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Association of dietary phytochemical index with sleep quality in older adults of Amirkola city

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Abstract

Background: Diet can play a significant role in sleep regulation, particularly in older adults. This study aimed to investigate the association between the Dietary Phytochemical Index (DPI) and sleep quality among the elderly in Amirkola City.

Methods: This case-control study was part of the second phase of the Amirkola Cohort Study on aging. A total of 800 elderly individuals aged ≥60 years (400 with good sleep quality and 400 with poor sleep quality, matched for age and sex) were randomly selected. Inclusion criteria comprised having complete demographic data in the cohort profile, no known history of malignancy (including gastric and intestinal cancers), absence of psychiatric or cognitive disorders (such as psychiatric hospitalization), and no drug addiction. Data were collected using the Pittsburgh Sleep Quality Index (PSQI) and a semi-quantitative food frequency questionnaire (SQ-FFQ), which were then analyzed statistically.

Results: Total energy intake and the number of chronic diseases significantly impacted sleep quality (OR=1.002, 95% CI: 1.001-1.003, P = 0.004 and OR=1.257, 95% CI:1.170-1.352, p < 0.001, respectively). Furthermore, Poorer sleep quality was significantly associated with a higher number of chronic diseases in both gender, male and female (OR=1.244, 95% CI: 1.097-1.411, P = 0.001 and OR=1.225, 95% CI: 1.106-1.357, P < 0.001). However, Dietary Phytochemical Index (DPI) and Energy intake from plant sources did not show a significant effect on sleep quality.

Conclusion: Dietary modifications and management of chronic diseases could be effective in improving sleep quality among the elderly. However, further research is recommended.

Keywords: Sleep quality, Phytochemicals, Aged, Elderly.

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The population of the world is aging, a trend significantly influencing both individuals and societies. Advances in medical knowledge have increased life expectancy, thereby raising the number of older adults. According to the World Health Organization (WHO), old age is defined as that >60 years in developing countries and >65 years in developed countries (1, 2). WHO has reported that by 2030, one in six people globally will be ≥60 years or older. In Iran, the elderly population was 5% in 1976, which increased to 10.2% in 2016 and to 10.4% in 2021 (1). Poor sleep quality is one of the most common issues the elderly face. Research indicates that after headache and gastrointestinal disorders, low sleep quality ranks third among health problems of the elderly (3). Sleep is a physiological process as well as a vital mechanism for the restoration and recovery of neurological and physiological system functions (4). The circadian rhythm of sleep is affected by aging. In older adults, the sleep phase advances, leading to earlier sleep onset, early awakening, and daytime sleepiness; however, these changes in sleep structure are not necessarily pathological (5).

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This suggests that sleep disturbances in the elderly are not an intrinsic component of aging (5), but are influenced by multiple factors, including various Chronic diseases, medications, psychosocial factors, and environmental changes such as hospitalization or nursing home residence (6). Poor sleep (insufficient duration or low quality) is associated with hypertension, obesity, diabetes, dyslipidemia, and metabolic syndrome (7) . Researchers emphasize the importance of regular sleep for reducing the risk of cardiovascular diseases, obesity, high blood pressure, and other conditions (8).

Diet may play a role in sleep regulation. Some studies have suggested that the consumption of plant-based foods and food groups such as fruits, vegetables, dietary fiber, and whole grains could improve sleep quality (9). Plant compounds contain phytochemicals; these are naturally occurring chemicals in plants that possess therapeutic or disease-preventive properties. These compounds are primarily found in plant-based foods like fruits, vegetables, grains, nuts, legumes, soy, olive oil, and tea. The effects of phytochemicals can be attributed to their antioxidant and anti-inflammatory properties, as well as influence on cell cycle regulation, hormones, vascular endothelium, and immune cells (10). McCarty introduced the Dietary Phytochemical Index (DPI) to quantify the phytochemical properties of the diet to provide a dietary reflecting the total phytochemical content of meals. The DPI is defined as the percentage of daily energy intake derived from phytochemical-rich foods (10, 11).

Unhealthy dietary patterns and physical inactivity are modifiable risk factors that, if corrected, may improve mental health outcomes; among dietary factors, foods rich in phytochemical compounds reduce the risk of mental health disorders (12). Previous studies have examined the association between DPI with risk factors for chronic diseases, indicating an inverse relationship between DPI and waist circumference, body mass index (BMI), hypertension, glucose intolerance, prediabetes likelihood, dyslipidemia, blood biomarkers, metabolic syndrome, type 2 diabetes, cancers, and cardiovascular disease (CVD) risk factors (13-17). The Dietary Phytochemical Index may have a significant correlation with sleep quality, especially in the elderly. Given the limited number of studies on the relationship between phytochemical index and sleep quality and considering the specific dietary patterns and cultural differences in Mazandaran Province, this study was conducted to investigate the association between Dietary Phytochemical Index and sleep quality in older adults using the Pittsburgh Sleep Questionnaire.

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Methods

Study design: This case-control study was conducted as part of the second phase of the Amirkola Cohort Study on aging. The research compared two groups: one with poor sleep quality (cases) and one with good sleep quality (controls) who were matched for age and sex.

Participants: This study included 800 elderly individuals aged ≥60 years from Amirkola city. The participants were divided into two groups: 400 individuals with poor sleep quality (PSQI score ≥ 5) and 400 individuals with good sleep quality (PSQI score < 5). The inclusion criteria were as follows: complete demographic data in the cohort profile, no known history of malignancy (including gastric and intestinal cancers), no record of psychiatric or cognitive disorders (such as hospitalization in a psychiatric ward), no drug addiction, and providing informed consent. Incomplete data was considered an exclusion criterion. Participants were randomly selected from a pool of 2135 individuals and matched by age and gender groups.

Data collection: Demographic information, including age, gender, education, marital status, living situation, and number of chronic diseases such as diabetes, hypertension, history of stroke, and Parkinson's was collected via a questionnaire. Sleep quality was assessed using the Pittsburgh Sleep Quality Index (PSQI) (18, 19). Dietary data were collected using a semi-quantitative food frequency questionnaire (SQ-FFQ) (20). Energy and nutrient intakes were assessed using Nutritionist 4 software based on the Iranian food composition table. Energy intake from phytochemical-rich foods [including fruits, vegetables (except for potatoes), legumes, whole grains, nuts, soy products, olive oil, olives, natural fruit and vegetable juices] was calculated separately. The Dietary Phytochemical Index (DPI) was then calculated using McCarty's (11) formula:

$$DPI = (\text{Energy from phytochemical-rich foods} / \text{Total daily energy intake}) \times 100$$

This study was approved by Ethics Committee of Babol University of Medical Sciences with the following code: code: IR.MUBABOL.REC.1402.133.

Data analysis: Data were analyzed using SPSS software (Version 25). Appropriate statistical tests, including the chi-square test, independent t-test, and Mann-Whitney U test, were used for group comparisons. Multiple logistic regression analysis was employed to adjust for potential confounders and predict sleep quality based on the studied variables. A p-value< 0.05 was considered statistically significant.

Results

In this case-control study, 800 elderly people from the Amirkola Cohort Project (APHP) data with a mean age of 71.44±8.06 years (range: 60-95 years) were randomly selected. The case group consisted of 400 (50%) elderly individuals with poor sleep quality (PSQI score > 5), and the control group consisted of 400 individuals with good sleep quality (PSQI score ≤ 5). The mean total PSQI score was 4.65±2.21, indicating relatively favorable overall sleep quality among the participants. However, the presence of minimum (0) and maximum (13) scores indicated considerable variation in sleep experiences. As shown in table 1, out of 800 participants, 540 (67.5%) were aged >75 years, 400 (50%) were females, 645 (80.6%) were married, and 706 (88.3%) lived with others.

Table 1. Frequency distribution of demographic variables in the elderly of Amirkola

Variable	Category	Frequency	N
Age	75>	67.5%	**540**
	75≤	32.5%	**260**
Sex	female	50.0%	**400**
	male	50.0%	**400**
Marital Status	Unmarried	19.4%	**155**
	Married	80.6%	**645**
Education Level	Illiterate	64.9%	**519**
	Primary	20.4%	**163**
	Up to Diploma	9.1%	**73**
	University	5.6%	**45**
Living Alone	Yes	11.8%	**94**
	No	88.3%	**706**

The mean±standard deviation of age was 71.7±11.96 years in the control group and 71.8±15.76 years in the case group. The case and control groups were matched for age and sex, indicating a balanced distribution of sleep quality across these demographic strata (P > 0.05). Findings regarding the association between demographic variables and sleep quality revealed that marital status did not have a significant impact on sleep quality. Out of 155 unmarried individuals, 78 (50.3%) had good sleep quality and 77 (49.7%) had poor sleep quality. Among the 645 married participants, 322 (49.9%) had good sleep quality but 323 (50.1%) had poor sleep quality. This difference was not statistically significant (P = 0.929). Education level also showed no significant association with sleep quality (P = 0.131). In the illiterate group, 47.0% had good sleep quality and 53.0% had poor sleep quality. In the primary education group, 57.1% had good and 42.9% had poor sleep quality. In the group with education up to high school diploma, 53.4% had good and 46.6% had poor sleep quality. In the university-educated group, 53.3% had good and 46.7% had poor sleep quality. Living status also did not significantly affect sleep quality (P = 0.826). Among the elderly living with others (n=706), 50.1% had good sleep quality and 49.9% had poor sleep quality. Among those living alone (n=94), 48.9% had good and 51.1% had poor sleep quality. In contrast, the number of chronic diseases showed a significant association with sleep quality (p < 0.001). The median number of diseases was significantly lower in individuals with good sleep quality [3 (IQR: 2-4.75)] compared to those with poor sleep quality [4 (IQR: 2-5)].

Stratified analysis by gender showed that among men, in the age group <75 years, 50.8% had good sleep quality and 49.2% had poor sleep quality, while in the age group >75 years, 48.7% had good and 51.3% had poor sleep quality (P = 0.682). Marital status also had no significant effect on sleep quality in men (P = 0.249). Education level (P = 0.694) and living status (P = 0.535) were not significantly associated with sleep quality in men, either. Among women, those aged >75 years had poorer sleep quality compared to those <75 years and this difference was statistically significant (P = 0.040). Marital status (P = 0.376), education level (P = 0.025), and living status (P = 0.895) also showed no significant association with sleep quality in women.

In examining the relationship between the number of diseases and sleep quality by gender, the median of Chronic diseases was significantly lower in men with good sleep quality [3 (IQR: 1-4)] compared to men with poor sleep quality [3 (IQR: 2-5)] (P = 0.002). Similarly, in women, the median was lower in those with good sleep quality [3 (IQR: 2-2.14)] than in those with poor sleep quality [5 (IQR: 3-6)] (p < 0.001 (table 2). Analysis of nutritional variables revealed that the mean total energy intake was higher in the group with poor sleep quality (1496.01±415.25 kcal) compared to the group with good sleep quality (1429.75±305.92 kcal); however, this difference was not statistically significant (P = 0.069). Similarly, for the variable energy intake from plant sources (P = 0.714) and the phytochemical index (P = 0.978), the mean differences between the two groups were not statistically significant.

Table 2. The relationship between demographic variables and sleep quality (PSQI) in the elderly of Amirkola Cohort Study

Variables		Total			Female			Male		
		Poor (PSQI score ≥ 5)	Good (PSQI score< 5)	p-value*	Poor (PSQI score ≥ 5)	Good (PSQI score< 5)	p-value*	Poor (PSQI score ≥)	Good (PSQI score< 5)	p-value*
Age, n (%)	75<	(48.0%) 259	(52.0%) 281	0.097	(47.0%) 139	(53.0%) 157	0.040	(49.2%) 120	(50.8%) 124	**0.682**
	≥75	(54.2%) 114	(45.8%) 119		(58.7%) 61	(41.3%) 43		(51.3%) 80	(48.7%) 76	
Marital Status, n (%)	Unmarried	(49.7%) 77	(50.3%) 78	0.929	(46.5%) 53	(53.5%) 61	0.376	(58.5%) 24	(41.5%) 17	**0.249**
	Married	(50.1%) 323	(49.9%) 322		(51.4%) 147	(48.6%) 139		(49.0%) 176	(51.0%) 183	
Education Level, n (%)	Illiterate	(53.0%) 275	(47.0%) 244	0.131	(54.8%) 154	(45.2%) 127	0.025	(50.8%) 121	(49.2%) 117	**0.694**
	Primary Education	(42.9%) 70	(57.1%) 93		(41.0%) 34	(59.0%) 49		(45.0%) 36	(55.0%) 44	
	Up to Diploma	(46.6%) 34	(53.4%) 39		(32.1%) 9	(67.9%) 19		(55.6%) 25	(44.4%) 20	
	University	(46.7%) 21	(53.3%) 24		(37.5%) 3	(62.5%) 5		(48.6%) 18	(51.4%) 19	
Living Alone, n (%)	Yes	(49.9%) 352	(50.1%) 354	0.826	(49.3%) 34	(50.7%) 35	0.895	(56.0%) 14	(44.0%) 11	**0.535**
	No	(51.1%) 48	(48.9%) 46		(50.2%) 166	(49.8%) 165		(49.6%) 186	(50.4%) 189	
Chronic Disease Median (IQR)		4 (2-5)	3 (2-4.75)	<0.001	5 (3-6)	3 (2-2.14)	0.002	3 (2-5)	3 (1-4)	**<0.001**

Table 3. Investigation of the relationship between nutritional variables and sleep quality (PSQI) in the elderly of the Amirkola cohort study

	Total			Female			Male		
Variables	Poor (PSQI score ≥ 5)	Good (PSQI score< 5)	p-value *	Poor (PSQI score ≥ 5)	Good (PSQI score< 5)	p-value*	Poor (PSQI score ≥ 5)	Good (PSQI score< 5)	p-value*
Total Energy Intake (kcal/day)	1429.01±415.25 (1480.79)	1429.75±305.92 (1448.50)	0.069	1265.53±293.87 (1303.28)	1457.97±346.78 (1464.58)	<0.001	1726.50±390.63 (1752.51)	1401.52±256.50 (1440.26)	**<0.001**
Energy from Plant Sources (kcal/day)	644.67±282.88 (616.75)	626.77±248.21 (627.95)	0.714	558.11±215.31 (558.80)	650.91±265.98 (637.40)	<0.001	731.23±314.68 (705.35)	602.64±227.18 (615.35)	**<0.001**
Phytochemical Index (%)	43.23±14.84 (43.70)	43.52±13.97 (43.69)	0.978	44.26±14.06 (44.53)	44.26±14.33 (43.85)	0.801	42.21±15.55 (43.06)	42.78±13.60 (43.45)	**0.803**

*Result based on the Mann-Whitney U test.

The numbers in this table are the mean±standard deviation (median).

Stratified analysis by gender showed that among men, the mean total energy intake was significantly lower in the elderly with good sleep quality (1401.52±256.50 kcal) than in those with poor sleep quality (1726.50±390.63 kcal) (P < 0.001). Furthermore, the mean energy intake from plant sources was significantly lower in men with good sleep quality (602.64±227.18 kcal) compared to those with poor sleep quality (731.23±314.68 kcal) (p < 0.001). Conversely, in women, the mean total energy intake was significantly higher in the elderly with good sleep quality (1457.97±346.78 kcal) than in those with poor sleep quality (1265.53±293.87 kcal) (p < 0.001). The mean energy intake from plant sources was also significantly higher in women with good sleep quality (650.91±265.98 kcal) compared to those with poor sleep quality (558.11±215.31 kcal) (p < 0.001). The phytochemical index showed no significant difference between the groups for either gender (p > 0.05) (table 3).

Table 4. Prediction of sleep quality (PSQI) based on multiple logistic regression model in the elderly of Amirkola cohort study

Variables	Total		Female		Male	
	OR (95%CI)	P value	OR (95%CI)	P -Value	OR (95%CI)	P - value
Total Energy Intake (kcal/day)	1.002 [1.001-1.003]	0.004	1.00 [0.998-1.002]	0.885	1.003 [1.001-1.005]	**0.008**
Energy from Plant Sources (kcal/day)	0.998 [0.995-1.00]	0.080	0.996 [0.991-1.001]	0.088	1.001 [0.996-1.005]	**0.797**
Phytochemical Index (%)	1.031 [0.993-1.071]	0.115	1.058 [0.993-1.127]	0.081	0.983 [0.912-1.059]	**0.649**
Number of Chronic Disease	1.257 [1.170-1.352]	<0.001	1.225 [1.106-1.357]	<0.001	1.244 [1.097-1.411]	**0.001**

As shown in table 4, the results of multiple logistic regression analysis indicated that the variables of total energy intake (OR=1.002, 95% CI: 1.001-1.003, P = 0.004) and number of Chronic diseases (OR=1.257, 95% CI:1.170-1.352, p < 0.001) had a significant effect on sleep quality. For each unit increase in total energy intake, the odds of poor sleep quality increased by 1.002 times, and for each unit increase in the number of chronic diseases, the odds increased by 1.257 times. The variables of energy intake from plant sources (OR=0.998, 95% CI: 0.995-1.00, P = 0.080) and the phytochemical index (OR=1.031, 95% CI: 0.993-1.071, P = 0.115) did not have a significant effect on sleep quality (Table 4). In men, the number of Chronic diseases significantly affected sleep quality (OR=1.244, 95% CI: 1.097-1.411, P = 0.001), with the odds of poor sleep quality increasing by 1.244 times for each additional disease. The variables of total energy intake (OR=1.003, 95% CI: 1.001-1.005, P = 0.008), energy intake from plant sources (OR= 1.001, 95% CI: 0.996-1.005, P = 0.797), and the phytochemical index (OR= 0.983, 95% CI: 0.912-1.059, P = 0.649) did not significantly affect sleep quality in men. In women, the number of chronic diseases also had a significant effect on sleep quality (OR=1.225, 95% CI: 1.106-1.357, p < 0.001), increasing the odds of poor sleep by 1.225 times per additional disease. The variables of total energy intake (OR= 1.00, 95% CI: 0.998-1.002, P = 0.885), energy intake from plant sources (OR=0.996, 95% CI: 0.991-1.001, P = 0.088), and the phytochemical index (OR=1.058, 95% CI: 0.993-1.127, P = 0.081) did not have a significant effect on sleep quality in women (table 4). Scatter plots (figures 1-3) demonstrate weak associations between the dietary phytochemical index with sleep quality, total energy intake with sleep quality, and energy intake from plant sources with sleep quality.

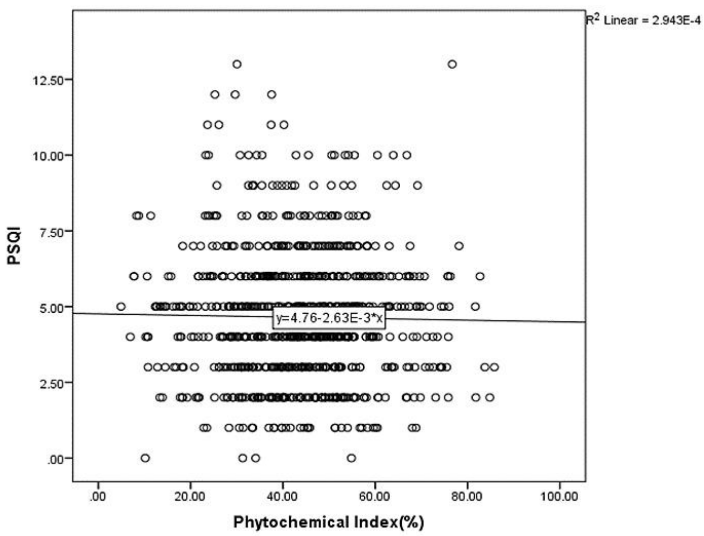

Figure 1. The association between Dietary Phytochemical Index and the Pittsburgh Sleep Quality Index (PSQI) score in the elderly of Amirkola cohort study

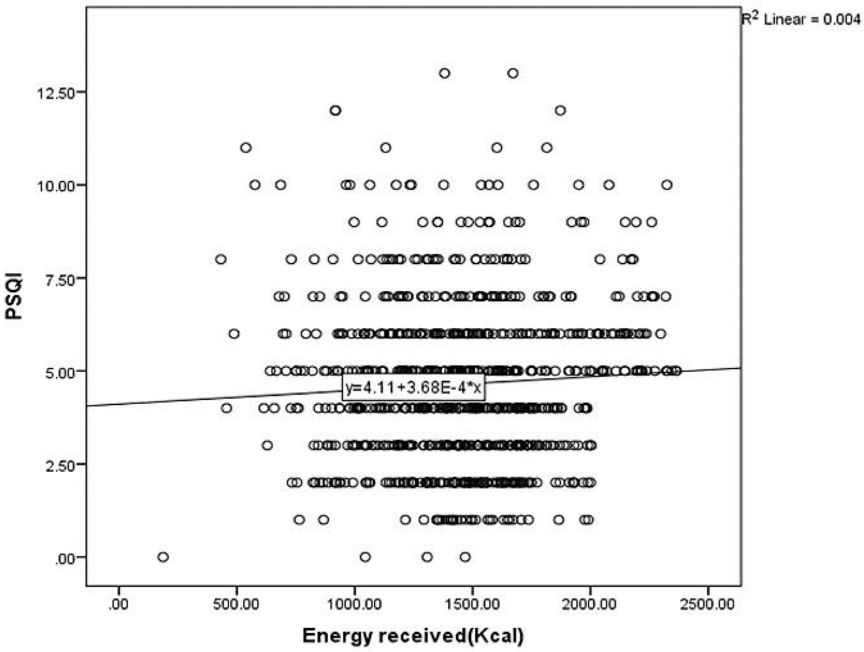

Figure 2. Scatter plot showing the correlation between total energy intake and Pittsburgh Sleep Quality Index (PSQI) scores in the elderly population of Amirkola cohort study

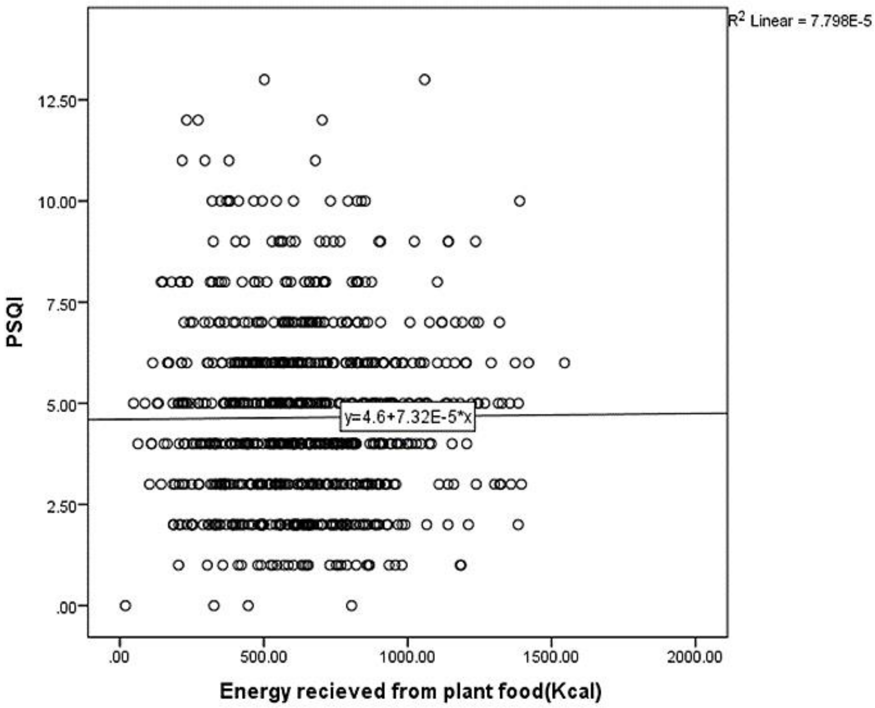

Figure 3. Scatter plot of the relationship between energy intake from plant sources and Pittsburgh Sleep Quality Index (PSQI) scores in the elderly population of Amirkola cohort study

Discussion

This study investigated the association between several variables, including total energy intake, energy intake from plant sources, the Dietary Phytochemical Index (DPI), and the number of chronic diseases with sleep quality in older adults from Amirkola city. The findings revealed that the number of chronic diseases and total energy intake significantly influenced sleep quality, such that an increase in these factors raised the likelihood of poor sleep quality. In contrast, energy intake from plant sources and the DPI did not exhibit a significant effect on sleep quality. In men, lower total energy intake and lower energy from plant sources were associated with improved sleep quality, whereas in women, lower intake was related with reduced sleep quality.

One of the most important results of this study is the association between a higher number of chronic diseases and poorer sleep quality in the elderly, which was not unexpected. The presence of various diseases such as hypertension, diabetes, cardiovascular diseases, and others can affect an individual's life and daily activities, thereby affecting their sleep quality. Furthermore, polypharmacy for managing these conditions can itself be a contributing factor to poor sleep quality. Consistent with the present investigation, previous studies have reported similar findings regarding the effect of chronic diseases on reduced sleep quality. In a study by Zhang et al. (21), which examined 35 chronic diseases among 1186 elderly individuals, the results showed that older adults with multiple diseases and longer duration of chronic conditions had poorer sleep quality compared to those without diseases or with a shorter duration of chronic illness. In a study on the effects of chronic diseases on quality of life mediated by sleep problems in middle-aged and older adults, Wu et al. (22) found that patients with chronic diseases had lower health status and more sleep problems and that sleep disturbance partially mediated the relationship between chronic diseases and health-related quality of life. In a cross-sectional study of 613 individuals, Wang et al. (23) demonstrated that chronic disease, depression, and anxiety are risk factors for poor sleep quality. Hsu et al. (24) also found that depression, the number of chronic diseases, and poor self-rated health were primary risk factors affecting subjective sleep quality in middle-aged and older adults.

Another finding of the present study pointed to the positive effect of reduced energy intake on improving sleep quality, so that increased consumption of carbohydrates and high-fat diets can lead to reduced sleep duration and poorer sleep quality. In line with this finding, Hashemi et al. (25) in a study on 60 adults assigned to a 750-calorie diet compared to a control group on a regular diet showed that a low-calorie, high-protein diet effectively improved apnea and sleep quality in obese adults. Similarly, Günal et al. (26) found that poor sleep quality was associated with higher intake of energy and macronutrients. The Pittsburgh Sleep Quality Index was used to assess sleep quality, and 24-hour dietary recall was employed to assess dietary intake.

In the present study, increased total energy intake and energy derived from plant sources were associated with improved sleep quality in women, whereas in men, they were related with reduced sleep quality. However, this association was not significant when adjusted for other variables in the logistic regression model. Dietary patterns and their effects differ between women and men due to variations in biology, metabolism, and social and cultural factors. Consequently, total energy intake and energy derived from plant sources may have differential effects on the sleep quality of men and women. Consistent with the present study, some previous research has also associated increased energy intake and increased intake from plant sources with improved sleep quality in women. Zhang et al. (27) found that increased consumption of fruits and vegetables was related with better sleep quality and lower stress levels among female nurses in Hong Kong. In a study examining the association of plant-based diet indices with depression, quality of life, and insomnia in 733 Iranian adolescent girls, Ahmadi et al. (28) showed that a higher healthy plant-based diet index was associated with lower odds of insomnia and depression. In a similar study, Hashimoto et al. (29) found that low energy intake and poor diet quality were related with poor sleep quality in young women. Indeed, adequate energy intake and a high- quality diet leads to improved sleep quality.

Consistent with the present study, some studies have proposed a link between reduced sleep quality and increased energy intake in men. Cheng et al. (30) found that men with a higher likelihood of insomnia had a higher average daily caloric intake. A similar trend was observed in men who had difficulty initiating sleep. However, the results of some studies were inconsistent with the current findings. In our study, no significant association was found between the Dietary Phytochemical Index (DPI) and sleep quality. However, in a study of 124 overweight women, Noruzi et al. (31) demonstrated that adherence to the phytochemical index could reduce depression and increase the Morningness-Eveningness Questionnaire (MEQ) scores. Furthermore, a relationship was found between adherence to the phytochemical index and circadian rhythm. The discrepancy between the results of that study and ours could be due to their smaller sample size and different age group. In addition, the phytochemical index might affect circadian rhythm but could not be directly associated with sleep quality.

In the present study, no significant association was found between energy intake from plants and sleep quality. Although inconsistent with our findings, Liu et al. (32) in a study of 6853 individuals found a significant correlation between a plant-based diet and sleep health in older adults; a higher plant-based diet index was related with higher odds of good sleep quality. Depression and anxiety were identified as parallel mediators between plant-based diets and sleep health. Similarly, a study by Tang et al. (33) on

2424 individuals showed that the plant-based diet index had an inverse relationship with Pittsburgh Sleep Quality Index scores but a direct relationship with sleep quality. These studies utilized larger sample sizes and different geographical regions, which could account for the difference in results.

In a study by Hua Gan et al. (34) on 464 individuals, it was shown that male participants who consumed a plant-based diet had a lower risk of insomnia, while no association was observed between adherence to a plant-based diet and insomnia in female participants, which was inconsistent with the present results. In a study by Rana F. et al. (35) on 158 female students, no significant relationship was found between a plant-based diet, academic performance, and sleep quality in women. Consequently, the reason for this discrepancy could be the smaller sample size, different data collection methods, study design, region, and the different age-related dietary patterns of the studied population.

Inconsistent with the present study, Aslan Çin et al. (36) in a study of 412 female students in Turkey showed that poor sleep quality and the presence of insomnia were associated with higher energy intake in women. Our study used different methods for data collection: the Pittsburgh Sleep Quality Index and the Insomnia Severity Index were used to assess sleep disorders, and the Healthy Eating Index was employed to assess diet quality, which differed from our methodology. This study demonstrated that poor sleep quality and insomnia were associated with higher energy intake and lower dietary quality in women.

Although the present research found no significant association between the Dietary Phytochemical Index and sleep quality, correlation might exist between other dietary indices, such as the Dietary Inflammatory Index (DII), and sleep quality. For example, Golmohammadi et al. (37) in a study titled "The association between dietary inflammatory index and sleep outcomes" found that adhering to an anti-inflammatory diet could potentially lead to improved sleep outcomes. In 2024, Bandari et al. (38) in a study entitled "Association Between Dietary Inflammatory Index and Sleep Quality: A Systematic Review" found that the DII and sleep quality have a significant relationship, and numerous studies have confirmed the impact of DII on sleep quality. However, due to differences in race, climatic conditions, and the number of studied individuals, this cannot be stated definitively, and more studies in this area are needed. Given the importance of sleep in the elderly and the adverse effects of insomnia on physical and mental health, further research on factors affecting sleep quality in older adults seems to be essential.

Strengths of this study include the case-control design, adequate sample size, matching of groups based on age and sex, and the use of standard questionnaires (PSQI and SQ-FFQ) for accurate assessment of variables. The most important limitation is that despite using standard questionnaires, the application of self-report methods may have introduced susceptibility to recall bias and other biases. Furthermore, because the samples belonged to a specific population (northern Iran), the generalizability of the results to other geographical and cultural regions may be limited. Finally, although some confounding factors were controlled, the potential influence of other unmeasured variables on the results should be considered.

For future studies, it is recommended that this research be conducted on a national scale, incorporating a sample of elderly individuals from various geographical and cultural regions of Iran. Such a study could more comprehensively examine the role of climatic differences, local dietary patterns, and socio-cultural factors in the relationship between diet and sleep quality, thereby enhancing the generalizability of the findings to the entire elderly population of the country.

This study identified increased total energy intake and a higher number of chronic diseases as factors contributing to reduced sleep quality. However, no significant effect of DPI on sleep quality was observed. It is possible that the statistical power to detect a significant association for DPI was insufficient, as its potential unobserved effect was masked by the chronic diseases. Also, some weaknesses of the semi-quantitative food frequency questionnaire (SQ-FFQ) in measuring food intake due to recall error and dietary diversity in the study population may have obscured any true association. Therefore, a definitive conclusion on the role of DPI requires future studies with a more robust design and accurate instrumentation. Interestingly, the effect of energy intake on sleep was gender-dependent, manifesting differently in men and women. Based on the findings, targeted nutritional interventions and management of comorbidities appear to be effective strategies for improving sleep quality in the elderly.

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Authors' contribution: MR and PS conceptualized the study and drafted the initial manuscript. SRH and AB performed the statistical analysis. AH and RG contributed to results interpretation and manuscript editing. All authors contributed to results interpretation, had full data access, and reviewed and approved the final manuscript for submission.

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