Correlation between age, training volume, and sleep disturbances in children and adolescents practicing artistic gymnastics

Correlación entre edad, volumen de entrenamiento y trastornos del sueño en practicantes de gimnasia artística

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Abstract

Introduction: Artistic gymnastics is characterized by early sports specialization and high technical demands that can influence the well-being of young practitioners. Sleep plays a fundamental role in the physical recovery, cognitive function, and injury prevention of these athletes.
Objective: to examine the relationship between age, weekly training volume, and sleep disturbances in children and adolescents practicing artistic gymnastics.
Methodology: consisted of an observational, cross-sectional, and correlational study involving 42 female gymnasts between 4 and 12 years of age (7.78 ± 2.23 years of age). Sleep disturbances were assessed using the Sleep Disturbance Scale for Children, answered by parents, and data were analyzed using Spearman's rank correlation.
Results: The results showed no significant correlation between weekly training frequency and sleep disturbances. However, a significant negative correlation was observed between age and sleep disturbances, indicating that younger gymnasts experienced more frequent or severe sleep issues.
Discussion: the findings were contrasted with literature suggesting that training duration and evening schedules may impact sleep more than frequency alone. The results supported the idea that sleep patterns in this population are more strongly influenced by maturational and biological processes than by training volume.
Conclusions: age is a relevant factor for sleep disturbances in young gymnasts, highlighting the importance of monitoring sleep health during early sports specialization.

Keywords

Exercise; gymnastics; physical education sciences.

Resumen

Introducción: La gimnasia artística se caracteriza por una especialización deportiva temprana y altas exigencias técnicas que pueden influir en el bienestar de las jóvenes practicantes. El sueño desempeña un papel fundamental en la recuperación física, la función cognitiva y la prevención de lesiones en estas atletas.
Objetivo: examinar la relación entre la edad, el volumen de entrenamiento semanal y los trastornos del sueño en niñas y adolescentes practicantes de gimnasia artística.
Metodología: consistió en un estudio observacional, transversal y correlacional que incluyó a 42 gimnastas de sexo femenino entre cuatro y siete años de edad (7.78 ± 2.23 años de edad). Los trastornos del sueño se evaluaron mediante la Escala de Disturbios del Sueño para Niños, completada por los padres, y los datos se analizaron utilizando la correlación de rangos de Spearman.
Resultados: os resultados no mostraron una correlación significativa entre la frecuencia de entrenamiento semanal y los trastornos del sueño. Sin embargo, se observó una correlación negativa significativa entre la edad y los trastornos del sueño, lo que indica que las gimnastas más jóvenes presentaron problemas de sueño más frecuentes o graves.
Discusión: los hallazgos se contrastaron con la literatura que sugiere que la duración del entrenamiento y los horarios nocturnos pueden impactar el sueño más que la frecuencia por sí sola. Los resultados respaldaron la idea de que los patrones de sueño en esta población están más fuertemente influenciados por procesos madurativos y biológicos que por el volumen de entrenamiento.
Conclusiones: la edad es un factor relevante para los trastornos del sueño en jóvenes gimnastas, lo que resalta la importancia de monitorear la higiene del sueño durante la especialización deportiva temprana.

Palabras clave

Ejercicio físico; gimnasia; ciencias de la educación física.

Introduction

A significant increase in training volume, characterized by weekly training frequency, is a hallmark of sport specialization processes (Jayanthi et al 2013; Myer et al, 2015). Sports specialization is characterized by a year-round training greater than eight months, focusing on a single main sport, frequently quitting other sports practices (Myer et al 2015), and youth sports specialization is a prevalent scenario in some sports, even though its direct association with injury risk, poorer lower extremity function, and burnout syndrome, which highlights detrimental effects in different aspects of an individual's life (McLellan et al 2022).

In this scenario, artistic gymnastics is a sport characterized by its early start, with the process of sport specialization typically beginning around the age of nine (Root et al., 2019). This discipline requires precise posture, high-quality movement, and coordinated use of apparatuses, demanding strong motor control, balance, flexibility, strength, power, and technical precision (Nunez Morales et al, 2025; Kafrawi et al., 2025). Several factors have been identified in the literature as motivating this process, including an optimal period for the development of physical abilities and the mechanical advantages provided by short stature and low body mass. Furthermore, the minimum age for high-performance competitions in this sport is 16 years (FIG, 2023), which would maybe lead to different settings if the minimum age were higher. Not only does training itself influence physical performance, but it also influences the long-term athlete development process. The literature supports that, among other variables, sleep has a significant impact in different contexts, ranging from athletic performance to injury risk (Fullagar et al., 2015; Cantón et al., 2026).

Sleep plays a fundamental role in physical performance, recovery, cognitive function, and injury prevention in young athletes (Charest; Grandner, 2023). Previously, empirical evidence has suggested that young athletes who reported poor sleep quality also exhibited higher levels of pain at rest and during sports practice, highlighting the relevance of considering sleep assessment as a routine strategy in different sporting contexts (Sandoval et al 2021). Also, adequate sleep duration and quality are associated with improved motor learning, strength development, and emotional regulation, whereas insufficient or poor-quality sleep may impair athletic performance and increase the risk of injuries (Milewski et al 2014). In the context of early sports specialization, training volume, competition demands, and rigid schedules may negatively influence sleep habits and sleep quality. Thus, youth athletes engaged in specialized training programs may be particularly vulnerable to sleep disturbances, which could further compromise both health and performance outcomes.

During childhood and early adolescence, sleep patterns undergo important developmental changes, and sleep disturbances are relatively common at these ages (Laberge et al., 2001; Cohen et al, 2024; Goel; Goel, 2024). These disturbances are not necessarily a direct consequence of sports specialization but may reflect age-related biological and behavioral factors (Laberge et al., 2001; Cohen et al, 2024; Goel; Goel, 2024). However, inadequate sleep or altered sleep quality may influence training responses by affecting perceived training load, fatigue, motivation, and overall well-being (Patel et al 2024). In this sense, the relationship between sleep and sports participation may be bidirectional, as training demands can affect sleep, while sleep characteristics may also shape how young athletes experience and tolerate training and early sport initiation. Nevertheless, little is known about the impact of age and training volume on sleep quality in artistic gymnastics practitioners. Therefore, the aim of the present study was to examine the relationship between age, weekly training volume, and sleep disturbances in female children and adolescents practicing artistic gymnastics.

Method

This was an observational, cross-sectional, and correlational study carried out on young gymnasts recruited from two specialized artistic gymnastics training centers.

Inclusion criteria	Description
Sex	Females

Experience	Practicing the sport for at least 6 months
Competition	Having previously participated in tournaments, cups, or competitions appropriate for their age group
Exclusion Criteria	Description
Diagnosis	Presenting a diagnosis of a neurological or psychiatric disorder

Participants

This study was approved by the Institutional Research Ethics Committee affiliated with the corresponding author. Written informed consent was obtained from legal guardians, and assent was obtained from participants using age-appropriate language, in accordance with the Declaration of Helsinki (WMA, 2025). Of 44 initial participants, two with autism spectrum disorder were excluded. The final sample included 42 young female gymnasts (mean age 7.78 ± 2.23 years) who met the inclusion criteria.

Sleep Disturbance Scale for Children (SDSC)

The SDSC is a 26-item Likert-type questionnaire for screening sleep disorders among children and adolescents aged 3 to 18 years old (Ferreira et al., 2009). The questionnaire is answered by the child's parent or primary caregiver and is able to differentiate among various sleep-related conditions, such as disorders of initiating and maintaining sleep, sleep breathing disorders, disorders of arousal, sleep-wake transition disorders, excessive somnolence, and sleep hyperhidrosis. Higher scores indicate more frequent and/or severe sleep disorders.

Data analysis

An a priori sample size calculation was conducted using the following parameters: expected correlation (ρ H1) = 0.40, alpha level = 0.05, and statistical power = 0.80. The expected correlation value was determined based on a pilot analysis performed by the authors using a smaller sample. The analysis indicated that a minimum sample size of 37 participants was required. Data analysis was performed with the statistical software IBM SPSS 21. Considering the ordinal and nonparametric characteristics of the instrument used to assess sleep disturbances, Spearman's rank correlation analysis was conducted. Level of significance was set at 5%, and the strength of the linear relationship was interpreted as follows: less than 0.3 (poor), 0.3 to 0.5 (fair), 0.6 to 0.8 (moderately strong), and at least 0.8 (very strong) (Chang, 2003).

Results

No significant correlation was found between weekly training frequency and sleep disturbances ($p = 0.34$). Additionally, a fair but significant negative correlation was observed between age and sleep disturbances (Figure 1) ($r = -0.40$; $r^2 = 0.16$; $p < 0.01$). A partial correlation between age and sleep quality was conducted while controlling for weekly training frequency to identify potential interactions, and the results indicated that weekly training frequency was not a variable with the potential to bias the previously observed correlation (Figure 2) ($r = -0.35$; $p = 0.02$).

Figure 1. Correlation between weekly training frequency and sleep disturbances

Correlations

			AGE	SLEEP
Spearman's rho	AGE	Correlation Coefficient	1,000	-,401**
		Sig. (2-tailed)	.	,009
		N	42	42
	SLEEP	Correlation Coefficient	-,401**	1,000
		Sig. (2-tailed)	,009	.
		N	42	42

**. Correlation is significant at the 0.01 level (2-tailed).

Figure 2. Partial correlation between age and sleep quality controlling for weekly training frequency

Correlations

Control Variables			AGE	SLEEP
FREQUENCY	AGE	Correlation	1,000	-,349
		Significance (2-tailed)	.	,025
		df	0	39
	SLEEP	Correlation	-,349	1,000
		Significance (2-tailed)	,025	.
		df	39	0

Discussion

The purpose of this study was to examine the relationship between age, weekly training volume, and sleep disturbances in children and adolescents who practice artistic gymnastics. The results showed no correlation between weekly training frequency and the presence of sleep disturbances. However, age was negatively correlated with sleep disturbances. Taken together, these results suggest that sleep quality may be more strongly related to maturational processes. Biological and developmental factors related to sex may influence sleep patterns in children and adolescents. Research suggests that hormonal changes during puberty and differences in circadian rhythms are associated with variations in sleep duration and quality between male and female youths (Duston et al., 2025), which supports the decision to include only female participants. Within the present age range, rapid eye movement and non-rapid eye movement parasomnias such as nightmares, confusional arousals, sleepwalking, and sleep terrors are prevalent (Cohen et al., 2024).

As observed in the present study, training volume, expressed as weekly training frequency, does not appear to significantly impact sleep quality. In this context, the duration and timing of training sessions may exert a greater influence on sleep among young athletes. Supporting this perspective, Tate et al. (2025) investigated the associations between training load, training schedules, weekly training frequency, and sleep in youth athletes. Their findings indicated that the duration of training sessions, as well as the occurrence of evening sessions after 8:30 p.m., were associated with greater negative impacts on sleep. High internal training loads appear to lead to a reduction in total sleep time and greater sleep fragmentation, which may also directly impact sleep quality and/or the presence of sleep disturbances (Aloulou et al., 2021). It is important to highlight the bidirectional relationship between sleep and training load, as just as the application of a high training load may affect sleep, pre-existing poor sleep quality may also directly influence the perception of training load.

Although high training loads may negatively affect sleep, regular participation in physical activity generally exerts positive effects on sleep quality in children (Song et al, 2026). From this perspective, the way in which sports participation is structured during childhood becomes particularly relevant, especially regarding the balance between early specialization and multilateral development. The development of youth athletes requires a balance between multilateral development and specialized training. Early stages of athletic development should prioritize broad-based motor development; however, the temptation to initiate specialized training prematurely can be considerable, particularly when young athletes show early success in a specific sport (Rodriguez et al., 2019). This tendency appears to be especially common in gymnastics disciplines (Root et al., 2019). An evaluation of

specialization patterns in youth sports indicated that gymnastics had the second-highest rate of single-sport specialization, second only to tennis, while gymnasts reported the highest mean weekly training volume (Root et al., 2019). Under these circumstances, the technical and physical demands of artistic gymnastics may reinforce the utterly relevant role that sleep may play in this population, highlighting the importance of monitoring sleep habits in young athletes engaged in structured training programs.

Younger children seem to require additional caution regarding training volume and intensity, not only due to concerns related to early sport specialization but also because sleep disturbances may negatively affect recovery processes. Sleep plays a fundamental role in physiological recovery, contributing to processes such as tissue repair, metabolic regulation, immune function, and hormonal responses associated with growth and adaptation to training (Fullagar et al 2015). In young athletes, inadequate sleep or the presence of sleep disturbances may compromise these processes, potentially impairing recovery from training loads and contributing to the accumulation of fatigue (Copenhaver et al 2017). Considering that childhood and early adolescence are periods of significant growth and development, ensuring adequate sleep becomes particularly important for supporting both healthy development and appropriate adaptation to training stimuli. Therefore, monitoring sleep patterns and considering sleep health when planning training loads may be especially relevant when working with younger athletes.

This study has some limitations that should be considered when interpreting the findings. First, the cross-sectional design does not allow causal relationships to be established between training characteristics and the presence of sleep disturbances. However, cross-sectional studies are commonly used as an initial approach to explore associations and generate hypotheses, particularly in areas where empirical evidence remains limited, which is the case. Another limitation concerns the assessment of sleep through a questionnaire completed by parents, which may be subject to reporting bias. Nevertheless, questionnaire-based assessments are widely used in pediatric sleep and sports sciences research due to their feasibility in field-based studies. The authors recommend that future studies should include larger samples, longitudinal designs, objective sleep assessments, and more comprehensive measures of training volume to further advance knowledge in this field.

Conclusions

These findings indicate that maturational factors may play a more relevant role in sleep characteristics than training frequency alone. Therefore, attention to sleep monitoring and its integration into training planning is recommended, particularly in younger athletes.

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