

Relationship between sleep quality, nutrition habits and body composition: A study on young athletes

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Abstract

Background: Adequate sleep, balanced nutrition, and optimal body composition are essential components that support health, recovery, and athletic performance in young athletes. Understanding how these factors interact is crucial for developing individualized strategies that aim to improve both overall well-being and sport-specific outcomes. **Purpose:** This study aims to examine the relationships between attitudes towards healthy nutrition, sleep characteristics, and body composition in young athletes. **Method:** The research used a correlational survey design, involving 33 volunteer athletes (16 women, 17 men) aged 18-23 who regularly participated in sports. Data were collected through the “Attitudes Towards Healthy Eating Scale,” “Smartwatch Sleep Tracking,” and “Bioelectrical Impedance Analysis (BIA).” The Shapiro–Wilk test confirmed normal distribution. An independent-samples t-test was used for gender comparisons, and Pearson's correlation analysis was employed to examine relationships among variables ($\alpha = 0.05$). **Results:** Male athletes had significantly higher BMI and muscle mass than female athletes, whereas female athletes had a higher percentage of fat mass ($p < 0.05$). Significant negative correlations were found between healthy eating attitude scores and weight, BMI, and muscle mass; attitude scores were also negatively correlated with breathing quality ($p < 0.05$). Light sleep showed a positive correlation with total nighttime sleep, whereas light sleep, deep sleep, REM sleep, and breathing quality showed significant negative relationships. **Conclusions:** The study demonstrates that young athletes' attitudes towards healthy eating may be associated with body composition indicators and that specific sleep components may be linked to physiological parameters. It emphasizes the importance of considering sleep, healthy eating habits, and body composition together and suggests that personalized lifestyle support programs may positively influence health and performance.

Keywords: Nutrition attitudes, BIA, Athletic health, Sleep quality, Body composition

Introduction

Nutrition is a fundamental requirement for living organisms to sustain life and support growth and development. Healthy nutrition is defined as the adequate and balanced intake of energy and nutrients (Aka, 2020; Arslantaş et al., 2017; Werner et al., 2022). For athletes, this process is not limited to maintaining health but is also directly related to supporting training efficiency, promoting muscle recovery, and maintaining fluid–electrolyte balance (Werner et al., 2022). Moreover, proper nutritional practices reduce the risk of injury, enhance recovery, and support long-term maintenance of body composition (Papadopoulou, 2020).

University-aged young athletes often face challenges maintaining healthy eating habits due to ongoing developmental changes, exposure to academic and social stressors, and changing environmental conditions (Magee et al., 2023; Mazurek-Kusiak et al., 2021). Research indicates that, despite engaging in regular physical activity, individuals in this age group frequently experience issues such as inadequate knowledge of healthy nutrition and irregular meal patterns (Özgür & Uçar, 2020; Werner et al., 2022). This situation may increase the risk of low energy availability, disordered eating behaviors, and an unbalanced body composition (Magee et al., 2023; Papadopoulou, 2020). Body composition, defined as the proportional distribution of body components such as muscle, fat, bone, and fluid, is a crucial indicator for monitoring an athlete's health and evaluating their performance potential. This parameter is influenced by multiple factors, including sex, age, physical activity level, and nutritional habits (Asan, 2023; Butnariu, 2025; Lombardo, Feraco, Camajani, et al., 2024; Ponti et al., 2020). Maintaining optimal body composition in athletes is essential not only for supporting physical performance characteristics such as endurance, strength, and agility but also for sustaining metabolic balance and hormonal regulation (Aka, 2020; Bocharin et al., 2025; Ozbay et al., 2024; Samanipour et al., 2025; Schroder et al., 2021; Toselli, 2021). Sleep plays a critical role in the physical and mental recovery processes of young athletes. Sleep quality is considered a crucial factor in the proper functioning of physiological systems, including muscle repair, immune function, and cognitive well-being (Mason et al., 2023). Research indicates that athletes who obtain sufficient sleep in terms of both duration and quality have a lower risk of injury and adapt more

effectively to training (Barnard et al., 2022; Hamlin et al., 2021; Mason et al., 2023). Conversely, high training loads and irregular lifestyles in young athletes can lead to reduced sleep duration and deteriorated sleep quality (Jindal et al., 2021). Various findings in the literature support the bidirectional relationship between nutrition and sleep. It has been reported that consuming protein sources high in tryptophan and high-glycemic-index carbohydrates in the evening can facilitate sleep onset and prolong deep sleep (Barnard et al., 2022). Therefore, it is recommended that athlete nutrition programs be designed not only with a focus on performance but also to support sleep quality (Doherty et al., 2019; Gallo et al., 2021). Carefully evaluating the interconnection between sleep, nutrition, and body composition is important for the holistic health of young athletes. This study comprehensively examined the relationships among sleep quality, eating habits, and body composition in young athletes. Although the literature provides separate findings for each variable (Doherty et al., 2019; Martín-Rodríguez et al., 2024), studies investigating all three parameters together appear to be relatively limited.

Young athletes are exposed to intensive training demands while continuing their academic and social development. Previous studies indicate that insufficient nutrition knowledge and irregular eating habits are common in this age group and may negatively affect energy balance and body composition (Magee et al., 2023; Martín-Rodríguez et al., 2024; Werner et al., 2022). Body composition is an important indicator of health and performance and is influenced by nutritional habits and physical activity levels (Asan, 2023; Butnariu, 2025; Toselli, 2021). Sleep quality is also a key factor for recovery, metabolic regulation, and injury prevention in athletes (Barnard et al., 2022; Hamlin et al., 2021; Mason et al., 2023). Poor sleep duration and quality have been associated with adverse health outcomes (Jindal et al., 2021; Kline et al., 2021; Ramya & Mukundan, 2024). Although relationships between nutrition, sleep, and body composition have been reported separately, studies examining these variables together in young athletes are limited (Doherty et al., 2019). Therefore, further research is needed to understand better how these factors are related within this population. In this context, the present study aims to examine the relationships between sleep quality, eating habits, and body composition in young athletes. The study is expected to contribute to the field by supporting the development of healthy lifestyle habits and enhancing performance, particularly among individuals who engage in sports at an early age.

Methods

Research Design

This study employs a correlational survey design, a quantitative research method. Correlational survey design aims to reveal the mutual relationships between two or more variables, focusing on testing whether there is an association between variables in a correlational, rather than causal, context (Büyüköztürk et al., 2015).

Participants

The study included voluntary young athletes aged 18–23 who had been engaging in regular sports activities for at least one year. The sample size was calculated using the G*Power program, based on an effect size of $|p| = 0.50$, a significance level of $\alpha = 0.05$, and a test power of $1 - \beta = 0.90$, indicating that a minimum of 28 participants would be sufficient. Considering the potential for data loss, the study was conducted with 33 participants (16 women and 17 men). Exclusion criteria included individuals with a chronic disease, those diagnosed with a sleep disorder, those experiencing an illness or injury during the study, those discontinuing regular sports activity, those using medications or supplements that could affect dietary habits, and those failing to comply with measurement protocols.

Table 1. Descriptive Statistics of the Participants (n = 33)

Variable	Minimum	Maximum	Mean $\pm$ SD
Age (years)	18.00	23.00	20.03 $\pm$ 1.65
Training Experience (years)	2.00	13.00	6.79 $\pm$ 3.19
Height (m)	1.56	1.91	1.74 $\pm$ 0.09
Body Mass (kg)	48.00	105.50	70.79 $\pm$ 15.89
Body Mass Index (kg/m ²)	18.20	30.50	23.24 $\pm$ 3.15
HNAS (Point)	57.00	89.00	73.94 $\pm$ 10.11
Muscle Ratio (%)	36.30	76.30	54.67 $\pm$ 11.66
Body Fat Ratio (%)	6.50	25.80	16.95 $\pm$ 4.76
Nocturnal Awakenings (count)	0.00	5.00	1.52 $\pm$ 1.44
Light Sleep (min)	131.00	577.00	284.58 $\pm$ 97.62
Total Night Sleep Duration (Min)	289.00	601.00	455.45 $\pm$ 72.45
Deep Sleep (min)	35.00	270.00	113.91 $\pm$ 49.96
REM Sleep (min)	6.00	130.00	61.76 $\pm$ 38.18
Deep Sleep Continuity (score)	52.00	95.00	71.15 $\pm$ 11.27
Breathing Quality Score (score)	86.00	100.00	96.36 $\pm$ 4.54

n: Number of Participants, HNAS: Healthy Nutrition Attitude Score, Min: Minutes

According to Table 1, the participants exhibited a mean age of 20.03 ± 1.65 years and an average training experience of 6.79 ± 3.19 years. Their mean height, body mass, and body mass index were 1.74 ± 0.09 m, 70.79 ± 15.89 kg, and 23.24 ± 3.15 kg/m², respectively. The mean muscle ratio was $54.67 \pm 11.66\%$, while the mean body fat ratio was $16.95 \pm 4.76\%$. Additionally, the Healthy Nutrition Attitude Score averaged 73.94 ± 10.11 . Regarding sleep-related parameters, the athletes demonstrated an average of 1.52 ± 1.44 nocturnal awakenings, with a light sleep duration of 284.58 ± 97.62 minutes and a total night sleep duration of 455.45 ± 72.45 minutes. Deep sleep and REM sleep durations were recorded as 113.91 ± 49.96 minutes and 61.76 ± 38.18 minutes, respectively. Furthermore, deep sleep continuity averaged $71.15 \pm 11.27\%$, while breathing quality was notably high at 96.36 ± 4.54 . Sleep stage values are expressed in minutes and were used to calculate the proportional distribution of each sleep stage relative to total nocturnal sleep duration.

Data Collection Tools

Personal Information Form

Participants' demographic and physical information, including age, sports history, height, and weight, was collected through this form.

Attitude Scale for Healthy Nutrition (ASHN)

To evaluate nutritional habits, the Attitude Scale for Healthy Nutrition (ASHN), developed by Tekkurşun Demir and Cicioğlu (2019), was used. The scale consists of four factors: Knowledge About Nutrition, Emotion Toward Nutrition, Positive Nutrition, and Poor Nutrition, with a total of 21 items. The internal consistency coefficients of the subscales range between 0.75 and 0.90 (Tekkurşun Demir & Cicioğlu, 2019).

Sleep Quality Measurement

Sleep data were collected over three consecutive weekday nights (Monday to Wednesday) using Huawei Watch GT 4 smartwatches. Weekend nights were excluded to minimize variability in sleep patterns. The mean values of the three nights were used for analysis. The data were evaluated using the device's photoplethysmography (PPG) sensors and accelerometer-based algorithms. Previous studies have demonstrated that wearable smart devices provide reliable measurements of sleep duration and quality in healthy individuals (Miller et al., 2022; Robbins et al., 2024). Sleep duration was calculated as the time from sleep onset to morning awakening, using a reference range of 6-10 hours (Thomas et al., 2009). The distribution of sleep stages REM, light, and deep sleep percentages was determined using the device's automatic classification algorithms based on cardiorespiratory signals and movement patterns, with reference ranges of 30–60% for light sleep, 10–30% for deep sleep, and 10–30% for REM sleep (Pham et al., 2012; Ralston et al., 2018). The deep sleep percentage was obtained by dividing it by the total sleep duration; deep sleep continuity was assessed by scoring uninterrupted deep sleep segments, with a score range of 70-100 considered 'optimal' (Qaseem et al., 2016; Yang et al., 2011). A wake-up count of 0-1 was considered normal (Bonnet & Arand, 2007); breathing quality was assessed using a 70-100-point respiratory stability scale (Nuckton et al., 2006; Schramm et al., 2013).

Body Composition Measurement

Body composition was assessed using a Tanita Bioelectrical Impedance Analysis (BIA) device. This device provides comprehensive information about body structure by analyzing variables such as body fat percentage, muscle mass, and BMI. The literature highlights that Tanita devices offer reliable results for assessing body composition in athletes (Lombardo, Feraco, Camajani, et al., 2024; Ponti et al., 2020).

Research Procedure

The study was conducted in individual sessions for each participant. First, participants' sleep quality was assessed using the smartwatches provided to them. After sleep data were recorded, the nutrition attitude scale was administered through face-to-face interviews. Subsequently, body composition measurements were performed. All measurements were conducted in the same sequence and under consistent conditions for all participants. Participants were instructed to wear the watches continuously until the researcher collected the data. Measurements were taken at the same time of day (10:00-12:00), and environmental conditions were kept constant to minimize the impact of external factors.

Data Analysis

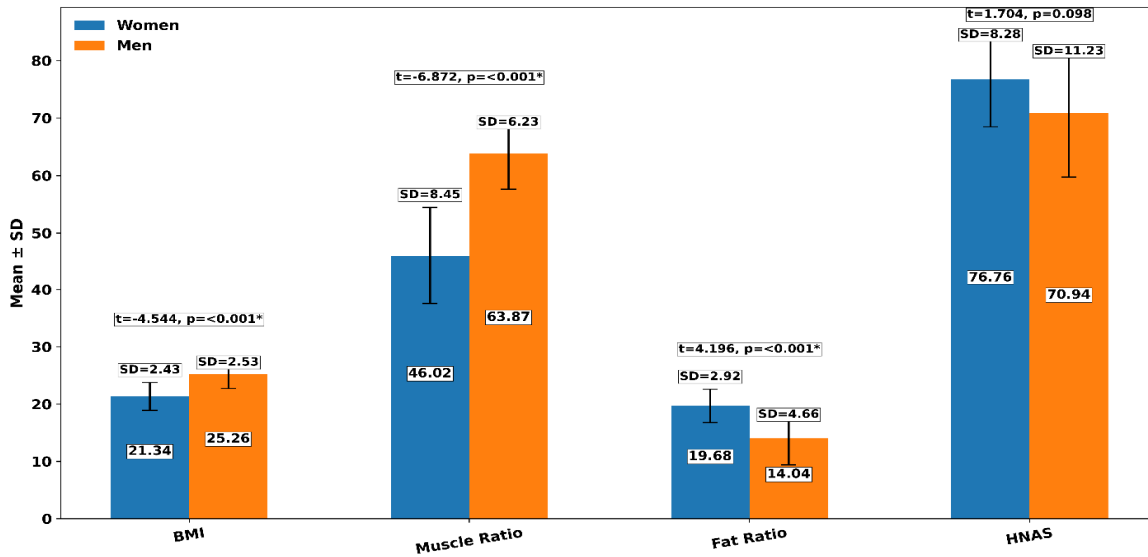
The statistical analysis of the data obtained in the study was conducted using IBM SPSS Statistics 27. Before initiating the analyses, the normality assumption for all variables was evaluated using the Shapiro–Wilk test and distribution plots, and the data were found to be normally distributed. An independent-samples t-test was used to examine differences between the two gender groups. Pearson correlation analysis was used to investigate relationships among variables, and correlation coefficients were reported to indicate the direction and strength of the associations. The significance level was set at $\alpha = 0.05$. All results were presented as mean $\pm$ standard deviation, and statistical significance was accepted at $p < 0.05$.

Ethical Considerations

The study was reviewed and approved by the Erzurum Technical University Ethics Committee on 21 April 2025 (Meeting No. 06, Decision No. 12). Written informed consent was obtained from all participants, confirming that they had been informed about the study's details and procedures. Participant rights and confidentiality were protected in accordance with the principles outlined in the Declaration of Helsinki.

Results

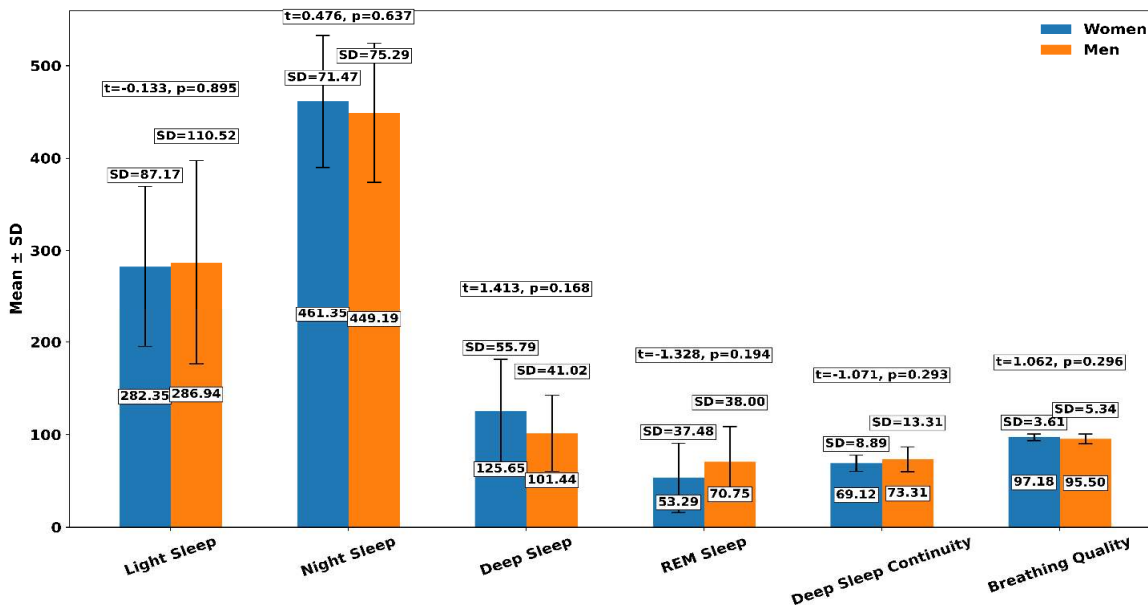
Figure 1. Comparison of Body Composition and Healthy Nutrition Attitude Score by Gender



*p<.05, HNAS: Healthy Nutrition Attitude Score, BMI: Body Mass Index

According to Figure 1, the mean and standard deviation values of the HNAS, BMI, Muscle Ratio, and Fat Ratio variables were compared between female and male participants. The analysis results indicate statistically significant differences between genders in BMI, Muscle Ratio, and Fat Ratio ($p = 0.001$). While male participants have a higher muscle ratio, female participants have a significantly higher fat ratio. In contrast, no significant gender difference was found in the HNAS variable ($p > 0.05$).

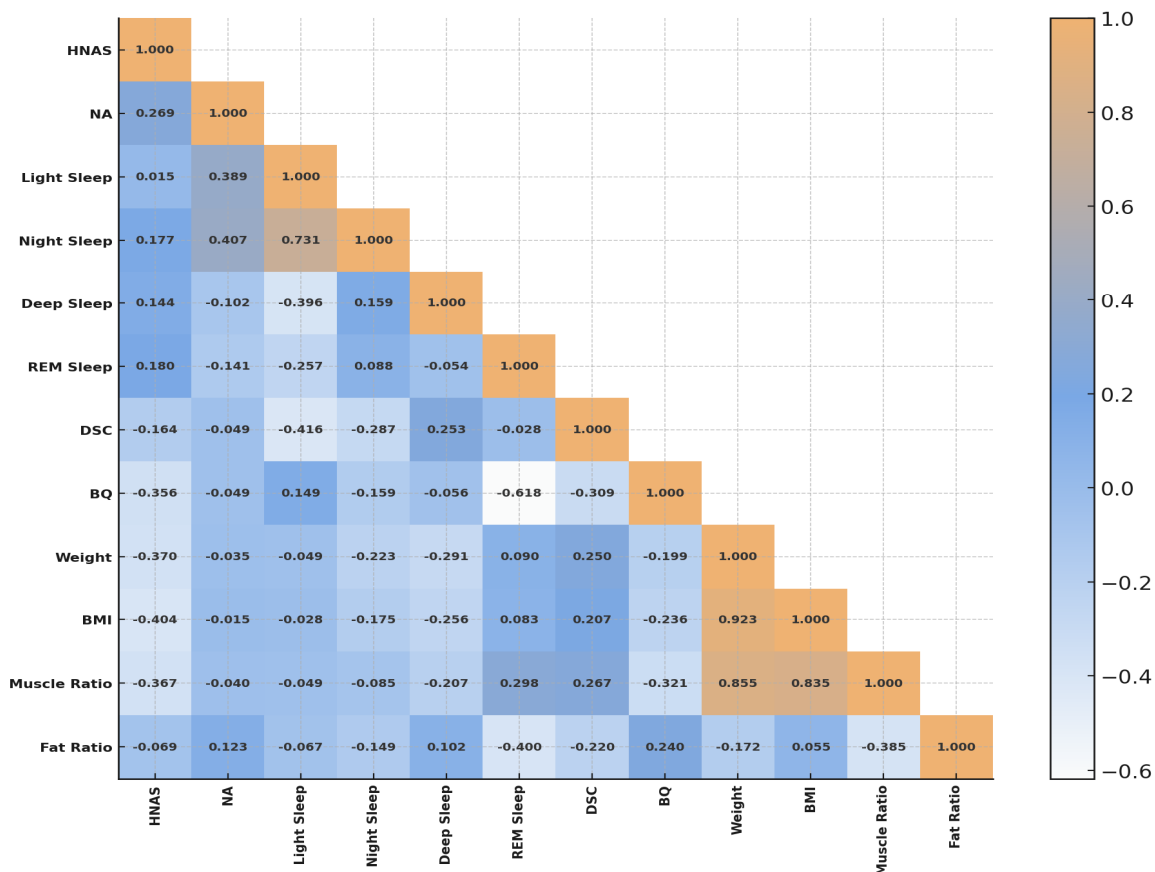
Figure 2. Comparison of Sleep Parameters by Gender



*p<.05

According to Figure 2, the mean and standard deviation values of various sleep parameters were compared between female and male participants. The analysis results indicate that there is no statistically significant difference between genders for the variables Light Sleep, Night Sleep, Deep Sleep, REM Sleep, Deep Sleep Continuity, and Breathing Quality (t-values and p-values > 0.05).

Figure 3. Relationship between Healthy Nutrition Attitude Score, Sleep Parameters and Body Composition Variables



HNAS: Healthy Nutrition Attitude Score, NA: Nocturnal Awakenings, DSC: Deep Sleep Continuity, BQ: Breathing Quality, BMI: Body Mass Index, **Positive correlations:** Towards orange, **Negative correlations:** Towards blue, **Neutral values:** White

According to Figure 3, a significant and negative relationship was found between the healthy nutrition attitude score and breathing quality ($r = -0.356$, $p < .05$). Significant negative correlations were also detected between HNAS and weight ($r = -0.370$, $p < .05$), BMI ($r = -0.404$, $p < .05$), and muscle ratio ($r = -0.367$, $p < .05$). A significant positive relationship was observed between the number of awakenings and light sleep duration ($r = .389$, $p < .05$) as well as total night sleep ($r = .407$, $p < .05$). Light sleep duration was positively correlated with total night sleep ($r = .731$, $p < .01$), and negatively correlated with deep sleep ($r = -0.396$, $p < .05$) and profound sleep continuity ($r = -0.416$, $p < .05$). Significant negative relationships were found between REM sleep and breathing quality ($r = -0.618$, $p < .01$) as well as fat ratio ($r = -0.400$, $p < .05$). The weight variable showed significant positive correlations with BMI ($r = .923$, $p < .01$) and muscle ratio ($r = .855$, $p < .01$), while showing no significant relationship with fat ratio ($p > .05$). A significant positive correlation was found between BMI and muscle ratio ($r = .835$, $p < .01$). Fat ratio was significantly and negatively associated with muscle ratio ($r = -0.385$, $p < .05$).

Discussion

In this study, the relationships among healthy nutrition attitude score, sleep quality, and body composition in young athletes were examined through a holistic framework. The findings indicate that individual health behaviors not only exert independent effects but also interact to shape the overall physiological status of young athletes. The existing literature frequently highlights the influence of lifestyle factors, particularly HNAS and sleep, on body composition and athletic performance (Desbrow, 2021; Doherty et al., 2019). The results of this study also yielded similar findings, highlighting the importance of jointly evaluating the relationships between score attitudes towards nutrition, sleep variables, and body composition indicators in the young athlete group.

Nutrition knowledge and athletes' attitudes toward healthy eating are among the primary determinants influencing body composition. Previous studies have shown that athletes with higher levels of nutrition knowledge or more favorable dietary attitudes tend to make more informed choices regarding macro- and

micronutrient intake, recovery strategies, and energy balance, which in turn positively affects components such as muscle mass and body fat percentage (Magee et al., 2023; Werner et al., 2022). Consistent with these observations, the present study identified significant negative correlations between healthy nutrition attitude scores and BMI, body mass, and muscle ratio. This indicates that athletes with more favorable attitudes toward healthy eating may be more likely to maintain a balanced body composition. The negative association observed between nutrition attitudes and breathing quality is notable; although direct parallels are limited in the literature, this finding aligns with research suggesting that behavioral and physiological processes are not entirely independent. Studies reporting that dietary behaviors vary across age and sex groups and that these differences generate meaningful differences in body composition (Lombardo, Feraco, Armani, et al., 2024; Martín-Rodríguez et al., 2024) further support the current findings.

Sex-based comparisons revealed significant differences in BMI, body fat percentage, and muscle ratio: males had a higher muscle ratio and BMI, while females had a higher body fat percentage. These results are consistent with previous studies that highlight sex-based physiological differences among young athletes (Lombardo, Feraco, Camajani, et al., 2024). However, no significant sex differences emerged in nutrition attitude scores or sleep parameters, suggesting that individual lifestyle habits may more strongly shape dietary behaviors and sleep patterns than biological sex.

Sleep is a fundamental determinant of both physical and cognitive performance in athletes. Prior research has established that inadequate sleep quality negatively impacts energy balance, hormonal regulation, cognitive function, and metabolic health (Barnard et al., 2022; Mason et al., 2023). In the present study, light sleep duration demonstrated a strong positive correlation with total night sleep duration, while exhibiting negative correlations with deep sleep duration and deep sleep continuity. This pattern suggests that sleep architecture varies considerably across individuals and that increased total sleep duration does not necessarily equate to improved sleep quality. The negative associations between REM sleep duration, breathing quality, and body fat percentage are consistent with studies linking diminished sleep quality to obesity, metabolic dysfunction, and respiratory regulation (Kline et al., 2021; Ramya & Mukundan, 2024). Furthermore, the positive relationships among nocturnal awakenings, light sleep, and total sleep duration may indicate that physiological or environmental factors influence sleep fragmentation in this age group.

Eating behaviors among athletes are also shaped by environmental, psychological, and social influences. Studies have shown that an excessive preoccupation with healthy eating may elevate the risk of disordered eating in university students (Arslantaş et al., 2017), while social media may influence body image and dietary choices (Özgür & Uçar, 2020). Additional research demonstrates associations among anxiety, body image, and eating behaviors in athletes (Ramírez-Goerke et al., 2025). Within this context, the present study's findings, which link nutrition attitude score to body composition, suggest that these attitudes are grounded not only in physiological factors but also in behavioral and psychosocial dimensions. However, because psychological variables were not directly assessed, future studies should aim to explore these underlying mechanisms in greater depth.

Various factors, including age, sex, physical activity level, and dietary habits, influence body composition. The literature highlights the importance of monitoring metabolic changes across different age groups and acknowledges that dietary patterns significantly shape compositional outcomes (Lombardo, Feraco, Armani, et al., 2024; Ponti et al., 2020). Studies involving young adults suggest that physically active individuals tend to adopt healthier eating behaviors, as reflected in their body composition profiles (Mazurek-Kusiak et al., 2021). The predominantly healthy body composition profiles observed among participants in the present study, along with the relatively high levels of training experience, underscore the importance of physical activity as a key determinant in young athletes. Moreover, the strong correlations among body composition variables observed in this study align with physiologically established relationships reported in prior research.

Intervention studies have demonstrated that nutrition counseling, dietary supplementation, and educational programs can lead to significant improvements in body composition and overall health. Nutritional interventions targeting individuals at risk of undernutrition have been shown to improve growth and body composition (Ow et al., 2025). Studies emphasizing the importance of structured nutrition strategies for young athletes (Desbrow, 2021) further corroborate the present findings. This study highlights the need for practical, behavior-focused educational programs over purely informational approaches in the context of nutrition attitudes and body composition.

Conclusion

This study examined the relationships between healthy nutrition attitudes, sleep characteristics, and body composition in young athletes. The findings indicate that nutrition attitudes are significantly associated with body weight, BMI, muscle ratio, and breathing quality. At the same time, several sleep components show meaningful relationships with both physiological and compositional variables. In addition, sex-based differences were observed in body composition parameters, whereas no significant differences were found in nutrition attitudes or sleep characteristics. These results confirm that body composition in young athletes is influenced not only by training but also by lifestyle-related factors such as nutrition, attitudes, and sleep structure.

Overall, the findings highlight the importance of evaluating nutrition, sleep, and body composition together rather than independently. From a practical perspective, athlete support programs that include nutrition education and sleep awareness may contribute to healthier body composition and better recovery quality. Although its cross-sectional design and sample size limit the present study, it provides a foundation for future research using larger, longitudinal samples to understand better the mechanisms underlying these relationships.

Strengths and Limitations of the Study

This study possesses several methodological strengths. First, it simultaneously examined multiple interrelated health indicators-nutrition attitudes, sleep patterns, and body composition-within the same sample, enabling a holistic interpretation. The objective assessment of sleep variables using smartwatch technology, combined with body composition evaluation via BIA, strengthened measurement reliability. Additionally, the use of standardized testing procedures and appropriate statistical methods, with all parametric assumptions met, further enhances the study's methodological rigor. However, certain limitations should be acknowledged. The sample consisted of only 33 young athletes (16 females and 17 males), which restricts the generalizability of the findings to other age groups or sport disciplines. Due to the cross-sectional design, causal inferences cannot be made, even when associations among variables are identified. Sleep data were based on short-term measurements, and healthy nutrition attitude scores were assessed via self-report; both methods may introduce measurement bias. Additionally, since the sample consisted solely of athletes aged 18–23, the findings may not apply to broader populations. Moreover, sleep measurements were obtained over three consecutive weekday nights in order to minimize variability associated with weekend sleep patterns. Although this approach enhanced measurement standardization, more extended monitoring periods could provide a more comprehensive representation of habitual sleep behavior.

Conflict of interest

All authors confirm that there is no conflict of interest in this study.

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Use of Generative AI

During the preparation of this work, the authors used ChatGPT. Artificial intelligence tools were used under human supervision to assist with translating the manuscript into various languages and to improve clarity and coherence, while ensuring academic integrity throughout the writing process.

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References

- Aka, H. (2020). A research on the evaluation of nutrition knowledge levels of soccer coaches. *Prog Nutr*, 22, 111-118. <https://doi.org/10.23751/pn.v22i1-S.9800>
- Arslantaş, H., Adana, F., Ögüt, S., Ayakdaş, D., & Korkmaz, A. (2017). Relationship between eating behaviors of nursing students and orthorexia nervosa (obsession with healthy eating): a cross-sectional study. *Journal of Psychiatric Nursing*, 8(3), 137-144. <https://doi.org/10.14744/phd.2016.36854>
- Asan, S. (2023). Investigation of The Relationship Between Body Composition and Speed in Adolescent Athletes. *Journal of Kafkas University Sport Sciences*, 3(3), 14-23.
- Barnard, J., Roberts, S., Lastella, M., Aisbett, B., & Condo, D. (2022). The Impact of Dietary Factors on the Sleep of Athletically Trained Populations: A Systematic Review. *Nutrients*, 14(16). <https://doi.org/10.3390/nu14163271>
- Bocharin, I., Vorozheikin, A., Alieva, K., Omurzakova, G., Myrzabekova, N., Akmatova, A., Kraynik, V., Vyazovichenko, Y., Smirnov, V., & Shirokova, M. (2025). Variation in body composition under the impact of a short health-enhancing fitness training cycle in a university setting. *Journal of Physical Education and Sport*, 25(3), 506–512. <https://doi.org/10.7752/jpes.2025.03055>
- Butnariu, M. (2025). The effect of physical activity on body composition: a study of athletic and non-athletic students. *Journal of Physical Education and Sport*, 25(7), 1497-1505. <https://doi.org/10.7752/jpes.2025.07167>
- Büyükoztürk, Ş., Akgün, Ö. E., Demirel, F., Karadeniz, Ş., & Çakmak, E. K. (2015). Scientific research methods.
- Desbrow, B. (2021). Youth Athlete Development and Nutrition. *Sports Med*, 51(Suppl 1), 3-12. <https://doi.org/10.1007/s40279-021-01534-6>
- Doherty, R., Madigan, S., Warrington, G., & Ellis, J. (2019). Sleep and Nutrition Interactions: Implications for Athletes. *Nutrients*, 11(4). <https://doi.org/10.3390/nu11040822>
- Gallo, L. A., Gallo, T. F., Young, S. L., Fotheringham, A. K., Barclay, J. L., Walker, J. L., Moritz, K. M., & Akison, L. K. (2021). Adherence to Dietary and Physical Activity Guidelines in Australian

- Undergraduate Biomedical Students and Associations with Body Composition and Metabolic Health: A Cross-Sectional Study. *Nutrients*, 13(10). <https://doi.org/10.3390/nu13103500>
- Hamlin, M. J., Deuchrass, R. W., Olsen, P. D., Choukri, M. A., Marshall, H. C., Lizamore, C. A., Leong, C., & Elliot, C. A. (2021). The Effect of Sleep Quality and Quantity on Athlete's Health and Perceived Training Quality. *Front Sports Act Living*, 3, 705650. <https://doi.org/10.3389/fspor.2021.705650>
- Jindal, I., Puyau, M., Adolph, A., Butte, N., Musaad, S., & Bacha, F. (2021). The relationship of sleep duration and quality to energy expenditure and physical activity in children. *Pediatr Obes*, 16(6), e12751. <https://doi.org/10.1111/ijpo.12751>
- Kline, C. E., Chasens, E. R., Bizhanova, Z., Sereika, S. M., Buysse, D. J., Imes, C. C., Kariuki, J. K., Mendez, D. D., Cajita, M. I., Rathbun, S. L., & Burke, L. E. (2021). The association between sleep health and weight change during a 12-month behavioral weight loss intervention. *International Journal of Obesity*, 45(3), 639-649. <https://doi.org/10.1038/s41366-020-00728-8>
- Lombardo, M., Feraco, A., Armani, A., Camajani, E., Gorini, S., Strollo, R., Padua, E., Caprio, M., & Bellia, A. (2024). Gender differences in body composition, dietary patterns, and physical activity: insights from a cross-sectional study. *Front Nutr*, 11, 1414217. <https://doi.org/10.3389/fnut.2024.1414217>
- Lombardo, M., Feraco, A., Camajani, E., Gorini, S., Strollo, R., Armani, A., Padua, E., & Caprio, M. (2024). Effects of Different Nutritional Patterns and Physical Activity on Body Composition: A Gender and Age Group Comparative Study. *Foods*, 13(4). <https://doi.org/10.3390/foods13040529>
- Magee, M. K., Jones, M. T., Fields, J. B., Kresta, J., Khurelbaatar, C., Dodge, C., Merfeld, B., Ambrosius, A., Carpenter, M., & Jagim, A. R. (2023). Body Composition, Energy Availability, Risk of Eating Disorder, and Sport Nutrition Knowledge in Young Athletes. *Nutrients*, 15(6). <https://doi.org/10.3390/nu15061502>
- Martín-Rodríguez, A., Belinchón-deMiguel, P., Rubio-Zarapuz, A., Tornero-Aguilera, J. F., Martínez-Guardado, I., Villanueva-Tobaldo, C. V., & Clemente-Suárez, V. J. (2024). Advances in Understanding the Interplay between Dietary Practices, Body Composition, and Sports Performance in Athletes. *Nutrients*, 16(4). <https://doi.org/10.3390/nu16040571>
- Mason, L., Connolly, J., Devenney, L. E., Lacey, K., O'Donovan, J., & Doherty, R. (2023). Sleep, Nutrition, and Injury Risk in Adolescent Athletes: A Narrative Review. *Nutrients*, 15(24). <https://doi.org/10.3390/nu15245101>
- Mazurek-Kusiak, A. K., Kobylka, A., Korez, N., & Sosnowska, M. (2021). Analysis of Eating Habits and Body Composition of Young Adult Poles. *Nutrients*, 13(11). <https://doi.org/10.3390/nu13114083>
- Miller, D. J., Sargent, C., & Roach, G. D. (2022). A Validation of Six Wearable Devices for Estimating Sleep, Heart Rate and Heart Rate Variability in Healthy Adults. *Sensors (Basel)*, 22(16). <https://doi.org/10.3390/s22166317>
- Nuckton, T. J., Glidden, D. V., Browner, W. S., & Claman, D. M. (2006). Physical examination: Mallampati score as an independent predictor of obstructive sleep apnea. *Sleep*, 29(7), 903-908. <https://doi.org/10.1093/sleep/29.7.903>
- Ow, M. Y. L., Tran, N. T., Berde, Y., Nguyen, T. S., Tran, V., Jablonka, M. J., Baggs, G. E., & Huynh, D. T. T. (2025). Efficacy of long-term oral nutritional supplementation with dietary counseling on growth, body composition and bone mineralization in children with or at risk for undernutrition: a randomized controlled trial. *Nutrition Journal*, 24(1). <https://doi.org/10.1186/s12937-025-01133-5>
- Ozbay, S., Ulupinar, S., Gencoglu, C., Ouerqui, I., Oget, F., Yilmaz, H. H., Kishali, N. F., Kiyici, F., Asan, S., Ucan, I., & Ardigo, L. P. (2024). Effects of Ramadan intermittent fasting on performance, physiological responses, and bioenergetic pathway contributions during repeated sprint exercise. *Front Nutr*, 11, 1322128. <https://doi.org/10.3389/fnut.2024.1322128>
- Özgür, M., & Uçar, A. (2020). Comparison of social media addiction and body perception and nutrition knowledge levels in girls students studying at university. *Ankara Journal of Health Sciences*, 9(2), 46-54.
- Papadopoulou, S. K. (2020). Rehabilitation Nutrition for Injury Recovery of Athletes: The Role of Macronutrient Intake. *Nutrients*, 12(8). <https://doi.org/10.3390/nu12082449>
- Pham, T. D., Thang, T. C., & Oyama-Higa, M. (2012). Toward the development of a cost-effective e-depression detection system. 2012 International Conference on Computerized Healthcare (ICCH),
- Ponti, F., Santoro, A., Mercatelli, D., Gasperini, C., Conte, M., Martucci, M., Sangiorgi, L., Franceschi, C., & Bazzocchi, A. (2020). Aging and Imaging Assessment of Body Composition: From Fat to Facts. *Frontiers in Endocrinology*, 10. <https://doi.org/10.3389/fendo.2019.00861>
- Qaseem, A., Kansagara, D., Forcica, M. A., Cooke, M., Denberg, T. D., & Clinical Guidelines Committee of the American College of Physicians. (2016). Management of Chronic Insomnia Disorder in Adults: A Clinical Practice Guideline From the American College of Physicians. *Ann Intern Med*, 165(2), 125-133. <https://doi.org/10.7326/M15-2175>
- Ralston, S. H., Penman, I. D., Strachan, M. W., & Hobson, R. (2018). *Davidson's Principles and Practice of Medicine E-Book: Davidson's Principles and Practice of Medicine E-Book*. Elsevier Health Sciences.

- Ramírez-Goerke, M. I., Tornero-Aguilera, J. F., Martín-Rodríguez, A., & Clemente-Suárez, V. J. (2025). The Effect of Anxiety and Nutritional Habits on the Body Distortion of Athletes. *Nutrients*, 17(4). <https://doi.org/10.3390/nu17040682>
- Ramya, K., & Mukundan, A. (2024). The Relationship Between Anthropometric Indices of Obesity and Sleep Disturbances in Young Adults. *Cureus*, 16(10). <https://doi.org/10.7759/cureus.71178>
- Robbins, R., Weaver, M. D., Sullivan, J. P., Quan, S. F., Gilmore, K., Shaw, S., Benz, A., Qadri, S., Barger, L. K., Czeisler, C. A., & Duffy, J. F. (2024). Accuracy of Three Commercial Wearable Devices for Sleep Tracking in Healthy Adults. *Sensors*, 24(20). <https://doi.org/10.3390/s24206532>
- Samanipour, M. H., Azizi, M., Salehian, O., Ceylan, H. I., Mielgo-Ayuso, J. F., Del Coso, J., Muntean, R. I., Bragazzi, N. L., & Herrera-Valenzuela, T. (2025). Exploring Gender-Specific Correlations Between Nutritional Intake, Body Composition, Psychological Skills, and Performance Metrics in Young Taekwondo Athletes. *Nutrients*, 17(7). <https://doi.org/10.3390/nu17071202>
- Schramm, P. J., Thomas, R., Feige, B., Spiegelhalder, K., & Riemann, D. (2013). Quantitative measurement of sleep quality using cardiopulmonary coupling analysis: a retrospective comparison of individuals with and without primary insomnia. *Sleep and Breathing*, 17(2), 713-721. <https://doi.org/10.1007/s11325-012-0747-6>
- Schroder, J. D., Falqueto, H., Mânica, A., Zanini, D., de Oliveira, T., de Sá, C. A., Cardoso, A. M., & Manfredi, L. H. (2021). Effects of time-restricted feeding in weight loss, metabolic syndrome and cardiovascular risk in obese women. *Journal of Translational Medicine*, 19(1). <https://doi.org/10.1186/s12967-020-02687-0>
- Tekkurşun Demir, G., & Cicioğlu, H. (2019). Attitude scale for healthy nutrition (ashn): validity and reliability study. *Gaziantep University Journal Of Sport Science*, 4(2), 256-274. <https://doi.org/10.31680/gaunjss.559462>
- Thomas, R. J., Weiss, M. D., Mietus, J. E., Peng, C. K., Goldberger, A. L., & Gottlieb, D. J. (2009). Prevalent Hypertension and Stroke in the Sleep Heart Health Study: Association with an ECG-derived Spectrographic Marker of Cardiopulmonary Coupling. *Sleep*, 32(7), 897-904. <https://doi.org/10.1093/sleep/32.7.897>
- Toselli, S. (2021). Body Composition and Physical Health in Sports Practice: An Editorial. *International Journal of Environmental Research and Public Health*, 18(9). <https://doi.org/10.3390/ijerph18094534>
- Werner, E. N., Guadagni, A. J., & Pivarnik, J. M. (2022). Assessment of nutrition knowledge in division I college athletes. *J Am Coll Health*, 70(1), 248-255. <https://doi.org/10.1080/07448481.2020.1740234>
- Yang, A. C., Yang, C. H., Hong, C. J., Tsai, S. J., Kuo, C. H., Peng, C. K., Mietus, J. E., Goldberger, A. L., & Thomas, R. J. (2011). Sleep state instabilities in major depressive disorder: Detection and quantification with electrocardiogram-based cardiopulmonary coupling analysis. *Psychophysiology*, 48(2), 285-291. <https://doi.org/10.1111/j.1469-8986.2010.01060.x>