



Research Article/Özgün Araştırma

Investigation of the effect of sleep quality on balance, reaction time and interoception in young women

Genç kadınlarda uyku kalitesinin denge, reaksiyon zamanı ve interosepsiyon üzerine etkisinin araştırılması

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Abstract

Aim: This study primarily examined the effects of sleep quality on dynamic balance, reaction time, and interoception in young women. The secondary aim of the study was to examine factors affecting sleep quality.

Materials and Methods: Forty-nine women aged 18–35 were divided into good (n=24) and poor (n=25) sleep quality groups based on the Pittsburgh Sleep Quality Index. Dynamic balance was evaluated with modified Lower Quarter Y Balance Test, reaction time with a FitLight Trainer™, and interoception with the Body Awareness Questionnaire.

Results: Poor sleep quality was associated with reduced dynamic balance (dominant $p=0.042$; non-dominant $p=0.007$), slower reaction times ($p=0.0001$), and reduced interoception ($p=0.026$). Reaction time predicted poor sleep; each unit increase raised risk by 44.5 % ($p=0.003$).

Conclusion: Poor sleep quality negatively impacts balance, reaction time, and interoception in young women, underscoring the importance of healthy sleep patterns.

Keywords: Sleep quality; Postural balance; Reaction time; Interoception; Young women.

Öz

Amaç: Bu çalışma, öncelikle genç kadınlarda uyku kalitesinin dinamik denge, reaksiyon zamanı ve interosepsiyon üzerindeki etkilerini inceledi. Çalışmanın ikincil amacı ise uyku kalitesini etkileyen faktörleri incelemektir.

Gereç ve Yöntem: Yaşları 18–35 arasında değişen 49 kadın, Pittsburgh Uyku Kalitesi İndeksi'ne göre iyi (n=24) ve kötü (n=25) uyku kalitesine sahip iki gruba ayrıldı. Dinamik denge, modifiye Alt Ekstremitte Y Denge Testi ile; reaksiyon zamanı, FitLight Trainer™ cihazı ile; interosepsiyon ise Vücut Farkındalığı Anketi ile değerlendirildi.

Bulgular: Kötü uyku kalitesine sahip katılımcılarda, dinamik dengede (dominant $p=0,042$; non-dominant $p=0,007$) azalma, reaksiyon zamanında ($p=0,0001$) uzama ve interosepsiyon skorlarında ($p=0,026$) düşüş gözlemlendi. Reaksiyon zamanı, kötü uyku kalitesinin anlamlı bir yordayıcısı olarak belirlendi ve her birim artış, kötü uyku riskini % 44,5 oranında artırdı ($p=0,003$).

Sonuç: Genç kadınlarda kötü uyku kalitesi, denge, reaksiyon zamanı ve interosepsiyonu olumsuz etkilemekte olup sağlıklı uyku alışkanlıklarının önemini vurgulamaktadır.

Anahtar Kelimeler: Uyku kalitesi; Postüral denge; Reaksiyon zamanı; İnterosepsiyon; Genç kadınlar.

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Bu makale araştırma ve yayım etiğine uygun hazırlanmıştır.



intihal incelemesinden geçirilmiştir.



Introduction

Sleep is a vital biological process that significantly influences overall health. The quality of sleep, a multifaceted concept that includes factors like sleep duration, continuity, the sensation of being refreshed upon waking, and daytime drowsiness^{1,2}, is crucial for the optimal functioning of both psychological and physiological processes.³

Inadequate sleep quality may result in cognitive impairments, diminished motor skills, emotional instability, and a decrease in performance. It may also increase accident risks and exacerbate various medical, neurological, and psychiatric conditions.^{4,5} These negative effects result in an overall decrease in quality of life, while the complex interactions between sleep and sensory processes represent a significant area of interest for researchers.⁶

Postural control is a complex skill that can be affected by sleep quality and is essential for regulating motor functions. It is achieved through the integration of somatosensory, visual, and vestibular systems; any dysfunction in these systems, particularly deficits in the vestibular system, can disrupt postural balance.⁷ Although numerous studies have investigated the effects of sleep quality on dynamic balance in older populations^{8,9}, there is a limited amount of research focusing on young adults.¹⁰ Including findings related to women in this relatively underexplored area is believed to offer new insights.

Reaction time, which refers to the ability to respond swiftly and accurately to environmental stimuli, is vital for both safety and performance.¹¹ Sleep deprivation can increase reaction times by reducing mental alertness and cognitive flexibility.¹² Previous studies have primarily used hand reaction time tests, often conducted in a seated position and focusing on the upper extremities.¹³⁻¹⁷ However, only one study has been found examining the effect of sleep quality on lower extremity reaction time, and the sample consisted of athletes.¹⁸ They assessed the impact of sleep quality on visuomotor reaction time using the Fit Light Trainer System.

Interoception and body awareness are conceptually related and sometimes used interchangeably in the literature. However, they are not identical. Interoception refers specifically to the perception of internal bodily signals, whereas body awareness is a broader concept that includes interoception along with other sensory inputs. A 2024 meta-analysis showed that self-report questionnaires were used to assess interoception in terms of individuals' awareness of internal bodily states¹⁹.

The intricate interactions between sleep and sensory processes are particularly evident in interoceptive modalities, such as thermosensation, nociception, visceral sensations, and the subjective experiences related to these sensations.⁶ Interoception, the ability to perceive and regulate internal bodily states, plays a vital role in maintaining emotional and physiological balance.²⁰ Insufficient sleep can disrupt the ability to sense bodily signals, leading to emotional and physiological imbalances.^{21,22} Young women may exhibit significant differences in sleep quality due to hormonal changes and social environmental factors.²³⁻²⁵ A study evaluating 3,778 young adults (aged 20.6 ± 0.86 years) reported that poor sleep quality was more prevalent among women than men (65.1% vs. 49.8%).²⁶ Therefore, this study seeks to examine the impact of sleep quality on interoception in young women.

This study aims to examine the effects of sleep quality on balance, reaction time, and interoception in young women. We hypothesize that poor sleep quality will have a negative effect on dynamic balance, reaction time, and interoception in young women. The secondary aim of the study was to examine factors affecting sleep quality.

Materials and Methods

The type of the study

The study was planned as a cross-sectional study and aimed to determine the effects of sleep quality on balance, reaction time, and interoception in young women.

The samples of the research

Sample size calculations were performed using G*Power 3.19 (Heinrich Heine University, Düsseldorf, Germany). Based on findings from the reference study²⁷, the power analysis indicated that 80% power would be achieved at a 95% confidence level when at least 48 participants (24 participants per group) were included in the study.

This study involved 49 female participants, 24 of whom reported good sleep quality and 25 reported poor sleep quality. Data collection took place between September and December 2024.

The study included female participants aged 18 to 35 years who volunteered and had no neurological or orthopedic health issues. Those with lower extremity fractures or surgeries within the past year were excluded. This age range was chosen because young adulthood is characterized by relatively stable neuromuscular function, hormonal profiles, and cognitive performance, with minimal decline compared to older groups²⁸. Selecting this range helped reduce variability from age-related sensory, motor, or hormonal changes, creating a more homogeneous sample.

Sociodemographic and health-related information of all participants were collected through a structured assessment form. The form collected information on personal and clinical data, including age, height, weight, dominant side, and history of surgeries or injuries. Participants' weight and height were measured using the Pulsemes BYH01 device. Measurements were taken without shoes, with participants standing upright.

Sleep quality was evaluated using the Pittsburgh Sleep Quality Index (PSQI), a commonly used self-report tool in research for assessing sleep quality.^{29,30} The PSQI was originally developed by Buysse et al. and adapted into Turkish by Ağargün et al.^{31,32} It assesses sleep quality and disturbances over the past month, consisting of 18 items divided into seven components: subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleep medications, and daytime dysfunction. Each component is rated on a scale from 0 to 3, with the total score ranging from 0 to 21.

Scores above 5 indicate poor sleep quality. Participants with good sleep quality were placed in the control group, while those with poor sleep quality were assigned to the poor sleep quality group.

Data collection tools

Outcome measures included dynamic balance, reaction time, and interoception. To control for potential hormonal influences, participants were evaluated outside of their menstrual phase, based on self-reported cycle timing.

Dynamic balance was assessed using the Modified Lower Quarter Y Balance Test (YBT). Leg length was measured bilaterally while the participants were in a supine position, from the anterior superior iliac spine to the medial malleolus. Participants were given a brief demonstration of the test by an experienced researcher, followed by six practice trials in each direction.¹⁰ After a two-minute rest, three test trials were performed in the anterior, posteromedial, and posterolateral directions for each leg (dominant and non-dominant). To determine the dominant lower extremity, the question "If you would shoot a ball on a target, which leg would you use to shoot the ball?" was asked³³. The highest score for each direction was recorded. The composite YBT score was calculated using the following formula:

$$\text{Composite Score} = \frac{\text{[Sum of Reach Distance in 3 Directions]} / (3 \times \text{Limb Length})}{1} \times 100$$

If the participant moved their supporting leg, removed their hands from the iliac crest, or lost balance during the test, the trial was deemed invalid and repeated.

Lower extremity reaction time was measured using the FitLight Trainer™ system, which consists of eight laser-equipped LED sensors.¹⁸ The sensors were arranged on the floor in a semi-circular pattern with equal spacing (Figure 1). The distance from each sensor to the participant was adjusted to correspond to one step length. Participants stood upright and were instructed to deactivate the randomly illuminated sensors by moving their foot toward the light without making

physical contact with the sensor. They were free to use either foot to deactivate the lights, as no specific instructions were given regarding foot selection.



Figure 1. Lower extremity reaction time measurement.

The test consisted of 30 random light activations (hits). The placement of the FitLights remained consistent across all trials for all participants. A demonstration of the test was provided before the assessment. Each participant performed the test twice, and the best reaction time result was recorded for statistical analysis.

Interoception was evaluated using the Body Awareness Questionnaire (BAQ), which is a questionnaire consisting of four subtitles (changes in body processes, sleep-wake cycle, prediction of disease onset, prediction of body reactions) and a total of 18 items, aiming to

determine the level of sensitivity to normal or abnormal body composition.³⁴ Participants rated each item on a 7-point Likert scale, with higher scores indicating greater body awareness.³⁵

Statistical Analysis

Statistical analyses were performed using the Statistical Package for the Social Sciences (SPSS) version 25.0 (SPSS Inc., Chicago, IL). Normal distribution of the variables was assessed using the Shapiro-Wilk test along with skewness and kurtosis values. Continuous variables were presented as mean \pm standard deviation, while categorical variables were reported as numbers and percentages. Group comparisons were conducted using the Independent Samples t-test for parametric data and the Mann-Whitney U test for non-parametric data. Multiple regression analysis was used to evaluate predictive relationships. The statistical significance level was accepted as $p < 0.05$.

Ethics committee approval

Ethical approval for the study was granted by the Van Yuzuncu Yil University Non-Interventional Clinical Research Ethics Committee (Decision No.: 2024/05-14). Before the study began, informed consent and written permission were obtained from all participants. The study was conducted in accordance with the principles of the Declaration of Helsinki (World Medical Association, Ferney-Voltaire, France, 2013).

Results

The group with good sleep quality was designated as the control group. Descriptive characteristics of participants in both the poor sleep quality group and the control group are presented in Table 1. Two groups showed similarity in terms of age, weight, height, and BMI ($p > 0.05$).

Table 1. Descriptive and clinic data of the participants

Variables	Control (n=24)	Poor Sleep Quality (n=25)	p
	Mean \pm SD	Mean \pm SD	
Age (years)	21.88 \pm 1.51	22.41 \pm 0.93	0.069 ^b
Weight (kg)	56.16 \pm 9.31	59.75 \pm 8.88	0.870 ^a
Height (cm)	162.01 \pm 4.98	162.51 \pm 5.77	0.164 ^a
BMI (kg/m ²)	21.42 \pm 3.59	22.61 \pm 3.11	0.596 ^a

^aIndependent-Samples T Test; ^bMann Whitney-U Test

The results of dynamic balance, interoception (BAQ), and reaction time assessments are presented in Table 2. In dynamic balance tests, individuals with poor sleep quality demonstrated significantly lower balance performance on both the dominant ($p = 0.042$) and non-dominant sides ($p = 0.007$).

Similarly, BAQ scores were significantly lower in individuals with poor sleep quality ($p = 0.026$). Regarding reaction times, individuals with poor sleep quality exhibited significantly longer reaction times compared to the control group ($p = 0.0001$).

Table 2. Comparison of dynamic balance, reaction time, and interoception (BAQ) by groups.

Variables	Control (n=24)	Poor Sleep Quality (n=25)	Mean Difference (95% CI)	p^*
	Mean \pm SD (95% CI)	Mean \pm SD (95% CI)		
Dynamic balance (%LL)				
Dominant YBT	88.94 \pm 5.60 (86.63-91.25)	85.29 \pm 6.60 (82.51-88.08)	3.65 (0.13 to 7.16)	0.042
Non-dominant YBT	88.37 \pm 5.83 (85.96-90.78)	83.58 \pm 5.92 (81.09-86.08)	4.78 (1.40 to 8.15)	0.007
Reaction time (sec)	34.40 \pm 1.64 (33.72-35.08)	37.75 \pm 2.12 (36.85-38.64)	-3.34 (-4.43 to -2.25)	0.0001
BAQ score	98,52 \pm 11.52 (93.76-103.27)	90.33 \pm 13.38 (84.68-95.98)	8.18 (1.01 to 15.35)	0.026

%LL: percentage of leg length; YBT: Y balance test; BAQ: Body Awareness Questionnaire; *: Independent-Samples T Test; Statistically significant differences were given in bold.

The determinants of sleep quality were examined using Multiple Linear Regression analysis (Table 3). According to the results of this analysis, reaction time was a significant predictor of sleep quality ($\beta = 0.445$, $p = 0.003$). This finding indicates that a one-unit

increase in reaction time is associated with a 44.5% higher risk of impaired sleep quality. However, the effects of interoception (BAQ) and dynamic balance parameters on sleep quality were not statistically significant ($p > 0.05$).

Table 3. Multiple linear regression results for factors affecting sleep quality

Variables	B	Std. Error	β	t	p
Constant	-4.342	9.251		-0.469	0.641
Dominant YBT	0.088	0.104	0.193	0.845	0.403
Non-dominant YBT	-0.147	0.107	-0.322	-1.370	0.178
Reaction time	0.507	0.159	0.445	3.183	0.003
BAQ score	-0.028	0.030	-0.127	-0.934	0.355

Dependent Variable: Quality of Sleep

R: 0.613 R²: 0.376 F: 6.616 p : 0.0001

YBT: Y balance test; BAQ: Body Awareness Questionnaire; Statistically significant differences were given in bold.

Discussion

This study evaluated the effects of sleep quality on balance, reaction time, and interoception in young women. Our findings revealed that individuals with poor sleep quality exhibited worse dynamic balance and interoception, as well as prolonged reaction times. Furthermore, it was observed that each unit increase in reaction time significantly elevated the risk of impaired sleep quality.

Marwanasari et al. reported a strong association between sleep quality and dynamic balance.⁸ Similarly, Serrano-Checa et al. found that poor sleep quality was associated with slower walking speed and reduced functional

mobility, attributing these findings to impaired dynamic balance.⁹ However, the sample of the studies consists of elderly individuals. It is well-established that the non-dominant lower limb has lower muscle strength compared to the dominant limb.³⁶ Castor et al. reported that in the presence of sleep deprivation, the muscle strength of the non-dominant limb was insufficient to maintain dynamic balance. Dynamic stability of the non-dominant limb has been reported to be more affected by sleep deprivation.³⁷ These findings align with our results. Tanwar et al. highlighted that the Y Balance Test is a reliable method for detecting dynamic balance impairments in individuals

with sleep deprivation.¹⁰ In our study, participants with poor sleep quality demonstrated significantly lower performance in dynamic balance tests, consistent with the adverse effects of sleep deprivation on motor skills and balance control. The literature also indicates that sleep deprivation negatively impacts the vestibular system, leading to reduced postural stability and impaired muscle control.^{11,38}

Previous studies have predominantly used Psychomotor Vigilance Tests (PVT) to assess reaction time.¹⁷ These tests provide an objective evaluation of changes in alertness resulting from sleep deprivation, extended wakefulness, circadian misalignment, and task-induced fatigue. PVT is typically administered over a 10-minute period. A 2011 study examined the validity and sensitivity of the brief version of PVT (PVT-B).¹³ The results indicated that the 3-minute PVT-B yielded faster reaction times, more false starts, and fewer lapses compared to the full PVT. In our study, reaction times were assessed using the Fit Light System, which recorded the time taken to complete 30 hits. Stavrou et al. employed a similar "sum of hits (rep/30 sec)" method in their study, which examined the effects of sleep quality on perceptual cognitive abilities in adolescent and adult athletes after intense exercise.¹⁸ Unlike PVT tests, our measurements were conducted while participants were standing and maintaining their balance on their extremities. Fit Light offers a shorter and more flexible assessment compared to traditional PVT tests, as it does not require a monitor. Recent studies have utilized Fit Light technology for evaluating upper extremity reaction times.^{39,40} However, research in this area remains limited. A study assessing lower extremity reaction times reported that perceptual abilities requiring sustained attention, alertness, and motor coordination were adversely affected by sleep deprivation.¹⁸ Similarly, our findings demonstrated that participants with poor sleep quality had significantly prolonged reaction times. The delay in reaction times highlights the profound impact of sleep quality on cognitive functions. Additionally, our results showed that reaction time is a significant

predictor of sleep quality, with each unit increase in reaction time substantially increasing the risk of impaired sleep quality.

Interoception, which involves the signaling and perception of internal bodily changes, is closely associated with individual differences, emotional style, and susceptibility to emotional disorders. Subjective scales are often used to assess interoceptive awareness. Previous studies have reported that sleep disturbances can impair perceptual and interpretive dimensions of body awareness, as well as interoceptive abilities.^{21,41} These studies used tools such as the Porges Body Perception Questionnaire and the Multidimensional Assessment of Interoceptive Awareness Version 2. In our study, the Body Awareness Questionnaire was used. One study reported a statistically significant association between women's body perception and subjective sleep evaluations⁴², which supports our findings. In our study, BAQ scores were significantly lower in the poor sleep quality group, likely due to impaired sensory processing and reduced body perception capacity resulting from poor sleep quality.

The strengths of this study include relating sleep quality to multiple physiological parameters such as dynamic balance, reaction time, and interoception.

Limitation of the study

The inclusion of only young female participants constitutes a limitation, as it precludes any comparisons across age or gender and consequently limits the generalizability of the findings. Future research involving more demographically diverse samples would offer broader and more representative insights into the effects of sleep quality. Additionally, psychological variables such as depression, anxiety, and daily stress—which may influence both reaction time and interoceptive awareness—were not assessed and may be beneficial to consider in future research.

Conclusion

In conclusion, our study demonstrated that sleep quality significantly affects dynamic balance, reaction time, and interoception in

young women. Individuals with poor sleep quality exhibited lower dynamic balance performance and interoceptive awareness, as well as significantly prolonged reaction times. Furthermore, the increase in reaction time was found to be a substantial predictor of impaired sleep quality. Our findings emphasize the critical role of sleep quality in motor skills, postural control, and sensory perception, underscoring the importance of improving sleep patterns for both individual health and performance.

Ethics Committee Approval

Ethical approval for the study was granted by the Van Yuzuncu Yil University Non-Interventional Clinical Research Ethics Committee (Decision No.: 2024/05-14).

Informed Consent

The purpose and procedures of the study were explained to all participants, and the study was conducted after obtaining their informed consent.

Author Contributions

Concept/Idea: M.B., S.S.; Design and Planning: M.B., S.S., Z.A.; Supervision/Consultancy: M.B., S.S.; Resources: M.B., S.S.; Materials: M.B., Z.A.; Data Collection and/or Processing: M.B., S.S., Z.A.; Analysis and/or Interpretation: S.S.; Literature Review: M.B., S.S. Writing: M.B., S.S.; Critical Review: M.B., S.S.

Conflict of Interest

No conflict of interest was declared by the authors.

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Peer-review

Externally peer-reviewed.

References

1. Harvey AG, Stinson K, Whitaker KL, Moskovitz D, Virk H. The Subjective Meaning of Sleep Quality: A Comparison of Individuals with and without Insomnia. *Sleep*. 2008;31(3):383-393.
2. Ohayon M, Wickwire EM, Hirshkowitz M, et al. National Sleep Foundation's sleep quality recommendations: first report. *Sleep Health*. 2017;3(1):6-19.
3. Walker M. Why we sleep: the new science of sleep and dreams. London, UK: Penguin UK; 2017.
4. Hirshkowitz M, Whiton K, Albert SM, et al. National Sleep Foundation's sleep time duration recommendations: methodology and results summary. *Sleep Health*. 2015;1(1):40-43.
5. Mollayeva T, Thurairajah P, Burton K, Mollayeva S, Shapiro CM, Colantonio A. The Pittsburgh sleep quality index as a screening tool for sleep dysfunction in clinical and non-clinical samples: A systematic review and meta-analysis. *Sleep Med Rev*. 2016;25:52-73.
6. Wei Y, Van Someren EJ. Interoception relates to sleep and sleep disorders. *Curr Opin Behav Sci*. 2020;33:1-7.
7. Nielson CA, Deegan EG, Hung ASL, Nunes AJ. Potential effects of sleep deprivation on sensorimotor integration during quiet stance in young adults. *WURJ Health Nat. Sci*. 2010;1(1).
8. Marwanasari PA, Thanaya SAP, Antari NKAJ, Vittala G. The relationship between sleep quality and dynamic balance in the elderly. *Physical Therapy Journal of Indonesia*. 2024;5(1):66-70.
9. Serrano-Checa R, Hita-Contreras F, Jiménez-García JD, Achalandabaso-Ochoa A, Aibar-Almazán A, Martínez-Amat A. Sleep quality, anxiety, and depression are associated with fall risk factors in older women. *Int J Environ Res Public Health*. 2020;17(11):4043.
10. Tanwar T, Veqar Z, Ghrouz AK, Spence DW, Pandi-Perumal SR. Is poor sleep quality associated with a deterioration in postural control? *Sleep Sci*. 2021;14(3):207-213.
11. Taheri M, Arabameri E. The effect of sleep deprivation on choice reaction time and anaerobic power of college student athletes. *Asian J Sports Med*. 2012;3(1):15-20.
12. Killgore WDS, Weber M. Sleep deprivation and cognitive performance. In: Bianchi M, ed. *Sleep Deprivation and Disease*. Springer; 2014:209-229.
13. Basner M, Mollicone D, Dinges DF. Validity and sensitivity of a brief psychomotor vigilance test (PVT-B) to total and partial sleep deprivation. *Acta Astronaut*. 2011;69(11-12):949-959.
14. Bumin G, Tatli Y, Cemali M, Kara S, Akyürek G. Vardiyalı ve gündüz çalışan sağlık çalışanlarında uyku kalitesi, reaksiyon zamanı, stres ve iyilik halinin karşılaştırılması. *Hacettepe Üniversitesi Hemşirelik Fakültesi Dergisi*. 2019;6(3):170-176.
15. Çalışkan F, Sayaca Ç. Bilgisayar oyunu oynama süresinin uyku kalitesi, el reaksiyon hızı ve fiziksel aktivite seviyesi üzerine etkisi. *Gaziantep Üniversitesi Spor Bilimleri Dergisi*. 2019;4(3):289-303.
16. Jarraya S, Jarraya M, Chtourou H, Souissi N. Effect of time of day and partial sleep deprivation on the reaction time and the attentional capacities of the handball goalkeeper. *Biol Rhythm Res*. 2014;45(2):183-191.
17. Powell NB, Riley RW, Schechtman KB, Blumen MB, Dinges DF, Guilleminault C. A comparative model: reaction time performance in sleep-disordered breathing versus alcohol-impaired controls. *Laryngoscope*. 1999;109(10):1648-1654.
18. Stavrou VT, Astara K, Tourlakopoulos KN, et al. Sleep quality's effect on vigilance and perceptual ability in adolescent and adult athletes. *J Sports Med (Hindawi Publ Corp)*. 2021;2021:5585573.
19. Clemente R, Murphy A, Murphy J. The relationship between self-reported interoception and anxiety: A systematic review and meta-analysis. *Neurosci Biobehav Rev*. 2024;167:105923.
20. Khalsa SS, Adolphs R, Cameron OG, et al. Interoception and mental health: a roadmap. *Biol Psychiatry Cogn Neurosci Neuroimaging*. 2018;3(6):501-513.
21. Ewing DL, Manassei M, Gould van Praag C, Philippides AO, Critchley HD, Garfinkel SN. Sleep and the heart: Interoceptive differences linked to poor experiential sleep quality in anxiety and depression. *Biol Psychol*. 2017;127:163-172.
22. Wang W, Zhu Y, Yu H, et al. The impact of sleep quality on emotion regulation difficulties in adolescents: a chained mediation model involving daytime dysfunction, social

- exclusion, and self-control. *BMC Public Health*. 2024;24(1):1862.
23. Foster RG. Sleep, circadian rhythms and health. *Interface Focus*. 2020;10:20190098.
 24. Bayoumy HMM, Sedek H, Omar H, Ayman S. Investigating the relationship of sleep quality and psychological factors among health professions students. *Int J Afr Nurs Sci*. 2023;19:100581.
 25. Zhai K, Gao X, Wang G. The role of sleep quality in the psychological well-being of final year undergraduate students in china. *Int J Environ Res Public Health*. 2018;15(12):2881.
 26. Fatima Y, Doi SAR, Najman JM, Mamun A Al. Exploring gender difference in sleep quality of young adults: findings from a large population study. *Clin Med Res*. 2016;14(3-4):138-144.
 27. Vardar O, Özkan S, Sercekus P. Postmenopozal kadınlarda uygulanan egzersiz programının uyku kalitesine etkisi. *Cukurova Medical Journal*. 2020;45(3):1108-1114.
 28. Seidler RD, Bernard JA, Burutolu TB, et al. Motor control and aging: Links to age-related brain structural, functional, and biochemical effects. *Neurosci Biobehav Rev*. 2010;34(5):721-733.
 29. Kline CE. Sleep Quality. In: *Encyclopedia of Behavioral Medicine*. Springer International Publishing; 2020:2064-2066.
 30. Shelgikar AV, Chervin R. Approach to and evaluation of sleep disorders. *Continuum (Minneapolis)*. 2013;19(1 Sleep Disorders):32-49.
 31. Buysse DJ, Reynolds CF, Monk TH, Berman SR, Kupfer DJ. The Pittsburgh sleep quality index: A new instrument for psychiatric practice and research. *Psychiatry Res*. 1989;28(2):193-213.
 32. Ağargün M, Kara H AÖ. Validity and reliability of the pittsburgh sleep quality index. *Turk Psikiyatri Derg*. 1996;7:107-115.
 33. van Melick N, Meddeler BM, Hoogeboom TJ, Nijhuis-van der Sanden MWG, van Cingel REH. How to determine leg dominance: The agreement between self-reported and observed performance in healthy adults. *PLoS One*. 2017;12(12):e0189876.
 34. Karaca S, Bayar B. Turkish version of body awareness questionnaire: validity and reliability study. *Turk J Physiother Rehabil*. 2021;32(1):44-50.
 35. Mehling WE, Gopisetty V, Daubenmier J, Price CJ, Hecht FM, Stewart A. Body awareness: construct and self-report measures. *PLoS One*. 2009;4(5):e5614.
 36. Jacobs C, Uhl TL, Seeley M, Sterling W, Goodrich L. Strength and fatigability of the dominant and nondominant hip abductors. *J Athl Train*. 2005;40(3):203-206.
 37. Castor CGM, Santos TRT, Souza TR, et al. Effect of sleep deprivation on postural control and dynamic stability in healthy young adults. *Neurosci Lett*. 2023;797:137055.
 38. Craven J, McCartney D, Desbrow B, et al. Effects of acute sleep loss on physical performance: a systematic and meta-analytical review. *Sports Medicine* 2022;52(11):2669-2690.
 39. Kocaoğlu Y. Relationship between dominant and non-dominant hand grip strength and visual response time in kickboxing athletes. *Adv Health Exerc*. 2024;4:113-118.
 40. Lee MC, Ho CS, Hsu YJ, et al. The impact of dazzeon asleep® far-infrared blanket on sleep, blood pressure, vascular health, muscle function, inflammation, and fatigue. *Clocks Sleep*. 2024;6(3):499-516.
 41. Arora T, Barbato M, Al Hemeiri S, Omar OM, AlJassmi MA. A mysterious sensation about sleep and health: the role of interoception. *BMC Public Health*. 2021;21(1):1584.
 42. Karaman S, Kayhan A, Can Ü, Kara İ. Investigation of the relationship between body appreciation and sleep quality. *Turk J Sport Exe*. 2024;26(1):100-106.