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RESEARCH

Effects of sleep quality and insomnia severity on metabolic and anthropometric parameters in elderly individuals

Uyku kalitesinin ve uykusuzluk şiddetinin yaşlı bireylerde metabolik ve antropometrik parametreler üzerindeki etkileri

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Abstract

Purpose: This study aimed to investigate the relationship of sleep quality and insomnia with metabolic/anthropometric parameters in elderly individuals.

Materials and Methods: This cross-sectional study was conducted with 474 elderly individuals. Their fasting blood glucose, haemoglobin A1c, total cholesterol, triglycerides, low-density lipoprotein, high-density lipoprotein, cortisol, C-reactive protein, weight, waist circumference, waist-to-hip ratio, skeletal muscle mass, body fat mass and body mass index were measured. Their sleep quality was evaluated using the Pittsburgh Sleep Quality Index, and insomnia was assessed using the Insomnia Severity Index.

Results: The mean age of the 474 elderly individuals included in the study was 71.02±4.90 years. Poor sleep quality prevalence was found to be 71.1% among the elderly participants and the prevalence of mild to moderate insomnia was 55.1%. The sleep quality score was positively correlated with the postprandial blood glucose level ($r=0.121$, $p<0.01$) and comorbidity index and negatively correlated with muscle mass ($r=-0.203$, $p<0.001$). Elderly individuals with poor sleep quality had higher postprandial blood glucose levels ($p=0.032$) and lower skeletal muscle mass levels ($p<0.001$). In the patients clinically diagnosed with insomnia, the postprandial blood glucose ($p=0.019$), haemoglobin A1c ($p=0.040$) and low-density lipoprotein levels were higher ($p=0.034$), while the muscle mass was lower ($p<0.001$). The factors that were found to increase the risk of insomnia were age (OR=1.06), being female (OR=2.08) and increased comorbidity burden (OR=1.32) and the factors that were found to increase the risk of poor sleep quality were being female (OR=2.43), lack of exercise (OR=1.95), poor diet (OR=1.85), age (OR=1.05) and increased comorbidity burden (OR=1.17).

Öz

Amaç: Bu çalışma yaşlı bireylerde uyku kalitesi ve uykusuzluğun metabolik ve antropometrik parametrelerle ilişkisini araştırmayı amaçlamaktadır.

Gereç ve Yöntem: Bu kesitsel çalışma 474 yaşlı birey ile gerçekleştirilmiştir. Açlık kan şekeri, hemoglobin A1c, toplam kolesterol, trigliserid, düşük yoğunluklu lipoprotein, yüksek yoğunluklu lipoprotein, kortizol, C-reaktif protein, ağırlık, bel çevresi, bel-kalça oranı, iskelet kas kütlesi, vücut yağı kütlesi ve vücut kitle indeksi ölçülmüştür. Uyku kalitesi Pittsburgh Uyku Kalitesi İndeksi ve uykusuzluk İnsomnia Şiddet İndeksi kullanılarak değerlendirilmiştir.

Bulgular: Çalışmaya dahil edilen 474 yaşlı bireyin ortalama yaşı 71,02±4,90 yıldır. Yaşlı katılımcılar arasında kötü uyku kalitesi prevalansı %71,1 hafif ve orta derecede uykusuzluk prevalansı %55,1'dir. Uyku kalitesi skoru, postprandiyal kan şekeri düzeyi ve komorbidite indeksi ile pozitif korelasyon ($r=0.121$, $p<0.01$) ve kas kütlesi ile negatif korelasyon ($r=-0.203$, $p<0.001$) göstermektedir. Uyku kalitesi düşük olan yaşlı bireylerin postprandiyal kan şekeri düzeyleri daha yüksek($p=0.032$), iskelet kas kütlesi ise daha düşüktür($p<0.001$). Klinik olarak uykusuzluk tanısı konulan hastalarda postprandiyal kan şekeri($p=0.019$), hemoglobin A1c ($p=0.040$) ve düşük yoğunluklu lipoprotein düzeyleri daha yüksekken ($p=0.034$) kas kütlesi daha düşüktür($p<0.001$). Uykusuzluk riskini artıran faktörler yaş (OR=1.06), kadın olmak (OR=2.08) ve artmış komorbidite yükü (OR=1.32) iken, uyku kalitesinin bozuk olma riskini artıran faktörler kadın olmak(OR=2.43), egzersiz eksikliği (OR=1.95), kötü beslenme (OR=1.85), yaş (OR=1.05) ve artmış komorbidite yükü (OR=1.17) olarak bulunmuştur.

Sonuç: Yaşlı bireylerde uykusuzluğun ve uyku kalitesinin düşük olmasının yüksek kan şekeri düzeyleri ve düşük kas kütlesi düzeyleri ile ilişkili olduğu bulunmuştur. Düzenli

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Conclusion: Poor sleep quality and insomnia in elderly individuals were found to be associated with high blood glucose levels and low muscle mass levels. Regular exercise and a diet can help reduce sleep problems in elderly individuals.
Keywords:. Sleep, blood glucose, cholesterol

egzersiz ve diyet yaşlı bireylerde uyku sorunlarını azaltmaya yardımcı olabilir.

Anahtar kelimeler: Uyku, kan şekeri, kolesterol

INTRODUCTION

In the last 40 years, numerous studies have shown that there is a U- or J-shaped relationship between sleep duration and mortality, with individuals with the shortest and longest sleep durations having the highest mortality risk. The National Sleep Foundation currently recommends 7–9 hours of sleep for young adults and 7–8 hours for older adults[1]. However, sleep duration alone may not fully capture the significance of this physiological trait. Factors such as sleep quality, independent of sleep duration, may also influence mortality outcomes. Sleep quality can help explain the mechanisms through which sleep affects mortality and morbidity risk[2]. The elderly population experiences chronic sleep disturbance at a high rate, with nearly 50% reporting this issue[3]. Chronic insomnia, which is characterised by fragmented sleep and early morning awakening, is particularly common in this age group[4]. Insomnia in older adults is also associated with mood and anxiety disorders, falls and cognitive impairment. Because of the significant health problems linked to insomnia and the potential harmful effects of commonly prescribed sedatives, there is a need for non-pharmacological treatment approaches to manage insomnia in older adults[5,6].

Mental health problems are also associated with sleep disorders, which are linked to poor physical health. Studies have found that various medical conditions such as diabetes and hypertension are more prevalent among individuals with insomnia compared to those without it. Individuals with chronic insomnia have been found to have lower immune levels. Furthermore, symptoms of insomnia have been associated with changes in appetite-regulating hormones and have been specifically linked to the development of metabolic syndrome. Chronic insomnia has also been associated with an increase in nighttime systolic blood pressure. Additionally, chronic insomnia is considered a significant risk factor in the development of mild to moderate hypertension. In addition to these points, it has been shown that insomnia increases the risk of cardiovascular disease, and it is even considered a risk factor for acute myocardial infarction and coronary heart disease among individuals without cardiovascular disease. Individuals who report multiple sleep problems such as difficulty initiating or maintaining sleep and early morning awakening have been shown to have an increased incidence of coronary heart disease. Difficulties in sleep initiation or maintenance have also been associated with an increase in diabetes risk by 57% to 84%, respectively[7].

Most noncommunicable diseases underlie preventable risk factors and most of them are associated with risk factors that lead to 4 basic metabolic/physiological changes (high blood pressure, overweight/obesity, high blood sugar and high cholesterol). The hypothesis of our study is that there is a relationship between insomnia and sleep quality in the elderly and fundamental modifiable risk factors. In older individuals with a higher burden of disease, there could be a vicious cycle between sleep and other illnesses. Sleep problems might lead to the deterioration of metabolic parameters, which in turn could exacerbate sleep issues. The results of our study contribute to the literature by shedding light on this dual relationship[8].

In summary, it is observed that sleep problems have negative effects on both physical and mental health and increase the risk of disease and death. Especially in older adults, sleep problems can have negative effects on the control of diseases and can lead to disease progression. This study evaluated the relationships between sleep quality, severity of insomnia and metabolic and anthropometric parameters in elderly individuals.

MATERIALS AND METHODS

Procedure

The study was cross-sectional and the study group consisted of 65 years old or older patients who applied to the polyclinic of endocrinology of Turgut Özal University Training and Research Hospital in Malatya, Turkey in 2023 (January and the first week

of February) before the earthquake. Ethics committee approval to conduct the study was obtained from Turgut Özal University's Non-interventional Clinical Research Ethics Committee (Date and decision no: 2023/4). Sample size calculation (design effect = 1; confidence interval = 5%; prevalence = 50%) revealed a minimum sample size of 384, among the 474 were included in the study after obtaining written consent from those who met the inclusion criteria. The number of participants was increased by 20% to account for potential losses.

Individuals under the age of 65 or who had undergone a recent surgery or had a psychiatric illness or dementia were excluded from the study. In the study, all elderly patients who presented to the outpatient clinic were evaluated by an endocrinologist. All patients who met the exclusion criteria were included in the study, and data collection was concluded once a sufficient sample size was reached.

Measurements

Metabolic parameters

Blood samples were collected from the participants after their submission of a filled-out Non-Interventional Form (NIF) for the detection of various metabolic parameters in their routine check-up examinations. These included fasting blood glucose (FBG), Postprandial blood glucose (It has been checked in the second hour after the first bite) haemoglobin A1c (HbA1c), total cholesterol, triglycerides, low-density lipoprotein (LDL), high-density lipoprotein, cortisol and C-reactive protein.

Bioelectrical impedance analysis

When the patients had submitted their filled-out NIFs, their body compositions were analysed using the Body Composition Analyzer BC-420MA device, in addition to metabolic measurements. The device measures bioimpedance by administering a 50 kHz electric current through electrodes placed on the feet. The analysis included measurements of weight, waist circumference, waist-to-hip ratio, skeletal muscle mass, body fat mass and body mass index.

Modified Charlson Comorbidity Index (MCCI)

MCCI is a scoring system that was originally developed to predict survival in individuals with cancer by assigning weights to certain diseases. Today, it is used as a guide for individuals with multiple comorbidities. In this index, diseases are scored based on their morbidity and mortality [9]. Myocardial infarction, congestive heart failure, peripheral vascular disease, cerebrovascular disease, dementia, chronic pulmonary disease, connective tissue disorder, peptic ulcer disease, mild liver disease and diabetes mellitus without end-organ damage are scored 1 point each; hemiplegia, moderate or severe renal disease, diabetes mellitus with end-organ damage, solid tumour without metastasis, leukaemia, lymphoma and multiple myeloma are scored 2 points each; moderate or severe liver disease is scored 3 points and metastatic solid tumour or acquired immune deficiency syndrome is scored 6 points. The sum of thescores of each disease gives the total score. In the present study, we used MCCI instead of Charlson Comorbidity Index (CKI) because MCCI adds 1 comorbidity point for individuals over 40 years old every 10 years, and our study was conducted in individuals aged 60 and above. Comorbidity is categorised as low (score ≤ 3), moderate (score 4 or 5), high (score 6 or 7) or very high (score ≥ 8)[10].

Insomnia Severity Index (ISI)

The index was developed and tested for validity by Bastien et al. in 2001 [11]. This scale is a valuable clinical tool for both screening insomnia and evaluating the results of clinical treatments in research. ISI is easy to administer and has balanced sensitivity and specificity, making it a good screening tool for detecting the prevalence of insomnia. It evaluates sleep-related problems in seven subdimensions: the severity of problems with falling asleep, staying asleep and waking up early in the morning; sleep satisfaction/dissatisfaction; the impact of sleep problems on daily functioning; the noticeability of sleep problems to others and stress due to sleep difficulties.

A 5-point Likert scale is used to rate each subdimension (0 = no problem; 4 = very severe problem). The total score is 0–28. The scores are classified as follows: 0–7 = no insomnia; 8–14 = subthreshold insomnia; 15–21 = moderate insomnia and 22–28 = severe insomnia. A total score greater than 14 indicates the presence of clinically significant insomnia [12]. In the present study, the participants with a total score greater than 14 were considered to have 'probable insomnia'. The Turkish validity and reliability study of ISI was conducted by Boysan et al. in 2010 [12]. The internal consistency coefficient calculated for all the subdimensions of the scale was 0.79. The intra-class correlation was 0.65 in the patient group and 0.82 in the healthy individuals.

Pittsburgh Sleep Quality Index (PSQI)

PSQI was developed by Buysse et al. in 1988 as an easy-to-use screening tool for determining good and poor sleep quality [13]. It is a self-reporting questionnaire that assesses population sleep quality and sleep problems over the past month. The scale consists of 19 questions and seven subcomponents that assess subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleep medication and daytime dysfunction, with each of the seven subcomponents scored 0–3, yielding a total score of 0–21. The cut-off score is 5. PSQI has 89.6% sensitivity and 86.5% specificity in distinguishing good and poor sleep quality. In the present study, the participants with a total score of above 5 were considered to have poor sleep quality. Ağargün et al. studied the Turkish validity and reliability of PSQI in 1996 [14].

Statistical analysis

SPSS 22 and JAMOVI were used for the data analysis. Qualitative data were presented as numbers and percentages, while quantitative data were presented as medians and interquartile ranges. The Kolmogorov–Smirnov test was used as the normality test. Parametric tests were used for normally distributed data, and nonparametric tests were used for non-normally distributed data. For comparisons between two groups of non-normally distributed numerical data, the Mann Whitney U test was employed. Spearman's correlation analysis was used for investigating relationships involving non-normally distributed numerical data.

In the effect size analysis, for the non-parametric Mann Whitney U test, the effect size was measured using the rank-biserial correlation coefficient. For the Kruskal Wallis test, the effect size was measured using eta-square.

In the logistic regression model, the independent variables were determined based on their clinical significance and their relevance to the hypothesis of the study. The rank-biserial correlation coefficient and eta-squared values were calculated for effect size evaluation. A rank-biserial correlation coefficient of 0.10 was considered a small effect size, 0.30 was considered a medium effect size and 0.50 or greater was considered a large effect size. A p-value of < 0.05 was considered statistically significant.

RESULTS

The mean age of the 474 elderly participants in the present study was 71.02 ± 4.90 years (range: 65–98 years). Of the patients, 57.2% were female and 89% had at least one chronic illness. The sociodemographic characteristics of the patients are presented in Table 1.

Poor sleep quality prevalence was found to be 71.1% among the elderly participants and the prevalence of mild to moderate insomnia was 55.1% (Table 1). When comparing the anthropometric and metabolic parameters according to sleep quality and severity of insomnia, it was found that the median FBG level was higher and the muscle mass level was lower in the patients with poor sleep quality. In the clinically diagnosed insomnia patients, the median FBG, HbA1c and LDL levels were higher, while the muscle mass level was lower. The effects of insomnia and poor sleep quality on blood glucose and muscle mass levels were found to be small (Table 2).

When the correlations between the sleep quality and insomnia severity scores and the metabolic and anthropometric values were examined, it was found that insomnia severity score had weak-positively correlated with cortisol level and comorbidity index, while weak-negatively with muscle mass. The sleep quality score showed a weak-positive correlation with FBG level and comorbidity index, while a weak negative correlation with muscle mass (Table 3).

The results of two logistic regression analyses created to predict the presence of poor sleep quality and clinical insomnia were found to be significant (omnibus test $p < 0.001$). The dependent variable for Model 1 was clinical insomnia status (ISI > 7), and that for Model 2 was poor sleep quality (risk = PSQI > 5). The independent variables in both models were age, gender (risk: female), having a separate bedroom (risk: no separate bedroom), exercise status (risk: no exercise), diet (risk: poor diet) and Charlson Comorbidity Index (CCI). It was found that each 1 unit increase in age increased insomnia risk by 1.06 (6%), being female increased it by 2.08 times and each 1 unit increase in CCI increased it by 1.32 times. The risk of poor sleep quality was found to increase by 2.43 times in women, 1.95 times in those who do not exercise regularly and 1.89 times in those who have a poor diet. Additionally, each 1 unit increase in age increased the risk of poor sleep quality by 1.05 (5%), and each 1 unit increase in CCI increased it by 1.17 (17%).

Table 1. Distributions of the sociodemographic characteristics of the patients in the present study

Characteristics	**n (%)**
Sex	
Female	271 (57.2)
Male	203 (42.8)
Education	
Illiterate	73 (15.4)
Literate	46 (9.7)
Primary School	137 (28.9)
Middle School	81 (17.1)
High School	89 (18.8)
University	48 (10.1)
Marital status	
Married	388 (81.9)
Single-widowed	85 (18.1)
Household income	
Less than expenses	145 (30.6)
Equal to expenses	306 (64.6)
Greater than expenses	23 (4.9)
Exercise	
Yes	324 (68.4)
No	150 (31.6)
Diet	
Yes	250 (52.7)
No	224 (47.3)
Presence of chronic illness	
Yes	420 (89.0)
No	52 (11.0)
Own room	
Yes	455 (96.0)
No	19 (4.0)
Sleep quality	
Good	137 (28.9)
Poor	337 (71.1)
Insomnia	
Clinically insignificant	213 (44.9)
Mild (below the threshold)	157 (33.1)
Moderate to severe	85 (17.9)
Severe	19 (4.0)
Total	474 (100.0)

Table 2. Comparison of anthropometric and metabolic measurements according to sleep quality and insomnia severity

	Sleep quality				Insomnia			
	Good PSQI ≤ 5	**Poor PSQI > 5**			**No ISI ≤ 7**	**Yes ISI > 7**		
	Median (IQR)	Median (IQR)	p	ES*	Median (IQR)	Median (IQR)	p	ES*
Fasting blood glucose	117 (49)	117 (64)	0.229	0.04	112 (46.75)	119 (65)	0.089	0.07
Postprandial blood glucose	145 (113)	184 (125)	**0.032**	0.10	145 (115)	189 (123)	**0.019**	0.11
Haemoglobin A1c	6.6 (2.1)	6.9 (2.4)	0.269	0.03	6.55 (2.3)	7 (2.5)	**0.040**	0.09
Low-density lipoprotein	113 (25)	113 (28)	0.548	0.007	111 (23.25)	116 (30)	**0.034**	0.09
High-density lipoprotein	50 (14)	50 (11)	0.329	0.02	50 (11.25)	50.5 (11)	0.290	0.02
Total cholesterol	186 (44)	189 (40)	0.250	0.03	187 (31)	188 (42)	0.200	0.04
Triglycerides	191 (43)	198 (38)	0.134	0.06	197 (43.5)	197 (37.75)	0.281	0.03
Cortisol	14 (5)	14 (6)	0.160	0.05	14 (4)	15 (5)	0.002	0.15
C-reactive protein	0.6 (0.3)	0.6 (0.1)	0.947	0.09	0.6 (0.1)	0.6 (0.1)	0.493	0.001
Weight	80 (21)	78 (18)	0.969	0.10	78 (20.25)	78 (18)	0.756	0.03
Body mass index	30 (7)	29 (6)	0.934	0.08	30 (7.22)	28.7 (6)	0.851	0.05
Waist circumference	84 (21)	82 (13)	0.639	0.02	81 (18)	83 (12)	0.283	0.03
Waist-to-hip ratio	0.9 (0.3)	0.8 (0.1)	**< 0.001**	0.20	0.8 (0.11)	0.8 (0.1)	0.750	0.03
Fat mass (kg)	26 (14)	29 (12)	0.716	0.02	26 (14)	29 (12)	0.124	0.06
Muscle mass (kg)	47 (16)	43 (10)	**< 0.001**	0.23	46 (14)	43 (10)	**< 0.001**	0.19

* PSQI = Pittsburgh Sleep Quality Index; ISI = Insomnia Severity Index; IQR = interquartile range; ES = effect size (rank-biserial correlation), IQR=interquartile range

Table 3. Correlations between insomnia severity and quality and metabolic and anthropometric variables

Parameters	**ISI**	**PSQI**
Fasting blood glucose	0.060	0.076
Postprandial blood glucose	0.090	0.121**
Haemoglobin A1c	0.070	0.062
Low-density lipoprotein	0.089	0.045
High-density lipoprotein	0.060	0.031
Total cholesterol	0.050	0.070
Triglycerides	0.036	0.076
Cortisol	0.118*	0.069
C-reactive protein	-0.003	-0.004
Modified Charlson Comorbidity Index	0.215***	0.161***
Weight	-0.060	-0.075
Body mass index	-0.059	-0.059
Waist circumference	-0.006	0.011
Waist-to-hip ratio	-0.048	-0.102*
Fat mass (kg)	0.042	0.044
Muscle mass (kg)	-0.205***	-0.203***

*p < 0.05, **p < 0.01, ***p < 0.001, PSQI = Pittsburgh Sleep Quality Index; ISI = Insomnia Severity Index

Table 4. Results of logistic regression analyses for predicting poor sleep quality and clinical insomnia

Parameter	Model 1 (R^2 = 0.102) Insomnia			Model 2 (R^2 = 0.09) Sleep quality		
	B	p	OR (95% CI)	B	p	OR (95% CI)
Age	0.059	**0.017**	1.06 (1.01–1.11)	0.056	**0.041**	1.05 (1.002–1.115)
Sex	0.736	**< 0.001**	2.08 (1.38–3.14)	0.889	**< 0.001**	2.43 (1.56–3.77)
Own room	0.757	0.181	2.13 (0.70–6.47)	0.192	0.739	1.21 (0.39–3.75)
Exercise	0.113	0.640	1.11 (0.69–1.79)	0.668	**0.013**	1.95 (1.15–3.30)
Diet	0.204	0.359	1.22 (0.79–1.89)	0.640	**0.011**	1.89 (1.15–3.10)
MCCI	0.281	**0.003**	1.32 (1.10–1.59)	0.160	0.113	1.17 (0.96–1.43)
Constant	-4.799	**0.003**	0.008	-3.726	**0.035**	0.024

OR:Odds Ratio, MCCI:Modified Charlson Comorbidity Index, CI: Confidence interval

DISCUSSION

Epidemiological studies have found that sleep problems are present in approximately 50% of the elderly population. However, sleep problems in elderly individuals are often unrecognised and inadequately treated in clinical practice[15]. The present study evaluated the relationship between insomnia, sleep quality and metabolic and anthropometric parameters in elderly individuals. The prevalence of poor sleep quality among the elderly participants in the present study was 71.1%, and the prevalence of mild to moderate insomnia was 55.1%. Poor sleep quality and insomnia were also found to have a negative effect on blood glucose, cholesterol and cortisol levels, comorbidity index and muscle mass in elderly individuals. The predictors of insomnia in elderly individuals were found to be increasing age, being female and increased comorbidity burden, while the predictors of poor sleep quality were found to be age, being female, lack of exercise, poor diet and increased comorbidity burden.

Decreased sleep duration and poor sleep quality are commonly seen in modern society. Sleep plays an important role in neuroendocrine function and glucose metabolism. Over the past 10 years, evidence of the negative health effects of shortening sleep duration has emerged. It is increasingly understood that sleep is important for hormone secretion and glucose regulation. In comparison to wakefulness, particularly slow-wave sleep, considered as the most restorative sleep stage, is associated with a decrease in sympathetic nervous activity, blood pressure and heart rate and cerebral glucose utilisation. In slow-wave sleep, the stress hormone cortisol is inhibited, but the anabolic growth hormone is released[16].

Laboratory and epidemiological evidence also suggests that sleep loss may be a new risk factor for obesity and type 2 diabetes. Epidemiological studies in adults and children and laboratory studies in young adults suggested that the risk of obesity and weight gain might be increased by partial chronic sleep loss. Sleep restriction causes metabolic and endocrine changes, reduces glucose tolerance and insulin sensitivity and increases cortisol levels[17,18]. The increased risk of obesity may be associated with the effect of sleep deprivation on the hormones that centrally control appetite and energy expenditure, such as leptin and ghrelin. Decreased leptin and increased ghrelin levels due to sleep loss are associated with an increased appetite in individuals having sleep restrictions. Indeed, evidence suggests that loss in sleep is an important but modifiable risk factor for metabolic syndrome, diabetes and obesity[16].

Studies have shown that repeated partial sleep deprivation in healthy young adults can lead to significant changes in glucose metabolism, particularly a decrease in glucose tolerance and insulin sensitivity [19]. In the present study, insomnia severity level was found to have a positive relationship with cortisol level in elderly individuals, and poor sleep quality and short sleep duration were found to have positive relationships with postprandial hyperglycaemia and abdominal obesity in the same individuals. Short sleep duration and poor sleep

quality are also associated with decreased muscle mass. In elderly individuals, there may be a dual relationship between sleep and metabolism problems, where the high burden of morbidity, particularly the prevalence of metabolic diseases, affects sleep quality and duration, while impaired sleep makes it difficult to control metabolic parameters. The present study revealed that an increase in comorbidity burden increases the risk of insomnia and poor sleep quality. This dual relationship can create a vicious cycle that positively feeds into each other. Thus, reducing/preventing sleep problems in elderly individuals may help control diseases.

One of the important findings of the present study is that exercise and a healthy diet can reduce the risk of poor sleep quality. Ageing changes the stages of sleep, and older people with this problem are often recommended medications, which can lead to long-term side effects and increased healthcare costs. Regular physical exercise can be a superior alternative due to its various positive effects. This can lead to a paradigm shift in the treatment of sleep disorders and provide an alternative method for the treatment of elderly individuals[20]. In Reid et al.'s study on older adults engaging in aerobic physical activity, improvement was shown in global PSQI sleep quality, sleep onset, sleep duration, daytime dysfunction and sleep efficiency PSQI subscores[21]. In a study by Hartescu et al., inactive adults with insomnia diagnosis criteria were made to undertake at least 150 minutes of moderate-intensity physical activity per week for 6 months to improve their sleep quality. A significant decrease in the severity of sleep disorder symptoms was observed in the physical-activity group 6 months after the start of the activity[22]. An examination of different patient populations showed that increasing physical activity improves sleep quality[23].

Dietary habits are also considered a leading behavioural risk factor for human health, and there is growing scientific evidence of a relationship between diet and sleep. A systematic review found that consuming healthy foods was associated with better sleep quality, while a high consumption of processed and sugary foods was associated with poor sleep quality. However, studies have found inconsistent evidence of these findings, and more research is needed to confirm them[24].

However, there is evidence of the existence of relationships between sleep, eating behaviour and physical activity. There are numerous connections between sleep patterns, eating behaviour and energy balance. In studies related to metabolic disorders, particular emphasis should be give on sleep and a lifestyle package traditionally focused on diet and physical activity should be revised to include emphasis on sleep[25].

Many articles have discussed sleep problems based on gender. Insomnia frequency is about 1.41 times more common in women compared to men. Women may be more susceptible to insomnia during certain periods of their lives. Hormonal changes during these periods may affect women's sleep patterns. These changes can occur during adolescence, pregnancy, postpartum or menopause [26]. In studies conducted by Zhang et al.[27] and Verlinden et al.[28], women in the late and adult age groups had lower sleep quality and more insomnia problems. The present study also found that sleep quality and insomnia problems are more common in elderly women and that being in the state of menopause may explain this situation.

We acknowledge the limitations of our study being conducted in a hospital-based setting, its single-center design, and the collection of sleep-related issues based on patients' self-report. Furthermore, we consider limitations such as patient non-compliance in blood parameter measurements and potential measurement errors related to the laboratory.

According to the results of our study, sleeplessness and poor sleep quality are common problems in elderly individuals. Sleep problems are associated with an increase in blood glucose and cholesterol levels. Age, increased comorbidity burden and being female increase the risk of sleep problems, while exercise and a healthy diet decrease it. Considering the negative effects of sleep problems on metabolic processes, non-pharmacological interventions such as exercise and dietary adjustments in elderly individuals may have significant results in controlling diseases. We recommend the conduction of larger-scale cohort studies that will further elucidate the relationship between sleep problems and metabolic parameters in elderly individuals. Additionally, our results suggest the need for intervention studies that explore the effectiveness of non-pharmacological interventions such as physical activity and diet. These studies would provide valuable insights into addressing these issues in the elderly population.

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