BMC Public Health

RESEARCH

Open Access

Effects of physical activity and body mass index on sleep quality and depression among Turkish adults

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Abstract

Background Nowadays, Physical Activity (PA) and Body Mass Index (BMI) have a significant impact on the general health status of adults. Inadequate PA and the imbalance of body weight may lead to the deterioration of sleep quality and an increase in the risk of depression. A sedentary lifestyle and obesity can adversely affect the quality of life of adults by triggering psychological and physiological health problems. In this context, this study aimed to investigate the effects of PA and BMI on sleep quality and depression among Turkish adults.

Methods In this study, the relational screening model was used. In the study, the purposive sampling method was used, and 1191 adults (Male: 864; Female: 327) aged 18–65 years using park and recreation areas (M_{Age}= 36.35 ± 2.52) voluntarily participated. In addition to the personal information form, participants answered the Pittsburgh Sleep Quality Index, International PA Questionnaire Short-Form, and Beck Depression Inventory. The collected data were analyzed using IBM SPSS 23.0 software. Independent samples t-tests were performed to examine the gender-based differences in sleep quality and depression levels. Additionally, Univariate analyses were conducted to examine the differences in sleep quality and depression levels based on participants' PA levels and BMI. The significance level was set at $p < .05$.

Results Statistically significant differences were found in adults' sleep quality based on their PA levels and BMIs ($p < .05$). Additionally, statistically significant differences were found in adults' depression levels based on their PA levels and BMIs ($p < .05$).

Conclusion Although increasing the PA level has a decreasing effect on depression levels, a normal BMI ensures that depression levels are at the lowest level. In addition, a significant decrease in sleep quality was observed as BMI increased. It can be said that as PA levels increase, sleep quality increases significantly in each BMI category.

Keywords Body mass index, Depression, Obesity, Physical activity, Sleep quality

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Introduction

Obesity is a complex, multifactorial chronic disease influenced by genetic, metabolic, behavioral, physiological, and psychological components and social determinants that continues to be a global health problem [1, 2]. Obesity is defined as abnormal or excessive fat accumulation due to excessive food intake and can impair health due to a high increase in adipose tissue [3]. Weight gain leads to an increase in Body Mass Index (BMI), which is calculated as weight divided by the square of height in meters [4]. BMI between 25 and 30 kg/m^2 is classified as overweight, while a BMI above 30 kg/m^2 is defined as obese [3].

Having an unhealthy BMI (e.g., obesity and overweight) has been shown to have a negative impact on quality of life [5, 6]. Furthermore, unhealthy BMI is associated with various chronic diseases such as cardiovascular disease, various types of cancer, type 2 diabetes mellitus, and sleep apnea [7–9]. However, poor sleep quality is also frequently associated with obesity and is mainly characterized by short sleep duration [10]. Sleep quality is important for health. Poor sleep quality leads to sleep disorders such as reduced sleep duration, insomnia, and obstructive sleep apnea. Sleep duration itself is not a disorder, but rather a symptom of sleep disorders [11]. In addition, poor sleep quality has been widely shown to be associated with negative consequences for multiple physical and mental health outcomes, including obesity, diabetes, cardiovascular diseases, decreased cognitive function, inattention, fatigue, anxiety, and depression [11–14].

Sleep quality has been conceptualized as a construct that includes both quantitative-objective and subjective aspects of sleep [15]. Numerous studies on children and young adults have observed a relationship between decreased sleep duration and weight gain and suggest that those who report sleeping less are more likely to be obese [14, 16, 17]. Previous studies examining the sleep-obesity relationship have mainly focused on the importance of sleep duration and used BMI as a measure of obesity. In general, studies and meta-analyses have concluded that short sleep duration is associated with an increased risk of obesity [14, 18]. Sleep disorders are overall among young adults [19]. Experts recommend that adults sleep at least 7–9 h to maintain their overall health and well-being [12]. Despite some evidence on the determinants of poor sleep quality, conflicting results have been reached when factors affecting sleep quality, including BMI and sleep duration, were investigated.

Adults who sleep for shorter periods show higher BMI, increased weight, and neck circumference compared to those who sleep 8 h per day, highlighting the association between short sleep duration, BMI, and central adiposity [20]. BMI is considered an indicator of lifestyle. While some studies have shown a negative association between sleep duration and BMI [21, 22], some studies have found that poor sleep quality is positively associated with increased BMI or increased weight and obesity [23–26]. Evidence suggests that obesity is associated with an increased risk of developing mental disorders, particularly anxiety and other disorders such as depression [17, 27, 28]. Irregular sleep is also known to be strongly associated with depression [29, 30]. Insomnia is considered an important symptom in the diagnosis of depression [30] and increases the risk of developing depression [31].

Physical Activity (PA) is defined as "movement that increases heart rate and breathing, any bodily movement produced by the contraction of skeletal muscles that results in a substantial increase in caloric requirements over resting energy expenditure [32]. Regular PA is considered a complementary alternative treatment for sleep disorders that improves sleep structure and quality in adults [33]. PA can improve the physiological, psychological, and spiritual functions of the human body, causing micro and macro changes in human organs. At the same time, it is emphasized that it is important for the prevention and treatment of diseases [34]. PA or exercise has also been reported to help prevent common diseases such as obesity [35], high blood pressure, heart disease, and diabetes [34]. It has also been emphasized that PA alleviates stress and negative emotions by releasing serotonin and dopamine and regulates mental health [24, 36, 37] and may improve sleep quality by reducing psychological symptoms such as anxiety and depression, which may improve psychological health [14, 38]. It is known that PA is an alternative treatment method for improving most diseases. The regular practice of PA could be a countermeasure to the altered quality of sleep. Baron et al. (2021) showed that to promote regular practice of PA is necessary to improve sleep quality [39]. Sleep influences the likelihood of engaging in PA, whereas practicing a PA improves sleep [40]. Oudegeest-Sander et. al. (2013) found that young adults with higher daily energy expenditure also have greater sleep efficiency [41]. On the other hand, one study showed that individuals who slept best tended to engage in higher amounts of leisure PA, while those who performed higher levels of occupational PA or no exercise at all tended to sleep worse [42].

To our knowledge, there are very limited studies on the relationship between PA and BMI with sleep quality. For this reason, this study aims to investigate the interrelationship between PA levels and BMI in relation to sleep quality and depression, to identify potential predictors of psychological and physiological well-being.

Materials and methods

Study design

This study was designed as a cross-sectional study in the relational screening model. In relational studies, the relationships between two or more variables are examined. In this context, the change in depression and sleep quality levels of the adults according to their PA levels and BMI was analyzed. As a cross-sectional study, the findings are limited to identifying associations between variables based on data collected at a single point in time [43]. Therefore, this design does not allow for causal inferences or the assessment of changes over time, and the results should be interpreted at the correlational level.

Study sample

Following the purpose of the study, the data collection process was planned to obtain data from adults who use parks and recreation areas throughout Türkiye at least once a week for PA and who do not have chronic diseases. The data collection process was carried out between October and December 2024. Due to the difficulties in reaching all participants in terms of time and cost, and the inability to determine the exact number of adults using parks and recreation areas in Türkiye, the purposive sampling method was preferred in determining the study sample. While purposive sampling allowed us to specifically target adults who regularly engage in PA in parks and recreation areas, it is acknowledged that this non-probabilistic method may limit the generalizability of the findings to the broader adult population. To mitigate this limitation, the study included a large and demographically diverse sample from various cities across Türkiye. Participants were recruited from multiple cities representing different regions of Türkiye, including urban and suburban areas, to enhance the diversity of the sample. Therefore, the findings are expected to be more applicable to adults with similar characteristics, particularly those who use public parks for PA. Inclusion criteria were being between 18 and 65 years of age, being male or female, using parks and recreation areas at least once a week for PA, having no chronic disease, and providing voluntary consent to participate. Exclusion criteria included being under 18 or over 65 years of age, having a chronic illness, not engaging in PA in the last week, providing incomplete, incorrect, or duplicate responses, or refusing to participate. In this context, 1197 adults who use parks and recreation areas across Türkiye were voluntarily included in the study. All questionnaires were screened by the research team, and six were excluded due to missing responses in key variables, inconsistent answers (such as reporting high activity with zero minutes specified), or duplicate entries identified through matching participant information. Thus, the data of a total of 1191 (327 women and 864 men) participants ($M_{Age} = 36.35 \pm 2.52$) were included in the statistical analysis. According to Sekaran (1992), when the population exceeds 10.000.000, a sample size of at least 384 participants is considered sufficient. Moreover, Sekaran (1992) suggests that for most research, sample sizes between 30 and 500 are appropriate. However, to improve the statistical power and generalizability of the results, a larger sample of 1191 participants was included in this study [44].

Data collection tools

Personal information form

In addition to descriptive questions such as age, height, weight, and gender, participants were asked whether they used parks and recreation areas at least once a week. BMI was calculated as weight in kilograms divided by height squared (kg/m^2) in meters [45].

International PA questionnaire short form (IPAQ-SF)

The IPAQ-SF developed by Craig et al. (2003) was used to determine the PA levels of the individuals in the study [46]. The validity and reliability study of the IPAQ-SF in Türkiye was carried out by Öztürk (2005) [47]. The IPAQ-SF covers the days and time spent walking for at least 10 min at moderate and vigorous intensity in the last 7 days and also includes the time spent sitting on weekdays in the last 7 days. The total score obtained from the IPAQ-SF is expressed as Metabolic Equivalent (MET)-min/week.

Walking score (MET-min/week) = 3.3 * walking time * walking day.

Moderate intensity activity score (MET-min/week) = 4.0 * duration of moderate intensity activity * days of moderate intensity activity.

Vigorous activity score (MET-min/week) = 8.0 * vigorous activity duration * vigorous activity days.

Total PA Score (MET-min/week) = Walking + Moderate intensity activity + Vigorous activity scores.

According to the total PA score, the PA levels of the participants were categorized as "low, moderate, and high". PA Levels:

1. Low: <600 MET-min/week.
2. Moderate: 600–3000 MET-min/week.
3. High: >3000 MET-min/week.

Pittsburgh sleep quality index

The self-report Pittsburgh Sleep Quality Index (PSQI) was used to assess sleep quality. The scale was developed by Buysse et al. (1989) [48] and adapted into Turkish by Agargun et al. (1996) [49]. The scale consists of a total of 18 items and 7 sub-dimensions. Each response is scored between 0 and 3 according to symptom frequency. The global score obtained varies between 0 and 21, and high

Table 1 Demographic characteristics of participants

Age	Mean	S.D.
	36.35	**2.52**
Gender	F	%
Male	864	72.5
Female	327	27.5
PA Levels	F	%
Low	214	18.0
Moderate	664	55.8
High	313	26.3
BMI Levels	F	%
Underweight	38	3.2
Normal weight	527	44.2
Overweight	441	37.0
Obese	185	15.5

values indicate poor sleep quality and a high level of sleep disturbance. A global score of 5 or above indicates clinically significant poor sleep quality.

Beck depression inventory (BDI)

BDI was developed by Beck et al. (1961) [50] to measure the risk of depression, the level of depressive symptoms, and the change in severity in adults, and was adapted into Turkish by Hisli (1989). The scale is a one-dimensional 4-point type scale consisting of 21 items. Each item is scored between 0 and 3 according to the severity of depression. The pathological cut-off score of the inventory is 17, and the total score varies between 0 and 63. BDI score ranges between 0 and 9 indicates no depression, 10–16 points indicate mild, 17–24 points indicate moderate, and 25 and above points indicate severe depressive symptoms [51].

Data collection procedure

The data were collected face-to-face by trained researchers in public parks and recreation areas across Türkiye. Participants completed the questionnaire on-site after being briefly informed about the purpose of the study. The average time required to complete the questionnaire was approximately 10 to 15 min. Before participation, all individuals were presented with an informed consent form explaining the aim of the study, voluntary participation, and confidentiality of their responses. Those who agreed to participate provided their consent verbally and proceeded to complete the questionnaire.

Statistical analysis

IBM SPSS 23 software was used in data analysis. Firstly, the normality distribution of the data was tested using skewness and kurtosis values. The skewness and kurtosis values obtained were found to be between + 2 and − 2, and parametric analyses were used [52]. In addition to descriptive statistics, independent samples t-tests were conducted to examine gender-based differences in depression and sleep quality levels. Following this, univariate analyses were performed to determine the levels of depression and sleep quality according to participants' PA levels and BMIs, as well as to assess the interaction effect of PA level and BMI on these variables. In all analyses, the significance level was taken as $p < .05$.

Table 2 Descriptive statistics of dependent variables

Variables	Mean	S.D.	Skewness	Kurtosis
Depression	15.88	1.07	0.291	0.1.576
Sleep Quality	15.77	1.09	− 0.020	0.464

N = 1191

Results

Table 1 presents the demographic characteristics of the participants ($N = 1191$). The participants had a mean age of 36.35 years (S.D.= 2.52). In terms of gender distribution, 72.5% were male ($n = 864$) and 27.5% were female ($n = 327$). Regarding PA levels, 18.0% of participants ($n = 214$) reported low PA, 55.8% ($n = 664$) reported moderate activity, and 26.3% ($n = 313$) reported high levels of PA. BMI classifications showed that 3.2% ($n = 38$) of participants were underweight, 44.2% ($n = 527$) had normal weight, 37.0% ($n = 441$) were overweight, and 15.5% ($n = 185$) were classified as obese.

Table 2 presents the descriptive statistics for the depression and sleep quality variables. The mean depression score was 15.88 (S.D.= 1.07), with a skewness of 0.291 and a kurtosis of 1.576, indicating a slightly positively skewed and leptokurtic distribution. The mean sleep quality score was 15.77 (S.D.= 1.09), with a skewness of − 0.020, suggesting a symmetrical distribution, and a kurtosis of 0.464, reflecting a moderately peaked distribution. Both variables exhibit skewness and kurtosis values within the acceptable range of ± 2, supporting the assumption of normality. These results indicate that the data are suitable for parametric analyses in the subsequent stages of the study.

The analysis revealed a statistically significant difference in depression and sleep quality levels based on participants' gender ($p < .05$). According to the findings, female participants reported higher levels of depression and sleep quality scores compared to male participants (Table 3).

The results of the analyses show that there was a statistically significant difference in the depression levels of the adults according to their PA level and BMIs ($p < .05$). In addition, it was observed that there was a statistically significant difference in the depression levels of the adults in the interaction of PA levels and BMIs ($p < .05$; Table 4). The depression scores regarding PA levels of adults with different BMIs were presented in Fig. 1.

Table 3 Results of the analysis of differences in depression and sleep quality levels according to participants' gender

Variables	Gender	*N*	Mean	S.D.	t	*p*
Depression	Female	327	17.64	3.99	4.182	0.001
	Male	864	15.22	3.89		
Sleep Quality	Female	327	16.43	2.74	5.140	0.001
	Male	864	15.52	2.59		

Table 4 Results of the difference analysis on depression level based on participants' PA levels and BMIs

Source	Sum of Squares	Df	Mean Square	F	*p*	η^2
Corrected Model	3380.776	11	307.343	3.917	0.000	0.035
Intercept	109201.758	1	109201.758	1391.593	0.000	0.541
PA Level	526.902	2	263.451	3.357	0.035	0.006
BMI	720.934	3	240.311	3.062	0.027	0.008
PA Level*BMI	993.641	6	165.607	2.550	0.048	0.011
Error	92519.054	1179	78.472			
Total	396237.000	1191				
Corrected Total	95899.830	1190				

Dependent Variable: Depression; *PA* Physical Activity; *BMI* Body Mass Index

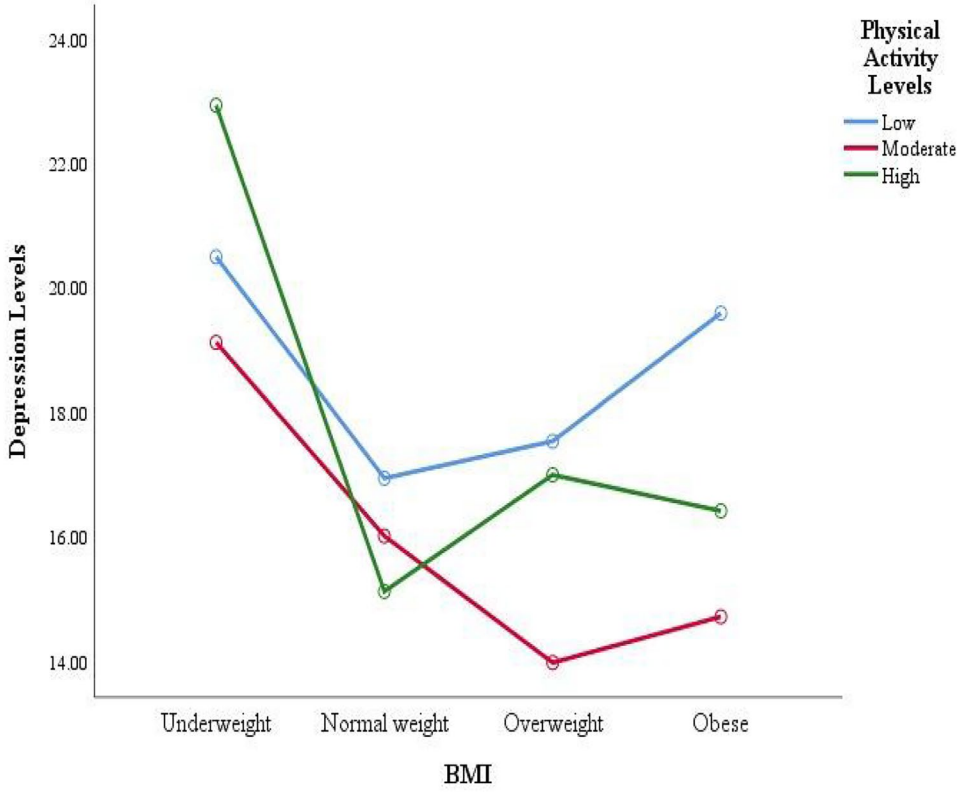

Fig. 1 Scores of depression levels based on PA levels of adults with different BMIs

When evaluated in terms of PA levels, the depression levels of adults with low PA levels reached the highest values, especially in the "Underweight" and "Obese" groups. In adults with moderate PA, depression levels were generally lower, reaching the lowest levels in the "Normal weight" category. A similar trend was observed in adults with high PA, with a significant decrease in depression levels, especially in adults in the "Normal weight" category of BMI. In general, increasing PA levels have a reducing effect on depression levels, while having a BMI in the "Normal Weight" range is associated with lower depression levels, particularly at higher PA levels (Fig. 1).

The results of the present study demonstrated that both PA levels and BMI independently contributed to significant differences in sleep quality among adults ($p < .05$).

Table 5 Results of the difference analysis on sleep quality level based on participants' PA levels and BMIs

Source	Sum of Squares	Df	Mean Square	F	*p*	η^2
Corrected Model	261.425	11	23.766	3.438	0.000	0.035
Intercept	82459.211	1	82459.211	11928.681	0.000	0.915
PA Level	59.447	2	29.724	4.300	0.014	0.008
BMI	99.184	3	33.061	4.783	0.003	0.013
PA Level*BMI	23.112	6	3.852	0.557	0.765	0.003
Error	7693.818	1113	6.913			
Total	287561.313	1125				
Corrected Total	7955.243	1124				

Dependent Variable: Sleep Quality; *PA* Physical Activity; *BMI* Body Mass Index

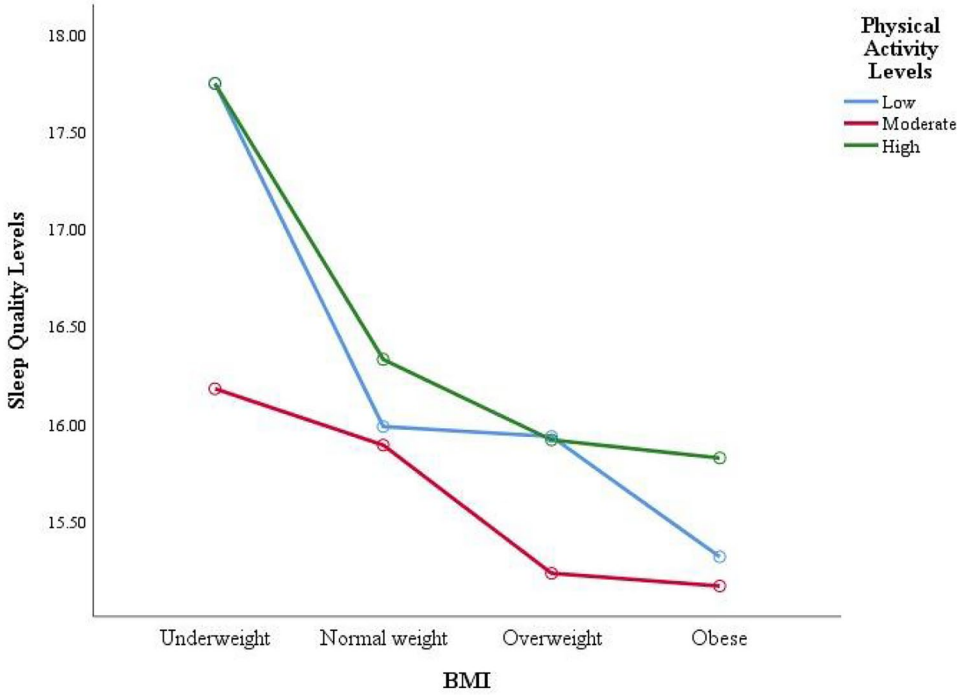

Fig. 2 Scores of sleep quality levels based on PA levels of adults with different BMIs

However, the interaction between these two variables was not statistically significant ($p > .05$; Table 5). The sleep quality scores regarding PA levels of adults with different BMIs were presented in Fig. 2.

While sleep quality was highest in the underweight BMI category, a significant decrease in sleep quality was observed as BMI increased. As PA levels increased, sleep quality increased significantly for adults in each BMI category. In particular, higher PA levels were associated with the highest sleep quality regardless of BMI level. These results suggest that increasing PA plays an important role in improving sleep quality, regardless of BMI levels (Fig. 2).

Discussion

This study aimed to examine the relationship between PA, BMI, depression, and sleep quality among Turkish adults. Results showed that 44.2% of participants were of normal weight, while 55.8% reported engaging in moderate levels of PA (Table 1). Our results showed that there was a statistically significant difference in the depression levels of the adults in the interaction of PA levels and BMIs ($p < .05$; Table 4). Hung et al. (2014) reported a positive relationship between high BMI and major depression [53]. de Wit et al. (2009) concluded that there was a relationship between very low or high BMI and depression in individuals aged 18–90 years [54]. In a study conducted by Tyrrell et al. (2019), it was concluded that there is a relationship between BMI and depression, and as the BMI value increases, depression scores increase [55]. Similar to previous studies and the findings of the current study, it was emphasized that obesity was an important factor in the development of diseases such as anxiety and depression [9, 27, 28]. Although PA is generally considered to be a therapeutic behavior that supports sleep, sleep quality is also known to play a role in changes in PA

functions [56, 57]. Several studies have found that moderate PA [58], physical and mental exercises, and challenging strength exercises [59, 60] are effective in improving sleep quality. In this study, we found that participants in the underweight BMI category demonstrated the highest sleep quality scores, while sleep quality decreased significantly as BMI increased. Participants with higher PA levels were associated with significantly better sleep quality and lower BMI and depression scores. (Fig. 1). Previous studies conducted to evaluate sleep quality have found a relationship between sleep disturbance and BMI [61, 62]. Regular PA allows adults to keep their body weight within normal limits and thus control their BMI [63]. In a cross-sectional study conducted by Kim et al. (2023) to examine the correlation of PA and sleep quality with anthropometric characteristics of university students, they were reported that university students generally had poor sleep quality, and BMI values were associated with their participation in PA [64]. In a study conducted by Adagide and Karataş (2021) on depression patients, a 14-week exercise program was applied to the patients, and it was concluded that increased PA levels reduced depression symptoms. It was also recommended that regular aerobic PA should be used in the treatment of depression [65]. In a study conducted in China, the effect of living environment and depression status of older adults on sleep quality was examined, and it was found that the living environment of the elderly had a direct effect on sleep quality, while depression acted as a mediator on living environment and sleep quality [66]. In a meta-analysis study conducted on the adult population, it was found that there was an inverse curvilinear relationship between PA levels and depression levels [67]. In a study conducted on 52 adolescents hospitalized in a clinic for depression treatment, exercise was applied to the research group for 6 weeks. As a result, it was stated that PA decreased depression findings and was a good adjunctive treatment tool in this regard [68]. Similarly, in a meta-analysis study on children and adolescents, it was emphasized that PA could be used to reduce depression symptoms [69]. In the current study and previous literature studies, it can be stated that PA has many positive effects on health and is significantly effective in reducing mental health and depression symptoms [70, 71]. According to the findings of this study, adults with normal BMI levels have the lowest levels of depression. Moreover, the increase in PA level shows that it has a decreasing effect on depression levels.

Some studies have suggested a very strong link between depression and sleep disturbance [29, 31]. In depressed subjects, sleep continuity is often impaired, sleep efficiency decreased, and total sleep time reduced. The results from the present study agree with an association between poor sleep quality and increased depression levels [30]. The analysis revealed a statistically significant difference in depression and sleep quality levels based on gender ($p<.05$); women's depression levels and sleep quality were found to be higher than men's (Table 3). Contrary to our findings, some studies have found that women have lower sleep quality than men [72–74]. In some studies, like this study, a meta-analysis on depression, including 90 studies from 30 countries, reported consistently higher prevalence rates of depression in women compared to men [75]. In a review on social anxiety disorder, including 14 studies from different countries, women were more often suffering from anxiety and reported elevated severity compared to men [76]. Our finding results, it can be said that the number of male participants is twice that of female participants, which causes differences in depression and sleep quality levels between genders. These gender disparities may be influenced by a range of factors, including differences in employment, societal roles, and cultural expectations, all of which may contribute to the heightened depression and sleep quality disturbances observed among women [77]. In addition to depressed women might prioritize rest or avoid stress-inducing activities, leading to more consistent sleep routines that temporarily improve sleep quality.

The results of this study demonstrated that both PA levels and BMI independently contributed to significant differences in sleep quality among adults. However, the interaction between these two variables was not statistically significant ($p>.05$; Table 5). Studies conducted with medical students in Saudi Arabia [78] and Brazil [79] found that students had low PA and low sleep quality. A study conducted with university students in China found that there was a significant negative relationship between the students' PA levels and their sleep quality [80]. Another study conducted with university students found that PA directly affects sleep quality to a significant extent and stated that there was a negative correlation between the degree of sleep quality and PA level, and that the more physically active the students were, the lower their sleep quality scores were [81]. In a study conducted by Jiang et al. (2022) on patients with insomnia, it was found that there was a relationship between PA, depression, and sleep quality and that depression significantly reduced sleep quality [82]. Kakinami et al. (2017) reported in their study on young adults that the intensity and duration of PA were not associated with sleep quality [83]. Seol et al. (2019) reported in their research on sedentary individuals that when low PA was replaced with high PA, no significant difference was found in the participants' sleep quality [84]. Rezaie et al. (2023) examined the relationship between sleep quality, emotional dysregulation, PA participation levels, age, and BMI in their study with 118 patients with major depressive disorder

and found that there was a negative relationship between sleep problems and emotional dysregulation and PA levels. At the same time, they stated that there was no significant relationship between sleep problems and age and BMI [85]. This can be said to be due to the association of more time spent on sedentary activities and lower levels of PA with lower sleep quality. This suggests that the effect of PA on sleep quality does not differ across BMI categories. In other words, regardless of whether individuals have a low, normal, or high body mass index, the relationship between PA and sleep quality appears to remain consistent. These findings indicate that PA and BMI influence sleep quality independently, without producing an interactive effect that alters this relationship.

Conclusion

This study highlights the significant influence of PA and BMI on sleep quality and depression levels. The findings suggest that higher levels of PA are associated with better sleep quality and reduced symptoms of depression. Conversely, elevated BMI is often linked to poorer sleep and higher rates of depressive symptoms. These results emphasize the importance of maintaining a healthy lifestyle, including regular PA and weight management, not only for physical health but also for improving mental well-being and sleep quality. Future research should explore these relationships across different age groups and populations to develop targeted health interventions.

Strengths

The current study has several important strengths. Firstly, the study examines the effects of PA and BMI on sleep quality and depression by considering these variables together. The study contributes to growing evidence supporting lifestyle-based interventions to improve mental and physical health. In previous studies, these variables have generally been evaluated separately, and their examination together in the same study was quite limited. In this context, our study was one of the unique studies that addressed the relationships between PA, BMI, sleep quality, and depression holistically. Secondly, this study was conducted on individuals who use parks and recreation areas for PA in Türkiye. Thus, the effects of PA on health status were examined in the context of Türkiye, which will allow for comparisons to be made with different cultural contexts in the future. However, it should be noted that the sample included a disproportionately high number of male participants compared to females, which may limit the generalizability of gender-based findings, particularly those related to depression and sleep quality. Therefore, the results regarding gender differences should be interpreted with caution, and future research is recommended to include more balanced gender distributions. In addition, all data, including height and weight for BMI calculation, were self-reported, which may introduce reporting and recall bias. This limitation should be considered when interpreting the findings, and future studies are encouraged to use objective measurements to reduce this potential bias. Thirdly, the effects of PA level and BMI on sleep quality and depression were analyzed in detail using the relational screening model in the study. The use of the Univariate analysis method provides a strong statistical framework in explaining the relationships between variables and analyzing the effects of the interaction of PA and BMI on sleep quality and depression.

In addition to the strengths of the study, there were also some limitations. Firstly, the study was conducted using the purposive sampling method. This method was preferred due to the inability to determine the exact number of adults using parks and recreation areas in Türkiye and due to time and cost constraints. However, although purposive sampling was used, it may limit the generalizability of the results for an unknown universe. Secondly, the study was conducted only on adults using parks and recreation areas. The effects of PA on sleep quality and depression were not compared with individuals performing PA in different environments (gyms, home exercises, etc.). It may be recommended that different PA environments be included in future studies. Thirdly, the study used the survey technique, which is a quantitative research method.

Limitation

The sample may not be representative of the general population, limiting the generalizability of the findings. Self-reported data on PA, sleep quality, and depressive symptoms may introduce bias or inaccuracies. To minimize this limitation, more objective data collection methods, such as PA and sleep quality measurements with trackable devices, such as pedometers, etc., can be used in future studies. In addition, more in-depth studies can be conducted on these topics with qualitative research techniques (interviews, observation, etc.) or mixed research methods. Potential confounding factors such as diet, medication use, and underlying health conditions were not controlled for in the analysis.

Abbreviations

BMI	Body Mass Index
BDI	Beck Depression Inventory
IPAQ-SF	International Physical Activity Questionnaire- Short Form
MET	Metabolic Equivalent
PA	Physical Activity
PSQI	Pittsburgh Sleep Quality Index

Acknowledgements

Legal permission for the use of the scales used in this study was obtained from the researchers who conducted the Turkish validity and reliability study of the scales. Additionally, the authors would like to thank all participants.

Authors' contributions
G.C. and O.I. contributions to the conception and design G.C. and G.D. and A.T. and wrote the main manuscript text C.A. and O.I. prepared tables and figures C.A. and O.I. analysis, interpretation of data All authors reviewed the manuscript and to have approved the submitted version (and any substantially modified version that involves the author's contribution to the study).

Funding
There is no financial support received for this study.

Data availability
The data sets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
This study was ethically approved by the Balıkesir University Health Sciences Non-invasive Research Ethics Committee, with decision number 2024/11.This study was approved by the Local Ethical Committee and performed according to the Declaration of Helsinki. In addition, informed consent was obtained from all participants before answering the questions.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

Received: 4 March 2025 / Accepted: 8 July 2025
Published online: 02 August 2025

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