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The Effect of Melatonin Supplementation in Training on Athletic Performance and Growth Hormone

Muhammed Öniz[1,a,*], Mehmet Şerif Ökmen[2,b]

[1,2]*Faculty of Sports Sciences, Mardin Artuklu University, Mardin, Turkey*

**Corresponding author*

Review Article

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ABSTRACT

Although melatonin is primarily known to regulate sleep and circadian rhythms, recent research has explored its use during athletic training. Studies have examined how melatonin supplementation may influence athletic performance by focusing on its interaction with growth hormones (GH). GH is key in muscle development, fat metabolism, and recovery, making it critical for athletic performance. Consequently, the relationship between melatonin and GH has attracted growing interest among coaches, sports scientists, and health professionals. However, most studies have been conducted in animals, with limited research in humans. The specific effects of melatonin on human GH levels remain unclear. This review aimed to systematically examine the existing literature on melatonin use during training and its potential impact on GH levels, providing directions for future research. Data were collected through a systematic search of academic databases. These results indicate that melatonin supplementation during training may increase, decrease, or have no significant effect on GH levels or athletic performance. Therefore, the findings remain inconclusive. Further research is necessary to clarify the effects of melatonin, considering individual variability. However, despite the inconsistency of findings, a synthesis of the evidence suggests that melatonin supplementation tends to offer more potential benefits than harms when used appropriately. These benefits are particularly related to improved recovery, sleep quality, and hormonal regulation all of which may indirectly support athletic performance. In conclusion, while more human-based and controlled studies are needed, melatonin appears to be a conditionally effective supplement, especially in athletes with sleep disturbances or high oxidative stress.

Keywords: Athletic performance, Growth Hormone, Hormone, Melatonin, Training

Melatonin Takviyesinin Antrenmanlarda Atletik Performans ve Büyüme Hormonu Üzerindeki Etkisi

**Sorumlu yazar*

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ÖZ

Melatonin esas olarak uykuyu ve sirkadiyen ritimleri düzenlemesiyle bilinse de son araştırmalar bu hormonun atletik antrenman sürecinde kullanımını da incelemeye başlamıştır. Çalışmalar, melatonin takviyesinin büyüme hormonu (GH) ile olan etkileşimine odaklanarak atletik performansı nasıl etkileyebileceğini araştırmaktadır. GH; kas gelişimi, yağ metabolizması ve toparlanmada kilit bir rol oynar, bu nedenle atletik performans için kritik öneme sahiptir. Dolayısıyla, melatonin ve GH arasındaki ilişki, antrenörler, spor bilimciler ve sağlık profesyonelleri arasında giderek artan bir ilgi görmektedir. Bununla birlikte, çalışmaların çoğu hayvanlar üzerinde yapılmış olup insanlarda yürütülen araştırmalar sınırlıdır. Melatoninin insan GH seviyeleri üzerindeki spesifik etkileri hâlâ net değildir. Bu derlemenin amacı, mevcut literatürü sistematik olarak inceleyerek antrenman sürecinde melatonin kullanımının GH seviyeleri üzerindeki potansiyel etkilerini ortaya koymak ve gelecekteki araştırmalar için yönlendirmeler sunmaktır. Araştırma verileri, akademik veri tabanlarında sistematik tarama yöntemiyle toplanmıştır. Elde edilen sonuçlar, antrenman sırasında melatonin takviyesinin GH seviyelerini veya atletik performansı artırabileceğini, azaltabileceğini ya da anlamlı bir etkisinin olmayabileceğini göstermektedir. Dolayısıyla mevcut bulgular kesin bir sonuca ulaşmak için yeterli değildir. Bireysel farklılıklar da göz önünde bulundurularak, melatoninin etkilerini netleştirmek için daha fazla araştırmaya ihtiyaç vardır. Bununla birlikte, bulguların tutarsız olmasına rağmen mevcut kanıtların sentezi, melatonin takviyesinin uygun şekilde kullanıldığında zarardan çok potansiyel fayda sağlayabileceğini düşündürmektedir. Bu faydalar özellikle toparlanmanın iyileşmesi, uyku kalitesinin artması ve hormonal düzenleme ile ilgilidir; bunların tümü dolaylı olarak atletik performansı destekleyebilir. Sonuç olarak, insan temelli ve kontrollü çalışmalara duyulan ihtiyaç devam etse de melatonin özellikle uyku bozukluğu yaşayan veya yüksek oksidatif stres altında olan sporcularda koşullu olarak etkili bir takviye olarak görünmektedir.

Anahtar Kelimeler: Atletik performans, Büyüme Hormonu, Hormon, Melatonin, Antrenman

[a] *muhammedoniz@artuklu.edu.tr* *Orcid ID: 0000-0002-1516-3449* [b] *mserifokmen@artuklu.edu.tr* *Orcid ID: 0000-0002-8636-3333*

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Introduction

Melatonin is an important hormone that regulates the circadian rhythms of the body (Ma et al., 2022; Imenshahidi et al., 2020). To maintain this rhythm, exogenous melatonin supplements have been used in recent years and have been the subject of many studies (Kruk et al., 2021; Paryab et al., 2021). Recent research suggests that melatonin supplements may have potential effects not only on sleep patterns but also on athletic performance (Almendros et al., 2023; Celorrio San Miguel et al., 2024; Drummond et al., 2024). GH is a determinant of athletic performance. GH is involved in several physiological processes such as fat metabolism, muscle development, and regeneration (Hall and Hall, 2020). Therefore, evaluating the effect of melatonin supplementation on GH levels is an important research area for many individuals and institutions seeking to improve the performance of athletes. In addition, examining the relationships between melatonin supplementation, GH, and athletic performance will be an important research area for sports scientists, coaches, conditioners, health professionals, and athletes. In the literature, the effect of melatonin supplementation on GH levels in humans has not been fully clarified. Some studies suggest that melatonin supplementation increases GH release and/or athletic performance (Forsling et al., 1999; Kasuya et al., 2006), whereas others suggest that it may decrease (Souissi & Dergaa, 2021; Karasek et al., 2007) or have no effect (Mero et al., 2006; Farjallah et al., 2022). To clarify the ambiguous relationship between melatonin supplementation, GH levels, and athletic performance, further evidence-based investigations are required within the field of sports sciences. This review study was designed to systematically examine the effects of melatonin supplementation during training, particularly its impact on GH secretion and athletic outcomes. In doing so, it aims to provide a comprehensive synthesis of the current literature and serve as a scientific resource for researchers, practitioners, and athletic professionals. Additionally, the study highlights current knowledge gaps and offers concrete recommendations for future research focused on optimizing supplementation strategies in athletic contexts.

Melatonin

Melatonin is known as the “darkness hormone” (Foster, 2021). Melatonin (N-acetyl-5-methoxytryptamine) was identified by dermatologist Aaron Lerner in 1958. Melatonin is an indole-derived neuroendocrine hormone secreted by the pineal gland, and its concentration varies according to signals from the circadian centers of the brain. The secretion and synthesis of melatonin are triggered by the light-dark transitions, and melatonin secretion is rhythmic. (Mero et al., 2006; Zeman et al., 1999; Imenshahidi et al., 2020). Melatonin reaches its highest secretion rate late at night and in the dark (Faria et al., 2024; Celorrio San Miguel et al., 2024; Drummond et al., 2024). Melatonin secretion starts to increase in the evening when it gets dark, reaches its highest levels at night (between 02.00-04.00), and decreases in the morning with the increase in daylight. The concentrations of melatonin in the blood and cells at night are 3–10 times higher than during the day (Günhan, 2021; Mero et al., 2006; Zeman et al., 1999). Melatonin receptors are widely distributed throughout the human body (Atasoy & Erbaş, 2017). Melatonin is produced in many organisms, including animals, plants, fungi, and bacteria (Morvaridzadeh et al., 2020). If we look at the process of melatonin secretion, firstly, light enters the body through the eyes and affects the cryptochrome pigment in the retina. Light or dark messages from the eyes to the body are then transmitted via the retinohypothalamic pathway to the circadian heart system located in the upper chiasmatic nucleus. At this location, signals are transmitted to the upper cervical ganglion and from there to the pineal gland via postganglionic fibers (Figure 1) (Mero et al., 2006; Zeman et al., 1999).

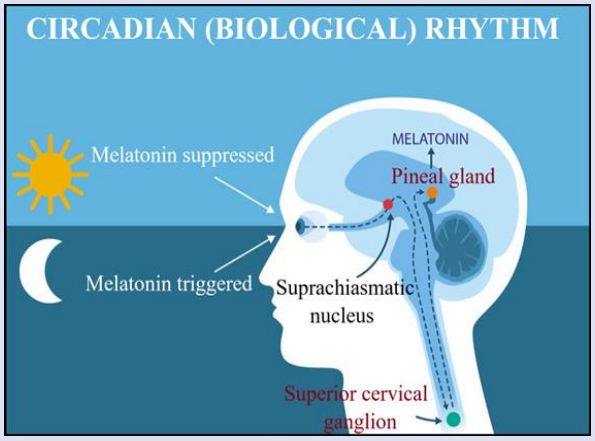

Figure 1. Interaction of melatonin with circadian rhythm (Demirdeşen, 2023)

Melatonin is also involved in the regulation of circadian rhythm. Melatonin is the gold standard for assessing circadian rhythm. This is because they directly reflect the rhythm of the central nervous system (Ma et al., 2022; Stacchiotti et al., 2020; Yıldırım and Ersü, 2023). Circadian rhythms are natural behavioral and biological activity changes that the organism shows in 24 h, that is, by adapting to the daily light and dark cycle. These rhythms are controlled by an internal biological clock that regulates many physiological processes such as the human sleep cycle, blood pressure, and body temperature. This internal clock allows the body to adapt to its external environment and synchronize daily activities (Nobari et al., 2023). Exogenous melatonin supplements are very effective for this synchronization. This is because melatonin administration triggers earlier sleep and changes the circadian rhythm. For this reason, some airline passengers traveling between meridians

(mainly athletes) use exogenous melatonin supplements to aid sleep and prevent the disruption of circadian rhythms (jet lag) (Mero et al., 2006; Kruk et al., 2021; Paryab et al., 2021). The interaction between melatonin and circadian rhythms is shown in Figure 1.

Melatonin, the most natural antioxidant, prevents oxidative stress. As melatonin is soluble both in the lipid phase and in water, it easily reaches all intracellular components and effectively prevents free radical damage to the cell membrane, nucleus, and organelles (Morvaridzadeh et al., 2020; Ma et al., 2022; Imenshahidi et al., 2020). Therefore, in addition to reducing oxidative stress, melatonin is effective in protecting brain tissue from oxidative damage. In addition, melatonin is an important hormone with many bioactivities, such as inhibiting tumor growth (antitumor), strengthening the immune system, improving sleep quality, anti-inflammatory effects, and stimulating antioxidant enzymes (Almendros et al., 2023; Kaya, 2023; Faria et al., 2024). In addition to its neuroprotective effects,

melatonin also has important effects on the control of chronic diseases such as diabetes, heart disease, and obesity (Stacchiotti et al., 2020; Yıldırım & Ersü, 2023; Morvaridzadeh et al., 2020). Melatonin also has a significant effect on the bone structure. The serum calcium concentration decreases with the suppression of

melatonin secretion, and melatonin supplementation increases this concentration (Atasoy & Erbaş, 2017).

Growth Hormone

Secreted pulsatile or intermittently from the anterior pituitary gland, growth hormone (GH) is a small single-chain protein with a molecular weight of 22.005 and a length of 191 amino acids (Chang & Johnson, 2021; Bidlingmaier et al., 2005; Hall and Hall, 2020). The release of GH, also known as "somatotropin," is regulated, stimulated, and suppressed by many factors and physiological stimuli (Figure 2) (Thomas et al., 2013; Backeljauw & Hwa, 2016). GH release and synthesis are governed by the direct action of the hypothalamus and negative feedback of somatomedin on the hypothalamus and pituitary. GH release is regulated by the growth hormone-releasing hormone (GHRH) and somatostatin (Kasuya et al., 2006; Sabag et al., 2021; Thomas et al., 2013). Most effects of GH are mediated by insulin-like growth factors (somatomedins) (IGF-I and IGF-II) (Hall & Hall, 2020).

In addition to its importance to cell health, GH enables cell renewal and growth (Forsling et al., 1999). GH is known to affect several body systems (Sabag et al., 2021). GH is a primary hormone that enables organisms to develop and grow after birth. GH affects lipid, carbohydrate, amino acid, and protein metabolism during the growth period, which starts immediately after birth and lasts until the age of 25 years, and ensures the growth of almost all tissues with growth properties. GH exerts its growth effect through somatomedins (Chennaoui et al., 2020; Wahl et al., 2010; Günay et al., 2006).

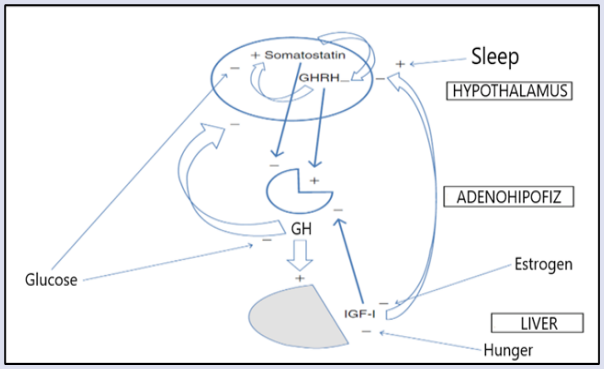

Figure 2. Regulations in GH secretion (Backeljauw & Hwa, 2016)

Physiological conditions such as sleep pattern and quality, age, sex, menopause, physical fitness level, physical activity level, diet and nutrition, obesity, and hyperventilation affect GH secretion. Exercise and sleep quality are particularly strong stimulants of GH secretion (Sasaki et al., 2014; Hall & Hall, 2020; Thomas et al., 2013).

Childhood and adolescence are periods of maximal GH secretion. GH secretion before puberty is almost twice that of adulthood (~700 µg/day in childhood to ~400 µg/day in adulthood). After puberty, the rate of GH release decreases with increasing age. GH release rates decline by approximately 14% every 10 years after the age of 40. There was a 15% decline in their thirties and 75% decline in their sixties (Thomas et al., 2013; Hall & Hall, 2020; Bidlingmaier & Strasburger, 2010).

In addition to its general effects on growth, GH has several other metabolic effects. GH increases fatty acid liberation from increased adipose tissue, increases the rate of free fatty acids in the blood, increases the rate of protein production in body cells and the rate at which fatty acids are used for energy, and also decreases the rate of glucose utilization throughout the body (Kurtoğlu et al., 2013; Sabag et al., 2021; Weltman et al., 2008).

GH secretion can be chronically and sometimes momentarily unbalanced in individuals, leading to a variety of health problems. For example, individuals can develop serious health problems such as dwarfism, low GH secretion, and high GH secretion (Hall & Hall, 2020; Melmed, 2006).

Exercise, Athletic Performance, and Melatonin Relationship

There is evidence that physical exercise affects melatonin secretion and melatonin supplementation affects athletic performance. For example, one study argued that melatonin intake before exercise was effective in increasing training tolerance and improving the sense of competition (Paryab et al., 2021). Similarly, physical exercise affects melatonin secretion (Kruk et al., 2021). Some studies have concluded that exogenous melatonin consumption is also effective in improving exercise performance, as it plays an important role in

reducing oxidative stress in muscles, increasing muscle strength, and increasing the amount of glucose in muscles (Kaya, 2023; Paryab et al., 2021; Stacchiotti et al., 2020). However, studies have suggested that melatonin supplementation decreases athletic performance (Souissi & Dergaa, 2021) and has no effect on athletic performance (Almendros et al., 2023; Celorrio San Miguel et al., 2024; Drummond et al., 2024). Owing to these contradictory results, more comprehensive studies will contribute to the literature.

Relationship between Exercise, Athletic Performance, and Growth Hormone

It is known that there is a relationship between physical exercise and GH, and that exercise and intensive training practices affect hormonal release and create several adaptations that can enable the organism to cope with exercise stress. (Pranoto et al., 2024; Koz et al., 2016). Exercise and intense training programs may decrease resting levels of some hormones, including GH, while increasing their levels during exercise (Koz et al., 2016). Previous studies reported that physical exercise increases GH levels in the bloodstream (Pranoto et al., 2024). Similarly, it has been argued that GH levels in the blood increase with exercise, and this increase continues as the intensity of exercise increases. When maximal exercise was reached, GH levels increased to approximately 25 times their resting value. A close relationship has also been reported between this increase in physical fitness levels (Koz et al., 2016). However, some studies also reported that the training program did not cause a statistically significant difference in GH levels between groups (Öniz et al., 2024). Owing to these contradictory results, more comprehensive studies examining the relationship between exercise and GH will contribute to the literature.

Interactions of Melatonin, Growth Hormone, and Sleep Triad

Sleep is a natural process that allows the repair and development of the nervous system and energy conservation in all mammals. Sleep is associated with many biological structures that control arousal, behavior, cognitive and automatic functions, and intracellular mechanisms. Therefore, adequate high-quality sleep is highly recommended for the health of adults and children (Chennaoui et al., 2020; Şahin & Aşçıoğlu, 2013). Melatonin is an ergogenic substance. The absorption of exogenous melatonin was rapid. The maximum levels are reached in the plasma approximately 1 h after oral melatonin supplementation (Drummond et al., 2024; Faria et al., 2024). Sleep patterns are highly effective in improving athletic performance, and melatonin supplementation is highly effective in improving sleep patterns (Cunha et al., 2023; Atasoy & Erbaş, 2017; Kruk et al., 2021). However, melatonin is not a "sleep hormone" (Foster, 2021). Sleep is unnecessary for melatonin secretion, and a dark environment is sufficient (Atasoy & Erbaş, 2017; Almendros et al., 2023). Melatonin supplementation is widely used by individuals with sleep difficulties or problems (Drummond et al., 2024). This is because exogenous melatonin supplementation has a sleep-enhancing effect on the central nervous system. With an increase in melatonin release, body temperature decreases with vasodilation, which creates a feeling of sleep; therefore, melatonin does not have a direct hypnotic effect (Atasoy & Erbaş, 2017). Many studies have examined the relationship between melatonin and sleep (Drummond et al., 2024; Paditz et al., 2024). Studies have shown that melatonin supplementation improves sleep quality (Fatemeh et al., 2022; Atasoy & Erbaş, 2017). Melatonin supplementation is safe, because it has few adverse effects. Thus, melatonin is an excellent agent for preventing inflammatory disorders (Cho et al., 2021). The richest sources of exogenous melatonin are fish, eggs, barley, mushrooms, oats, and nuts (Günhan, 2021). Although the relationship between melatonin and GH has not been fully clarified in the literature, increasing evidence suggests that GH secretion is associated with. Studies have shown that melatonin affects GH secretion rates and that high doses of melatonin stimulate GH secretion (Forsling et al., 1999). However, when we examined the literature, the results of studies conducted on humans showed inconsistencies. In some studies, melatonin supplementation decreased GH levels (Karasek et al., 2007); in some studies, it increased GH levels (Forsling et al., 1999; Kasuya et al., 2006; Ma et al., 2022); and in some studies, it did not affect GH levels (Mero et al., 2006; Zeman et al., 1999). However, decreased GH secretion has been reported in response to sleep disturbances. Sleep quality and level affected the GH secretion rate by approximately 95%. Depending on the extent of insomnia, GH secretion can be reduced to minimum levels or even completely disappear (Yıldırım & Ersü, 2023; Rosenblum et al., 2024; Chennaoui et al., 2020). Non-Rapid Eye Movement (NREM) sleep constitutes half of sleep and is divided into four periods. Although the functions of the 1st and 2nd periods are not fully known, the 3rd and 4th periods constitute the deep-sleep period, during which physical rest is provided. It is very difficult to wake up a person who sleeps during the 3rd and 4th periods. GH is secreted during this period in children. In adults, an increase in GH release has been observed, particularly during the 4th period (Şahin & Aşçıoğlu, 2013; Forsling et al., 1999).

Method

In the present study, a literature review method was used to examine the effects of melatonin supplementation on athletic performance and GH depth. Therefore, current research data were obtained through a literature review. Web of Science, Scopus, PubMed, TR Dizin, and Google Scholar electronic databases were searched for studies related to the subject of the current research. In the literature review, 14 academic studies investigating similar variables and topics were compiled to evaluate the effects of melatonin supplementation on

athletic performance and GH. Based on the findings and results of these studies, evaluations were made in the current study, and a conclusion section of the research was formed. A flow diagram of the literature review process prepared within the framework of this study is shown in Figure 2.

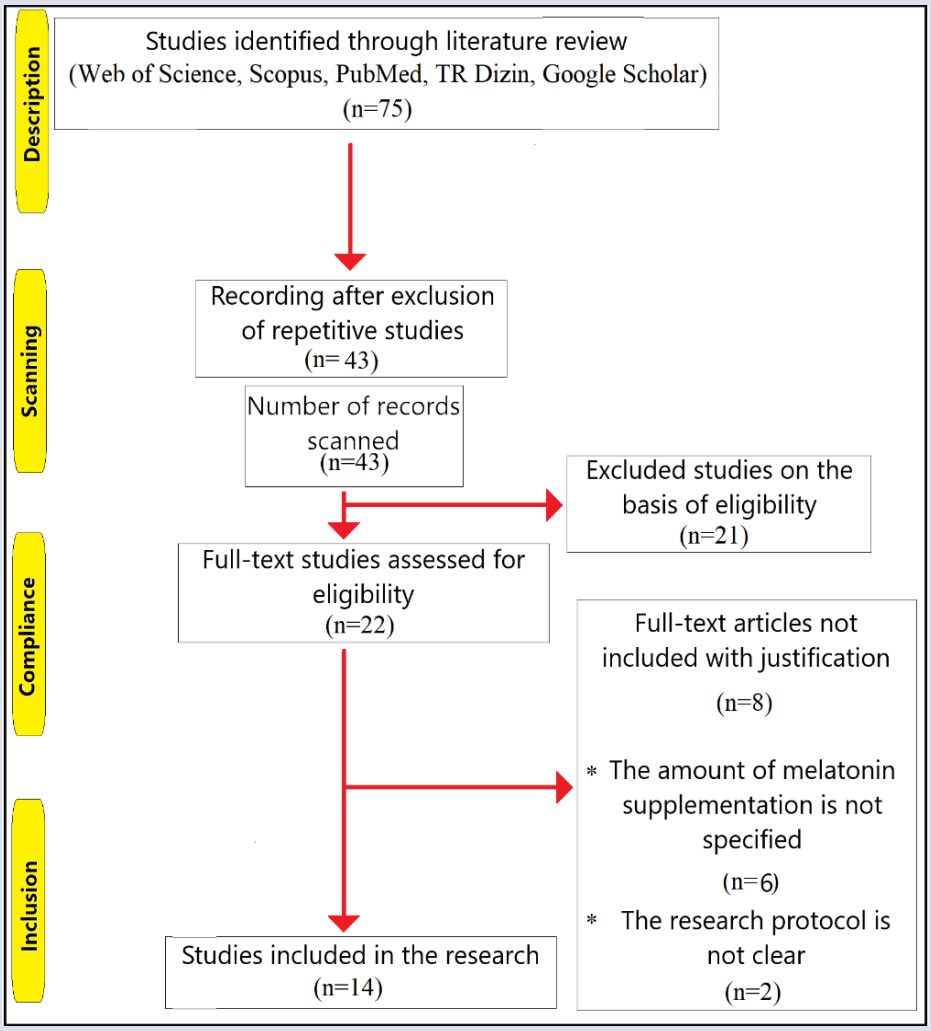

Figure 3. Flow diagram of the literature review process

Inclusion Criteria

- The research must be published in full text and be open to access.

- Sources must be research articles, meta-analyses or review articles.

- The study to be analyzed should be on "melatonin and athletic performance", or "melatonin and growth hormones".

Related Literature Review

Literature searches of related studies were conducted on the Web of Science, Scopus, PubMed, TR Index, and Google Scholar electronic database sites. The research topic was searched and analyzed in these academic databases until April 2024. Both Turkish and English equivalents of the words "Melatonin," "Melatonin and Hormones," "Melatonin and Exercise," "Melatonin and Growth Hormone," "Growth Hormone," "Circadian Rhythm," "Sleep Pattern," and similar word combinations were used in the searches. The scientific academic studies compiled for this research did not limit the age, sex, body weight, and health status of the volunteers. A summary of the literature on the effects of melatonin supplementation on athletic performance and growth hormone levels is presented in Table 1.

Table 1. Effect of melatonin supplementation on athletic performance and growth hormone

Reference	Title	Type of Res.	Characteristics of the participant population	Supp. amount (mg)	Variable examined in relation to mel. supp.	Effect of mel. supp.
(Almendros et al., 2023)	Effects of Melatonin Supplementation on Professional Football Player Performance: A Systematic Review	Review	Review (59 academic studies)	5-8 mg	* Athletic Performance	-
(Souissi & Dergaa, 2021)	An Overview of the Potential Effects of Melatonin Supplementation on Athletic Performance	Review	Review (many studies included in the review)	6 mg	* Athletic Performance	↓
(Celorrio San Miguel et al., 2024).	Impact of Melatonin Supplementation on Sports Performance and Circulating Biomarkers in Highly Trained Athletes: A Systematic Review of Randomized Controlled Trials	Review	Review (21 academic studies)	5-100 mg	* GH * Athletic Performance	- -
(Mero et al., 2006)	Effects of Resistance Exercise Session After Oral Ingestion of Melatonin on Physiological and Performance Responses of Adult Men	Research Article	10 male athletes (athletes doing resistance training) (age 24±3 years)	6 mg	* GH * Athletic Performance	- -
(Faria et al., 2024)	Influence of Acute Melatonin Administration on Human Physical Performance: A Systematic Review	Review	Review (10 academic studies)	5-10 mg	* Athletic Performance	-
(Karasek et al., 2007)	Increased Melatonin Concentrations in Children With Growth Hormone Deficiency	Research Article	22 volunteer healthy sports children (2 women / 20 men) (11.1-16.9 age group)	Melatonin supp. was not given. GH and melatonin values were checked	* GH	↓
(Kaya, 2023)	The Relation Between Melatonin and Exercise	Research Article	Spraque-Dawley 30 adult male rats (4 weeks / 30 min daily swimming exercise) (Control group: n=10; Swimming group: n=10; Melatonin+Swimming group: n=10)	3 mg	* Athletic Performance	↑
(Forsling et al., 1999)	The Effect of Melatonin Administration on Pituitary Hormone Secretion in Man	Research Article	8 healthy men Age 21±5 years (same volunteer observed 4 times. 0.05mg - 0.5mg - 5.0mg melatonin and fourthly placebo)	0.05mg - 0.5mg - 5.0mg	* GH	↑
(Kasuya et al., 2006)	Effect of Melatonin Injected Into the Third Ventricle on Growth Hormone Secretion in Holstein Steers	Research Article	11 Holstein cattle (7-8 months)	100 - 300 - 600 µg	* GH	↑
(Drummond et al., 2024)	Is Melatonin as an Ergogenic Hormone a Myth? A Systematic Review and Meta-Analysis	Review	Review (19 academic studies)	5-8 mg	* Athletic Performance	-
(Ma et al., 2022)	Melatonin Promotes The Growth and Development of Lambs By Increasing Growth Hormone and Testosterone, Targeting on Apoptosis Signaling Pathway and Intestinal Microflora	Research Article	A total of 120 healthy 2-month-old male lambs with a body weight of approximately 19 kg (n=40 X 3 groups)	G 1: 0 mg, G 2: 3 mg G 3: 4.5 mg	* GH	↑
(Farjallah et al., 2022)	Effects of Melatonin Ingestion on Physical Performance and Biochemical Responses Following Exhaustive Running Exercise in Soccer Players	Research Article	13 professional male soccer players (age 17.5 ± 0.8 years) (Maximal aerobic rate - running exercise until exhaustion)	6 mg	* Athletic Performance	-
(Paryab et al., 2021)	Melatonin Supplementation Improves Psychomotor and Physical Performance in Collegiate Student Athletes Following a Sleep Deprivation Night	Research Article	33 athletes are university students (20 ± 2 years of age) (The effects of melatonin supplementation administered 30 minutes before training after 4 hours and 24 hours of sleep deprivation on athletic performance were investigated)	6 mg	* Athletic Performance	↑
(Stacchiotti et al., 2020)	Impact of Melatonin on Skeletal Muscle and Exercise	Review	Review (many studies included in the review)	0.5-100 mg	* Athletic Performance	↑

The melatonin supplementation has an increasing effect (↑), a decreasing effect (↓), no effect or uncertain (-), supp: supplementation, res: research, mel: melatonin, G: group

Discussion

The relationship between GH release levels, which play a very important role in the development and optimization of athletic performance, and melatonin hormone, which is associated with circadian rhythm and sleep patterns, and what kind of effect the interaction between these three factors will have on improving athletic performance and maintaining their current fitness, has been a matter of curiosity for athletes, coaches, and sports scientists. Recent studies have shown that melatonin supplements are frequently used in training. The present study addresses the potential effects of melatonin supplementation during training on both GH release levels and athletic performance and contributes to the understanding of these relationships in light of the existing literature. In the present study, a literature review method was used to evaluate the effects of exogenous melatonin supplementation during training on athletic performance and/or GH levels in individuals and to examine the subjects in depth. Various studies have examined the effects of melatonin supplementation on both athletic performance and GH release. Within the framework of the results obtained from the literature, evaluations were performed for the results of the current study. Although the results are mixed, the inconsistencies can be attributed to differences in study design, melatonin dosage, participant characteristics (age, sex, training level), supplementation duration, and measurement methods (Souissi & Dergaa, 2021; Almendros et al., 2023). The results of the present study show that melatonin supplementation during training can increase, decrease, or not affect GH levels and/or athletic performance. Therefore, the effects of melatonin supplementation on GH levels and athletic performance remain unclear, and further research is required to clarify this issue.

These mixed findings likely reflect significant methodological heterogeneity differences in dosing (ranging from 0,5 mg to over 100 mg/day), timing of ingestion (pre- vs post-exercise; daytime vs nighttime), participant chronotype or baseline melatonin levels and variability in outcome measures and training types (e.g. resistance vs sprint protocols) (Farjallah et al., 2020; Atkinson et al., 2005; Celorrio San Miguel et al., 2024).

For example, ingestion of 5 mg or 10 mg melatonin before training has sometimes increased perceived exertion and enhanced jump or sprint performance in some athletes, while higher doses (8 mg) in daytime trials impaired alertness and reaction time without improving strength metrics. Likewise, nocturnal doses of 5 mg during intensive training camps reduced oxidative stress and muscle damage markers such as creatine kinase and improved repeated-sprint recovery in soccer players (Farjallah et al., 2020; Atkinson et al., 2005; Celorrio San Miguel et al., 2024).

Below, the literature supporting the examination of the interaction between melatonin, GH, and athletic performance elements is presented. In the following sections, both positive and negative results are included for reliability and validity in a detailed discussion of the research topic.

Evaluation of the Effects of Melatonin Supplementation on Athletic Performance

In the existing literature, the effects of melatonin supplementation on athletic performance remain unclear. Some studies have shown that melatonin supplementation during training improves athletic performance (Kaya, 2023; Paryab et al., 2021; Stacchiotti et al., 2020), while others have argued that melatonin supplementation negatively affects athletic performance (Souissi & Dergaa, 2021). Others have argued that melatonin supplementation does not affect athletic performance (Celorrio San Miguel et al., 2024; Faria et al., 2024; Drummond et al., 2024; Almendros et al., 2023; Farjallah et al., 2022; Mero et al., 2006).

The study conducted by Paryab et al., (2021) included 33 university students (aged 20 ± 2 years). The present study investigated the effects of melatonin supplementation on athletic performance during sleep deprivation training. Melatonin is a hormone that is associated with sleep patterns and circadian rhythms. In this study, the training program was applied after 4 h and 24 h of sleep deprivation, and the experimental group received 6 mg melatonin supplementation immediately before training. The findings of this study showed that melatonin supplementation 30 min before training sessions following sleep deprivation contributed to the improvement in athletic performance of athletes (Paryab et al., 2021). In another review, studies investigating melatonin supplementation of 0.5-100 mg/kg administered during training were included. In this review, the effects of melatonin administration on athletic performance are investigated. Melatonin supplementation has been shown to increase muscle strength and improve athletic performance (Stacchiotti et al., 2020). Similarly, Kaya et al., (2023) performed a 4-week (30 min daily) swimming exercise program on 30 adult male Sprague-Dawley rats in their study. In their training program, the experimental group was supplemented with 3 mg melatonin, and the effect of melatonin supplementation on athletic performance was investigated. As a result of the research, they argued that athletic performance increased in the experimental group given melatonin supplementation (Kaya et al., 2023). However, there is no clear consensus on the effects of melatonin supplementation on athletic performance. Some studies have argued that melatonin supplementation has no significant effect on athletic performance, whereas others have argued that it decreases athletic performance. For example, a review study examining the effects of exogenous melatonin supplementation on athletic performance found that melatonin supplementation (~6 mg) negatively affected athletic performance (Souissi and Dergaa, 2021).

Regarding the effect of melatonin supplementation on athletic performance, there are studies where there is no effect or the effect is uncertain. For example, Almendros et al., (2023) reviewed the effects of melatonin supplementation on the performance of professional

soccer players. For this purpose, 59 academic studies analyzing the effects of melatonin supplementation between 5 and 8 mg during training on athletic performance were compiled. As a result of the research, it was argued that melatonin supplementation did not affect the performance of professional soccer players (Almendros et al., 2023). A review study by Celorrio San Miguel et al., (2024) examined the effects of melatonin supplementation between 5 and 100 mg on athletic performance. For this purpose, 21 academic studies were analyzed in depth. According to the results obtained by the literature review method, melatonin supplementation applied during training does not affect athletic performance (Celorrio San Miguel et al., 2024). Similarly, the effects of 5–10 mg melatonin supplementation during training on athletic performance were investigated in a review study by Faria et al., (2024), which included 10 academic studies. They argued that melatonin supplementation did not cause statistically significant changes in athletic performance (Faria et al., 2024). Another review of 19 academic studies concluded that melatonin supplementation of 5–8 mg during training did not affect athletic performance (Drummond et al., 2024). In addition to these review studies, the relationship between melatonin and athletic performance has also been a subject of research. For example, Mero et al., (2006) administered 6 mg melatonin supplementation to the experimental group in resistance training programs of 10 male athletes (24±3 years) and investigated the effects of this supplementation on athletic performance.

The results of this study suggest that melatonin supplementation does not cause significant changes in athletic performance (Mero et al., 2006). Similarly, in another study, 6 mg melatonin supplementation was applied to the experimental group in the maximal aerobic speed running exercise protocol of 13 professional male soccer players (17.5 ± 0.8 years), and it was investigated whether this supplementation affected athletic performance. They concluded that melatonin supplementation did not affect athletic performance (Farjallah et al., 2022).

The different results in the existing literature are thought to be due to the dose of melatonin used, characteristics of the population, duration of administration, type of study, and individual characteristics of the participants. To obtain clearer results, more studies are needed, in which the number of participants is high, long-term protocols are applied, and supplements are used on scientifically accepted scales.

Furthermore, timing of ingestion significantly influences outcomes: trials administering 6 mg melatonin at night reported improved next-day high-intensity performance and reduced muscle soreness in trained males (Mahdi et al., 2025), whereas daytime administration (~5 mg) impaired psychomotor parameters without improving performance (Kim & Cho, 2023; Almendros-Ruiz et al., 2023).

Evaluation of the Effects of Melatonin Supplementation on Growth Hormone

Similar to the effects of melatonin on athletic performance, the effects of melatonin supplementation on GH remain unclear. Some studies have suggested that melatonin supplementation during training increases GH release levels (Ma et al., 2022; Kasuya et al., 2006; Forsling et al., 1999). Some studies have suggested that melatonin decreases GH release levels (Karasek et al., 2007), while others have suggested that melatonin does not affect GH release levels (Celorrio San Miguel et al., 2024; Mero et al., 2006). Meeking et al. (1999) reported that oral melatonin ingestion potentiated exercise-induced GH response, increasing peak and AUC compared to placebo in young adults. Additionally, Nassar et al. (2007) demonstrated that 0.5 mg and 5 mg melatonin taken before heavy resistance exercise increased GH and IGFBP-3 levels, while reducing somatostatin.

In a study by Forsling et al., (1999), melatonin supplementation was added to the training protocols of 8 healthy male volunteers with an average age of 21±5 years, and the effect of this supplementation on GH release was investigated. In this study, the same volunteer was observed with 4 different amounts and types of supplementation. The volunteer was given 0.05 mg - 0.5 mg - 5.0 mg melatonin, and the fourth was a placebo; and GH levels were examined. GH was measured in samples taken at 30-minute intervals for 150 minutes after melatonin administration. As a result of the study, it was concluded that acute melatonin supplementation at doses of 0.5 mg and 5.0 mg significantly increased GH release in healthy males (Forsling et al., 1999). Another study showed that injecting melatonin into the third ventricle at 100 - 300 - 600µg significantly increased GH release in 11 7-8 month-old Holstein cattle (Kasuya et al., 2006). Similarly, in the study of Ma et al., (2022), a total of 120 (n=40 X 3 groups) healthy 2-month-old male lambs with a body weight of approximately 19 kg were divided into three groups, and their GH levels were examined by injecting 0 mg, 3 mg, and 4.5 mg melatonin into the groups respectively. The results showed that Melatonin supplementation increased GH levels in sheep (Ma et al., 2022). However, no clear conclusions have been reached regarding the effects of melatonin supplementation on GH levels. Some studies have argued that melatonin supplementation has no significant effect on GH levels, whereas other studies have argued that GH levels decrease with melatonin supplementation. For example, in a study that examined the relationship between melatonin and GH, research was conducted on 22 volunteers (2 female / 20 male) children (11.1 - 16.9 years). In this study, the volunteers were not administered melatonin supplements, and only GH and melatonin levels were examined. GH and melatonin levels were assessed based on nine blood samples collected at 4-hour intervals during the day and 2-hour intervals at night, with the dark period lasting from 22:00 to 06:00. After this evaluation, the 24-hour blood sample results were compared. This study found that, although the relationship between melatonin and GH is not fully understood,

stimulation of GH is associated with the inhibition of circulating melatonin in children. In other words, an inverse relationship was found between melatonin and GH (Karasek et al., 2007). In terms of the effect of melatonin supplementation on GH levels, if we look at studies where there is no effect or the effect is uncertain, for example, 21 academic studies were analyzed in depth in a review study in which melatonin supplements between 5 and 100 mg were administered, and the effect of this supplementation on GH levels was investigated. The results of this study suggest that melatonin supplementation does not cause significant changes in GH levels (Celorrio San Miguel et al., 2024). Similarly, Mero et al., (2006) applied 6 mg melatonin supplementation to the experimental group in resistance training programs of 10 young male athletes and investigated the effects of this supplementation on GH levels. Melatonin supplementation did not cause significant changes in GH levels (Mero et al., 2006).

It is thought that these different results seen between studies, just like in athletic performance results, may be due to the type, intensity, and duration of training, the dose of melatonin used, and the characteristics of the volunteer population. Further studies with more participants, different time intervals, and different supplementation scales are required to clarify the relationship between melatonin and GH.

Taken together, moderate-dose melatonin (3-6 mg), especially when administered nocturnally before exercise, appears to support recovery and may enhance GH responses, positioning melatonin more as a recovery-supportive aid rather than a direct ergogenic or endocrine therapy (Nassar et al., 2007; Meeking et al., 1999; Mahdi et al., 2025).

Conclusion and Recommendations

The results of the studies obtained through the literature review showed that melatonin supplementation during training can increase, decrease, or have no effect on GH levels and/or athletic performance. Therefore, the effects of melatonin supplementation on GH levels and athletic performance remain unclear. Some studies have argued that melatonin supplementation increases GH release and athletic performance, while others have argued that it decreases GH release, and others have argued that this effect is not evident. Despite the contradictory findings, it is possible to deduce a general trend: melatonin supplementation appears to be more beneficial than harmful when applied carefully and in accordance with individual needs. In particular, improvements in recovery, sleep regulation, and reduction in oxidative stress are consistently supported by current literature, and these factors are strongly linked to better performance outcomes. More research is needed to clarify the effect of melatonin supplementation on GH levels and athletic performance, and individual differences should be considered a top priority. The current body of evidence leans toward viewing melatonin as a conditionally effective supplement that could benefit athletes when applied with attention to dosage, timing, and individual needs. To better understand the effects of melatonin supplementation on GH levels and athletic performance during training, it is recommended that similar studies include controlled experiments and that these be long-term studies. Furthermore, clinical trials are needed to determine the appropriate dose and timing of melatonin supplementation for improving athletic health and performance. Additionally, future research should investigate how variables such as age, gender, sleep patterns, and baseline hormonal profiles may influence the outcomes of melatonin use in training environments.

The recommendations based on the results of this study are presented below.

Recommendations:

To better understand the effects of melatonin supplementation on GH levels in athletes, controlled clinical studies should be conducted rather than review studies. In this way, clearer results can be obtained for this subject, which has not been extensively studied.

It is important to inform and educate athletes and coaches on the appropriate use of melatonin supplementation in training programs. Seminars, conferences, and training meetings can be organized on this subject.

Larger-scale studies that include athletes from different sports branches should be conducted, and the specific effects of melatonin supplementation for each sports branch should be evaluated. Longer research protocols on the relationship between melatonin and GH should be conducted, and sex, age, and body mass index factors should be considered in these studies.

Studies examining the relationship between melatonin supplementation and other hormones related to athletic performance should be conducted. Thus, the physiological effects of melatonin on athletic performance may be clearer.

Psychological factors also affect athletic performance. Therefore, to evaluate the effects of melatonin supplementation on psychological factors, further studies should be conducted to investigate the effects of melatonin supplementation on stress, anxiety, and motivation.

Consideration of these recommendations will further strengthen the role of melatonin supplementation in the evaluation of its effect on GH and help coaches and athletes optimize their training strategies and protocols. In conclusion, this review emphasizes the increasing importance of melatonin supplementation on GH in sports and serves as a resource that can guide future research and practice.

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Ethical Statement of the Research

This study complies with scientific, ethical, and citation rules; no alterations have been made to the collected data, and in the event of any ethical violations, neither the "Sivas Cumhuriyet University Journal of Sports Sciences" nor its editor shall bear any responsibility, as all responsibility lies with the corresponding author. The corresponding author also certifies that this study has not been submitted for evaluation to any other academic publication.

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Conflicts of Interest

The authors declare no conflict of interest.