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CHRONOTYPE AND SLEEP PATTERNS: EFFECTS ON SPRINT PERFORMANCE AND OFFICIAL RACE TIMES

CRONÓTIPO E PADRÕES DE SONO: EFEITOS NO DESEMPENHO DE VELOCIDADE E TEMPOS DE CORRIDA OFICIAL

CRONÓTIPO Y PATRONES DE SUEÑO: EFECTOS EN EL DESEMPENHO DE VELOCIDAD Y TIEMPOS DE CARRERA OFICIAL

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ABSTRACT

Sprint performance depends on the interaction of neuromuscular, metabolic, technical, and environmental factors. Among the variables that may contribute to performance fluctuations, chronotype and sleep have received increasing attention because of their influence on circadian rhythms, alertness, anaerobic power, reaction time, and perceived exertion. This article analyzes, through a narrative literature review, how chronotype, time of day, habitual training schedule, and sleep quality may affect performance in sprint events, with particular emphasis on the 200-meter race. The literature indicates that morning- and evening-type athletes may reach their peak performance at different times of the day and that late chronotypes tend to experience greater performance impairment when required to perform early in the morning. Sleep quality is also associated with anaerobic power and recovery, while sleep restriction and irregular sleep schedules may negatively affect physiological and cognitive functions relevant to sprinting. However, evidence directly linking chronotype or sleep characteristics to official 200-meter race times remains limited. Therefore, chronotype and sleep should be regarded as complementary factors within a broader performance strategy rather than isolated determinants of competitive results. Individual assessment and progressive adaptation of sleep and training schedules to competition times may help athletes optimize their performance.

Keywords: Chronotype. Sleep. Sprint Performance. Circadian Rhythm. 200-meter Race. Anaerobic Power.

RESUMO

O desempenho em sprints depende da interação de fatores neuromusculares, metabólicos, técnicos e ambientais. Entre as variáveis que podem contribuir para flutuações de desempenho, o cronotipo e o sono receberam atenção crescente devido à sua influência nos ritmos circadianos, alerta, potência anaeróbia, tempo de reação e sensação de esforço. Este artigo analisa, por meio de uma revisão narrativa de literatura, como o cronotipo, hora do dia, horário habitual de treinamento e qualidade do sono podem afetar o desempenho em

eventos de sprint, com ênfase particular na corrida de 200 metros. A literatura indica que atletas matutinos e vespertinos podem atingir seu desempenho máximo em diferentes horas do dia e que cronotipos tardios tendem a experimentar maior comprometimento de desempenho quando necessário realizar no início da manhã. A qualidade do sono também está associada à potência anaeróbia e à recuperação, enquanto a restrição de sono e horários irregulares de sono podem afetar negativamente as funções fisiológicas e cognitivas relevantes para sprinting. No entanto, a evidência que vincula diretamente o cronotipo ou características do sono aos tempos oficiais de corrida de 200 metros permanece limitada. Portanto, o cronotipo e o sono devem ser considerados como fatores complementares dentro de uma estratégia de desempenho mais ampla, em vez de determinantes isolados dos resultados competitivos. Avaliação individual e adaptação progressiva dos horários de sono e treinamento aos tempos de competição podem ajudar os atletas a otimizar seu desempenho.

Palavras-chave: Cronotipo. Sono. Desempenho em Sprints. Ritmo Circadiano. Corrida de 200 Metros. Potência Anaeróbia.

RESUMEN

El desempenho en sprints depende de la interacción de factores neuromusculares, metabólicos, técnicos y ambientales. Entre las variables que pueden contribuir a las fluctuaciones de desempeño, el cronotipo y el sueño han recibido atención creciente debido a su influencia en los ritmos circadianos, alerta, potencia anaeróbica, tiempo de reacción y percepción del esfuerzo. Este artículo analiza, mediante una revisión narrativa de la literatura, cómo el cronotipo, la hora del día, el horario habitual de entrenamiento y la calidad del sueño pueden afectar el desempeño en eventos de sprint, con énfasis particular en la carrera de 200 metros. La literatura indica que los atletas matutinos y vespertinos pueden alcanzar su desempeño máximo en diferentes horas del día y que los cronotipos tardíos tienden a experimentar un mayor deterioro del desempeño cuando es necesario realizar en la madrugada. La calidad del sueño también está asociada con la potencia anaeróbica y la recuperación, mientras que la restricción del sueño y los horarios de sueño irregulares pueden afectar negativamente las funciones fisiológicas y cognitivas relevantes para los sprints. Sin embargo, la evidencia que vincula directamente el cronotipo o las características del sueño con los tiempos oficiales de carrera de 200 metros sigue siendo limitada. Por lo tanto, el cronotipo y el sueño deben considerarse como factores complementarios dentro de una estrategia de desempeño más amplia, en lugar de determinantes aislados de los resultados competitivos. La evaluación individual y la adaptación progresiva de los horarios de sueño y entrenamiento a los tiempos de competencia pueden ayudar a los atletas a optimizar su desempeño.

Palabras clave: Cronotipo. Sueño. Desempeño en Sprints. Ritmo Circadiano. Carrera de 200 Metros. Potencia Anaeróbica.

1 INTRODUCTION

Sprint performance results from the interaction of several physiological, neuromuscular, biomechanical, psychological, and environmental factors. In short-distance track events, particularly the 200-meter race, relatively small changes in acceleration, maximal running velocity, reaction time, and the ability to maintain speed may influence competitive performance. Because these capacities fluctuate throughout the day, circadian rhythms have become an important area of investigation in sports science [1-3].

Human physiological functions follow approximately 24-hour cycles regulated by the circadian system. Body temperature, hormone secretion, alertness, muscle activation, and perceived exertion may vary according to the time of day. However, these fluctuations are not identical across individuals. Chronotype describes an individual's tendency toward earlier or later periods of sleep, wakefulness, and peak activity and is generally classified as morning, intermediate, or evening type [1,4].

The relevance of chronotype becomes particularly evident when training or competition schedules differ from an athlete's preferred biological timing. Morning-type individuals generally reach higher levels of physical and cognitive readiness earlier in the day, whereas evening-type individuals tend to achieve their best performance later. Experimental evidence suggests that the interval between waking and peak performance can differ substantially between chronotypes, making time since awakening an important variable in addition to clock time itself [2].

Sleep represents another important component of this relationship. Athletes frequently experience insufficient or irregular sleep due to early training sessions, travel, pre-competition anxiety, environmental disturbances, and demanding schedules. Poor sleep may affect recovery, cognitive function, perceived effort, and several components of physical performance [5-7].

Against this background, the purpose of this article is to analyze how chronotype and sleep characteristics may influence sprint-related performance, particularly in events such as the 200-meter race. Rather than assuming that chronotype or sleep independently determines official race performance, this review examines the physiological and behavioral mechanisms through which these variables may contribute to variations in sprint performance.

2 BACKGROUND

The relationship between circadian rhythms and athletic performance has been investigated across several sports and exercise protocols. Reviews indicate that many components of physical performance tend to improve during the afternoon or early evening, often accompanying the daily rise in core body temperature and neuromuscular activation [1,3]. However, this general pattern varies considerably according to individual chronotype.

Facer-Childs *et al.* showed that the timing of peak physical performance differs markedly between early and late chronotypes. Morning-type individuals reached peak performance relatively soon after waking, whereas evening-type individuals performed optimally much later in their biological day. The study also demonstrated that late chronotypes may experience greater impairment during morning testing, suggesting that biological timing may be more relevant than clock time alone [2].

This distinction is particularly important in sprint events. Sprint performance requires rapid force production, high rates of neuromuscular activation, anaerobic energy availability, and efficient motor coordination. Several of these functions demonstrate time-of-day variation and may therefore be affected by the alignment or misalignment between competition schedules and an athlete's circadian preference [1,3,8].

Habitual training time may further modify this relationship. Rae *et al.* reported that the time at which athletes usually train can influence diurnal performance patterns. Athletes accustomed to training in the morning may demonstrate reduced morning performance impairment, suggesting that repeated exposure to a specific training schedule can produce partial adaptation [9].

Sleep interacts with these circadian mechanisms. Athletes with later chronotypes frequently experience greater difficulty when required to sleep and wake early for morning training or competition. This mismatch between biological preference and externally imposed schedules may reduce sleep duration and increase sleep latency, creating an additional source of performance impairment [4,6,10].

Sleep quality has also been associated with anaerobic performance. Lim *et al.* observed relationships between chronotype, sleep quality, and Wingate-test performance in elite athletes. Poorer sleep quality was associated with lower mean and peak anaerobic

power, while athletes with later chronotypes tended to report less favorable sleep characteristics [4].

Although the Wingate test does not directly reproduce a 200-meter sprint, it evaluates the ability to generate and sustain high power output through predominantly anaerobic energy systems. Therefore, these findings are physiologically relevant to sprint athletes, even though they should not be interpreted as direct evidence of slower or faster official race times.

3 METHODOLOGY

This study adopts an analytical narrative literature review. Scientific publications addressing chronotype, circadian rhythms, sleep quality, athletic performance, anaerobic power, sprint performance, habitual training time, and recovery strategies were selected.

The review prioritizes studies involving athletes and physically active individuals, while also incorporating experimental and review studies that help explain physiological mechanisms relevant to sprint performance. Particular attention is given to evidence involving high-intensity exercise, anaerobic performance, reaction time, training schedules, and sleep-related interventions.

Because relatively few studies directly investigate official 200-meter race performance according to chronotype or sleep characteristics, evidence from other sprint protocols, laboratory tests, swimming, soccer, and elite-athlete populations is also considered. These studies are used to identify mechanisms potentially applicable to sprinting rather than to establish direct causal effects on official 200-meter race times.

The purpose of the review is therefore not to estimate a single quantitative effect of chronotype or sleep on sprint results, but to identify the main mechanisms through which biological timing and sleep behavior may enhance or constrain performance.

4 RESULTS AND DISCUSSION

The reviewed literature suggests that chronotype can influence the timing of peak physical performance. Morning-type athletes generally reach high levels of readiness earlier in the day, while evening-type athletes tend to perform better later. The magnitude of this effect appears to be greater in evening chronotypes when they are required to perform early in the morning [1,2].

One explanation is that evening-type individuals may experience greater circadian misalignment during early exercise. At this time, physiological variables such as body temperature, alertness, neuromuscular activation, and subjective readiness may still be below their daily optimal levels. As a consequence, physical tasks performed shortly after waking may be perceived as more demanding and may result in lower performance compared with the same task performed later in the day [1,2,8].

Time since awakening appears to be particularly relevant. Facer-Childs *et al.* reported that early chronotypes reached peak physical performance substantially earlier after waking than late chronotypes. This finding suggests that scheduling an event according only to clock time may overlook important individual differences in biological timing [2].

For sprint athletes, this issue may affect several components of performance. The 200-meter race requires rapid acceleration from the starting blocks, development of maximal or near-maximal velocity, and maintenance of high running speed despite increasing fatigue. These phases depend on neuromuscular power, coordination, reaction capacity, and anaerobic energy production. Variations in these functions throughout the day could therefore contribute to changes in sprint performance.

However, available evidence does not support the conclusion that chronotype alone determines official 200-meter times. Competitive results depend on numerous interacting variables, including training status, technical efficiency, race strategy, environmental conditions, psychological state, fatigue, and previous competition rounds. Chronotype should therefore be interpreted as one contributing factor rather than a dominant determinant.

Sleep quality represents another important component. Lim *et al.* found that poorer sleep quality was associated with lower mean and peak power during anaerobic testing in elite athletes [4]. Because high power production is essential for sprinting, inadequate sleep may create conditions that are less favorable for maximal performance.

Athletes are particularly susceptible to sleep disruption. Early training schedules, evening competitions, travel, academic or professional obligations, and pre-competition anxiety may shorten sleep duration or reduce sleep efficiency [5-7]. Evening chronotypes may be especially vulnerable when required to wake early, because their preferred sleep phase occurs later and may be difficult to advance abruptly [4,10].

Sleep regularity may also be relevant. Halson *et al.* observed considerable variability in sleep patterns among elite athletes and highlighted the importance of regularity when evaluating recovery and sleep efficiency [7]. From a practical perspective, maintaining relatively stable sleep and wake schedules may help preserve recovery and reduce unnecessary circadian disruption.

Studies examining sleep interventions provide additional evidence. Strategies such as sleep extension, planned naps, improved sleep hygiene, and controlled light exposure have been investigated as methods to improve recovery and readiness. In elite swimmers, sleep-related interventions have been associated with improvements in some sleep variables and reaction-time measures [11]. While these results cannot be directly transferred to track sprinting, they support the potential relevance of sleep management in sports requiring rapid motor responses.

Habitual training time represents another important consideration. Athletes repeatedly training at a specific time of day may partially adapt to that schedule. Rae *et al.* demonstrated that habitual training time can influence the magnitude of diurnal performance variation, indicating that morning training may reduce disadvantages associated with early competition in some athletes [9].

This observation has practical relevance because competition schedules are usually predetermined and cannot be adjusted according to each athlete's chronotype. Athletes may therefore benefit from progressively modifying training and sleep schedules before important competitions. Rather than attempting abrupt changes immediately before an event, gradual adjustment may improve alignment between biological timing and the expected competition schedule.

Table 1

Chronotype- and sleep-related factors associated with athletic performance

Variable	Main evidence	Potential relevance to sprint performance
Chronotype	Morning- and evening-type individuals reach peak performance at different times of day [1,2].	Competition occurring outside an athlete's preferred biological period may create less favorable conditions for maximal performance.
Time since awakening	Late chronotypes tend to reach peak physical performance later after waking than early chronotypes [2].	Wake-up time may be relevant when planning preparation for heats and finals.
Time of day	Several components of physical performance tend to improve later in the day, although responses vary individually [1,3].	Neuromuscular and anaerobic capacities required for sprinting may vary throughout the day.
Habitual training time	Athletes may perform better when tested at times similar to their usual training schedule [9].	Training at expected competition times may facilitate adaptation.
Sleep quality	Poor sleep quality has been associated with lower mean and peak anaerobic power [4].	Reduced sleep quality may compromise high-intensity performance and recovery.
Sleep regularity	Elite athletes frequently show variability in sleep duration and efficiency [5,7].	Maintaining consistent sleep schedules may support recovery and physiological stability.
Sleep-related interventions	Sleep extension, naps, sleep hygiene, and light exposure may improve selected recovery and performance variables [6,11,12].	These strategies may assist athletes preparing for competitions scheduled outside their habitual routine.

Source: Created by author.

The distribution of chronotypes across sports also provides evidence of interaction between biological preference and sporting environment. Lastella *et al.* found differences in chronotype distribution among elite athletes from different sports, suggesting that training schedules and the traditional timing of specific sports may influence athlete selection, adaptation, or both [5].

This relationship should not be interpreted as evidence that a particular chronotype is inherently superior for sprinting. Instead, it indicates that repeated exposure to specific schedules may shape how effectively athletes function at different times of the day.

For 200-meter runners, the most important practical implication is therefore not the identification of a universally optimal competition time. Rather, performance preparation should consider the athlete's individual chronotype, habitual sleep schedule, wake-up time, usual training period, and competition schedule together.

When early competition is unavoidable, evening-type athletes may benefit from gradually advancing sleep, waking, and training schedules before the event. Conversely, athletes preparing for evening finals may need to preserve daytime recovery and avoid

unnecessarily early awakening. These interventions should be individualized because responses to circadian adjustment vary considerably between athletes.

Another limitation of the current literature is that many studies rely on laboratory tests rather than official competition results. Wingate performance, reaction time, strength, and short sprint tests provide useful physiological information, but they do not capture all the technical and competitive demands of a 200-meter race. Consequently, direct research involving competitive sprinters remains necessary to determine how strongly chronotype and sleep characteristics influence official race times.

5 CONCLUSION

Chronotype and sleep are associated with physiological and behavioral variations that may influence sprint-related performance. The available literature indicates that morning- and evening-type athletes can reach their optimal physical performance at different times of the day and that evening chronotypes may experience greater impairment when required to perform shortly after waking.

Sleep quality, duration, and regularity also contribute to athletic recovery and are associated with anaerobic power, alertness, and other functions relevant to sprinting. The interaction between chronotype and sleep becomes particularly important when training or competition schedules conflict with an athlete's habitual biological rhythm.

Nevertheless, current evidence does not demonstrate that chronotype or sleep independently determines official 200-meter race times. Much of the available research is based on laboratory protocols, other sports, or general athletic populations. Therefore, these factors should be understood as components of a broader performance model that also includes training status, technique, recovery, environmental conditions, and psychological preparation.

For sprint athletes, assessing chronotype and monitoring sleep may provide useful information for individualized preparation. When competition schedules are known in advance, gradual adaptation of training, sleep, and waking times may reduce circadian misalignment and create more favorable conditions for performance. Further studies involving competitive sprinters and official race results are needed to quantify the magnitude of these effects more precisely.

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