomerular filtration rate; GDS: geriatric depression scale; PSQI: Pittsburgh Sleep Quality Index; SBP: systolic blood pressure; SMI: skeletal muscle mass index.
Continuous variables are expressed as average ± SD (median). Categorical variables are expressed as number (%). †Mann–Whitney U-test ‡ X^2 test § The recommended BMI range for older people has been established as 21.5–24.9 kg/m^2 to prevent frailty, according to the Dietary Reference Intakes for Japanese (2020).

Table 2. Multivariate regression analysis of PSQI score (n=160)

Variates	Unstandarized coefficients		Standarized coeffients	p
	B	95% CI (lower, upper)		
Age-adjusted model				
Dietary variety score	−0.373	−0.618, −0.128	−0.234	<0.01
Multivariate model 1[†]				
Dietary variety score	−0.391	−0.646, −0.136	−0.245	<0.01
Multivariate mode 1[†] + GDS score				
Dietary variety score	−0.336	−0.590, −0.082	−0.211	<0.05

BMI: body mass index; DBP: diastolic blood pressure; eGFR: estimated glomerular filtration rate; GDS: geriatric depression scale; PSQI: Pittsburgh Sleep Quality Index; SBP: systolic blood pressure; SMI: skeletal muscle mass index.
[†]Other variables in the multivariate model were age (increase by 5 years), lower BMI (<21.5 kg/m^2), lower SMI (<5.7 kg/m^2), higher SBP (≥140 mmHg), higher DBP (≥90 mmHg), lower serum albumin level (<4.3 mg/dl), current smoking status (yes or no), habitual alcohol drinking (yes or no), habitual outing (yes or no), morbidities (diabetes, hypertension, and dyslipidemia), and tertile of eGFR

Table 3. Eating frequency of each food category according to PSQI score

	PSQI score	Eating frequency				$p^{\dagger}$
		Almost every day	Once every 2 days	1 or 2 days a week	Rarely	
Fish and seafood						0.093
	<6	34 (33.7)	42 (41.6)	22 (21.8)	3 (3.0)	
	≥6	12 (20.3)	22 (37.3)	23 (39.0)	2 (3.4)	
Meats						0.263
	<6	31 (30.7)	42 (41.6)	23 (22.8)	5 (5.0)	
	≥6	14 (23.7)	23 (39.0)	21 (35.6)	1 (1.7)	
Eggs						0.005
	<6	56 (55.4)	21 (20.8)	24 (23.8)	0 (0.0)	
	≥6	21 (35.6)	17 (28.8)	16 (27.1)	5 (8.5)	
Daily products						0.689
	<6	77 (76.2)	6 (5.9)	6 (5.9)	12 (11.9)	
	≥6	45 (76.3)	2 (3.4)	6 (10.2)	6 (10.2)	
Soybean and soybean products						<0.01
	<6	70 (69.3)	15 (14.9)	14 (13.9)	2 (2.0)	
	≥6	23 (39.0)	17 (28.8)	16 (27.1)	3 (5.1)	
Green and yellow vegetables						<0.05
	<6	84 (83.2)	12 (11.9)	4 (4.0)	1 (1.0)	
	≥6	38 (64.4)	17 (28.8)	4 (6.8)	0 (0.0)	
Seaweed						0.423
	<6	31 (30.7)	32 (31.7)	31 (30.7)	7 (6.9)	
	≥6	12 (20.3)	19 (32.2)	21 (35.6)	7 (11.9)	
Potatoes						0.274
	<6	23 (22.8)	34 (33.7)	38 (37.6)	6 (5.9)	
	≥6	13 (22.0)	12 (20.3)	30 (50.8)	4 (6.8)	
Fruit						<0.05
	<6	72 (71.3)	20 (19.8)	9 (8.9)	0 (0.0)	
	≥6	35 (59.3)	13 (22.0)	6 (10.2)	5 (8.5)	
Fat and oil						0.078
	<6	61 (60.4)	20 (19.8)	14 (13.9)	6 (5.9)	
	≥6	27 (45.8)	9 (15.3)	16 (27.1)	7 (11.9)	

PSQI: Pittsburgh Sleep Quality Index.
Data are expressed as number (%).
[†]p values were estimated with X^2 test.

Table 4. Stepwise multiple linear regression analysis of PSQI score (n = 160)

Variates	Unstandardized coefficients		Standardized confidents	*p*
	B	95% CI (lower, upper)		
Model 1†				
Soybean and soybean products	−0.706	−1.346, −0.066	−0.178	<0.05
GSD score	0.203	0.011, 0.396	0.171	<0.05
Model 1† + DVS score				
DVS score	−0.338	−0.578, −0.098	−0.212	<0.01
GDS score	0.250	0.071, 0.430	0.210	<0.01

BMI: body mass index; DBP: diastolic blood pressure; eGFR: estimated glomerular filtration rate; GDS: geriatric depression scale; PSQI: Pittsburgh Sleep Quality Index; SBP: systolic blood pressure; SMI: skeletal muscle mass

†Age (increase by 5 years), lower BMI (<21.5 kg/m2), lower SMI (<5.7 kg/m2), higher SBP (≥140 mmHg), higher DBP (≥90 mmHg), lower serum albumin level (<4.3 mg/dl), current smoking status (yes or no), habitual alcohol drinking (yes or no), habitual outing (yes or no), morbidities (diabetes, hypertension, and dyslipidemia), tertile of eGFR, GDS score (continuous), eating frequency of fish and seafoods, meats, eggs, daily products, green and yellow vegetables, soybean and soybean products, seaweed, potatoes, fruit and milk each were included in this model. Variables not shown were excluded from the model.