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The traveller gymnast: trends, myths and clocks

O ginasta viajante: modas, mitos e relógios

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Abstract

Objective: To discuss the influence of biological clocks on traveling gymnasts.

Methods: This conference reported on the scientific basis of the neurophysiology of biological rhythms and discussed associated factors such as travel, sleep, physical

exercise and nutrition. Main results: The traveling gymnast is subject to the characteristics of the location, where they will compete and/or train, which can influence their daily routines and the functioning of their biological clocks with repercussions on their well-being and health general. In the case of athletes, who compete internationally, these aspects take on special relevance, given the possibility of crossing multiple time zones and the desynchronization of their biological rhythm. In this way, plan the athlete's trip appropriately and in a timely manner, considering their energy and nutritional needs, hydration, training, sleep and rest routines, which will allow them to better adapt to the new location and maximize their sport performance. There are several factors that must be considered during the gymnast's journey, namely age, sex, direction and number of time zones crossed, nutrition, dehydration, exposure to light, sleep-wake cycle, basal body temperature, melatonin production, physical exercise, and chronotype. Conclusions: Although jet-lag syndrome is benign, it can effectively break athletes' fashions and routines, negatively affecting their physical and mental health, as well as their sporting performance. It is necessary to educate athletes, coaches, parents and sports managers to fully prepare the athlete, prior to a trip related to a competition in order to avoid or minimize potential losses in sports performance, as well as, and firstly, a decrease in the health status.

Keywords: athlete; trip; biological clocks; sleep; physical exercise; nutrition.

Resumo

Objetivo: Discutir a influência dos relógios biológicos na(na) ginasta viajante. Métodos: Esta conferência relatou as bases científicas da neurofisiologia dos ritmos biológicos e discutiu os fatores associados, como as viagens, o sono, o exercício físico e a nutrição. Principais resultados: O ginasta viajante, ou a ginasta viajante estão

sujeitos às características do local, onde vão competir e/ou treinar, o que pode influenciar as suas rotinas diárias e o funcionamento dos seus relógios biológicos com repercussões no seu bem-estar e na saúde geral. No caso dos atletas que competem internacionalmente, estes aspetos assumem uma especial relevância, dada a possibilidade do cruzamento com vários fusos horários e a dessincronização do seu ritmo biológico. Desta forma, planejar adequada e atempadamente a viagem do(a) atleta, considerando as suas necessidades energéticas e nutricionais, hidratação, rotinas de treino, de sono e de descanso, o que lhe permitirá uma melhor adaptação ao novo local e maximizar-se o desempenho desportivo. São vários os fatores que devem ser considerados durante a viagem do ginasta, nomeadamente, a idade, o sexo, a direção e o número de fusos horários atravessados, a nutrição, a desidratação, a exposição à luz, o ciclo sono-vigília, a temperatura corporal basal, a produção de melatonina, a prática de exercício físico, e o cronotipo. Conclusões: Apesar da síndrome de jet-lag ser benigna, esta pode efetivamente quebrar modas e rotinas dos atletas, afetando-os negativamente ao nível da sua saúde física e mental, bem como, no seu desempenho desportivo. É necessário educar os atletas, treinadores, pais e dirigentes desportivos para uma preparação completa do atleta, previamente a uma viagem relacionada com uma competição, de forma a evitar ou minimizar-se as potenciais perdas de rendimento desportivo, assim como, e em primeiro lugar, a diminuição do seu estado de saúde.

Palavras-chave: atleta; viagem; relógios biológicos; sono; exercício físico; nutrição.

Introduction

The search for factors that may contribute for high performances and the achievement of the best results in competitions are a priority for both athletes and coaches. The desire for a continuous improvement is also a permanent objective of the scientific community in the sports area, which has been increasing research in the study of biological rhythms and associated factors, such as travelling, physical exercise and sleep regulation (Silva and Paiva, 2015).

Biological rhythms are characterized by day-night rhythms that constitute the human sleep/wake cycle (Silva et al., 2016). These rhythms can correspond to periodic, ultra-daily, daily, weekly, monthly, seasonal or annual changes exhibited by living beings (animals and plants) and are generated intrinsically, and though the influence of external synchronizers (Silva, Paiva, & Silva, 2019).

Some are related to the rhythmic cycle of the days and seasons of the year and may occur regularly in relation to the time of the year or period of the day (Monk & Welsh, 2003), and synchronize with relevant temporary stimuli, such as light, temperature and mealtimes (O'Neill & Reddy , 2011).

Any circadian rhythm results from endogenous and exogenous factors (Monk and Welsh, 2003).

The endogenous factors are originated in the biological clock or internal circadian pacemaker, which is located in the central nervous system of the hypothalamus, or in another peripheral pacemaker. Exogenous factors are originated from the environment, behaviour, posture and sleep/wake cycle that the individual adopts throughout life (Silva & Paiva, 2019).

In fact, light is the most effective stimulus to adjust the biological rhythm (Kolb and Whishaw, 2002; Monk and Welsh, 2003).

Therefore, the aim of this chapter is to discuss the influence of biological clocks in the traveller gymnast.

Neurophysiological basis of biological clocks

The body has a “central biological clock” located in the hypothalamus, specifically in the suprachiasmatic nucleus, which receives and emits information. These rhythms are adjusted to environmental elements, mainly the day/night cycle, with light being its main environmental synchronizer (Silva & Paiva, 2015).

Other exogenous stimuli are food intake, stress, physical activity or sleep, also called “zeitgebers”, that refers to any external stimulus capable of helping to maintain the periodicity of circadian rhythms (Ayala et al., 2021).

The circadian rhythm is directly related to regular physiological activities and behaviours of humans and animals to adapt to the Earth's rotation (Silva, Paiva, & Silva, 2019).

There are several types of biological rhythms, circadian, ultradian and infradian, with circadian being the most significant to act in the time corresponding to 24 hours. Ultradian refers to a period of time less than 20 hours and infradian to cycles greater than 28 hours (Thun et al., 2019).

The circadian rhythm of the sleep-wake cycle can be very accurate due to the synchronization of physiological and behavioural variables in the day-night cycle (Silva, Paiva, & Silva, 2019). Thus, the system phase can be delayed or postponed, in a predictive way through light pulses provided at a certain time of the day (Silva & Paiva, 2019).

Sleep is a complex part of the physiological system that regulates the time of occurrence of several variables daily (Monk & Welsh, 2003).

Timekeeping by the biological clock is resistant to changes in temperature (for example, animals that hibernate and wake up at the correct time in Spring).

Thus, the clock and the behaviour it generates are separate, that is, the biological clock can keep time, even if the marked behaviours do not occur (Kolb & Whishaw, 2002).

Biological rhythms

The largest circadian biological clock (internal clock or pacemaker of the mammalian circadian system) is located in the hypothalamus, and is called the suprachiasmatic nucleus (Williams, 2011).

The suprachiasmatic nucleus is a biological clock with the following characteristics: metabolic activity is greater during the light period than during the dark period of the day-night cycle, as 2-deoxyglucose (a form of glucose fixed to metabolically active cells) transmits to suprachiasmatic cells, a rhythmic metabolic activity, and their active period relates to the illuminated period of the day-night cycle (Silva et al., 2019). In this region, neurons are most active during the light period, so each neuron has a rhythmic pattern of electrical activity (Silva & Paiva, 2015).

If all afferent and efferent pathways to the suprachiasmatic nucleus are cut-off, its neurons maintain their activity rhythmic electrical activity, and therefore, the suprachiasmatic nucleus neurons have a rhythmic pattern of activity that is intrinsic, and not a response to a rhythmic orientation from some other brain structure (Kolb & Whishaw, 2002).

Biological clocks and performance

Over the years, it has been noticed that the time at which athletes train influence their physical performance.

Physical performance is not determined solely by training, but also by the endogenous circadian system, that is, it is generated by the organism itself (genetic factors) (Berson et al., 2002; Silva et al., 2022).

It is well established that people vary widely in the timing of their natural behavioural alignment with daily light-dark cycles (Duglan and Lamia, 2019).

Thus, it is known that internal clock time also influences physical performance, causing early chronotypes to perform better around noon, intermediate chronotypes around noon, and late chronotypes at night (Lok et al., 2020).

Many studies argue that professional and amateur athletes have greater sporting performance when training is carried out in the afternoon. This increase in performance is the result of synchronization between physiological, psychological and metabolic rhythms (Silva & Paiva, 2013a, 2013b).

All these parameters reach their maximum in the early afternoon, in coordination with cardiovascular processes that also have a circadian pattern (Vitale et al., 2019).

The fact that there are several circadian rhythms depending on the individual, these can also contribute to the variation in the time of day in physical performance, that is, the speed of movement of the limbs and muscle strength depend on the time of day at which the exercise is taking place. be performed, as well as muscular flexibility and grip strength.

The improvement in performance coincides with lower levels of insulin, cortisol, total and free testosterone and greater oxygen consumption, aerobic mechanical

power, metabolic rate and glucose and growth hormone concentrations (Silva et al., 2019).

Furthermore, factors such as sleep duration, quality and inertia influence performance (Lok et al., 2020).

Neurobiology of the traveller gymnast

The sunrise and sunset, as well as the moments of the feeding process, can adjust the circadian clock, and therefore, constitute environmental stimuli that regulate the biological rhythm called zeitgebers (“time givers”).

Zeitgebers are responsible for regulating the nucleus suprachiasmatic, for example, as a result of moving from East to West, or the need to work shifts, and this regulation takes a few days to become complete (Silva et al., 2019).

An example of this need to redefine the biological rhythm concerns the jet-lag phenomenon, which constitutes a deregulation of the circadian rhythm; corresponds to the difference between the person's circadian rhythm and the daylight cycle in the new environment, which can cause disorientation (Abbott, 2003; Monk & Welsh, 2003).

The jet-lag results in a set of undesirable symptoms caused by the rapid transition between places with different times, namely modified sleep pattern, fatigue, decreased motivation, loss of concentration, changes in mood and irritability, loss of appetite, feeling of bloating after eating, and intestinal changes (Williams, 2011).

The number, severity and duration of symptoms depend on several factors, namely the length of the flight path, the number of time zones crossed and the altitude.

There are also inter-individual, age-related variations, with seasonal variations in day length.

Another fundamental factor is the direction of the flight: when traveling west, crossing 6 time zones means that fatigue at night will be greater and the traveller will have little difficulty falling asleep, as a result of a delay in sleep due to the journey and, partly to the external cause, darkness.

It is possible for a premature awakening to occur due to the increase in plasma adrenaline and core temperature being conditioned by an earlier awakening.

When traveling East, crossing the same six time zones, the results are the opposite, that is, difficulty falling asleep, but without waking up prematurely, given that the new wake-up time corresponds to the original nighttime at the destination (Silva et al., 2019).

Mood state, mental capacity and intestinal function seem to adapt more quickly than other symptoms.

Williams (2011) emphasizes that symptoms related to sleep and fatigue must be identified in an attempt to adapt to local time as quickly as possible.

The jet-lag effect in the traveller gymnast

Given the number of competitions in most international gymnasts, regular short-distance (domestic) and long-distance (international) travel is a constant necessity, and therefore, jet-lag is a constant in these individuals (Simmons et al., 2022).

Jet-lag is the circadian misalignment that results from transmeridian travel, where time zones are crossed, for example, a plane trip that goes from East to West or from West to East. The severity of travel is more pronounced with the increase in the number of time zones crossed, knowing that traveling in at least three different time zones leads to the jet-lag syndrome (Simmons et al., 2022; Forbes-Robertson et al., 2019).

When the journey is from the North to the South or from the South to the North, regardless of the duration of the flight, jet-lag is not seriously affected, because the transmeridian journey has a specific effect on the biological clock, that is, the internal clock ends up not be in tune with external conditions (Silva, Paiva, & Silva, 2019).

Jet-lag symptoms occur as the biological clock tries to adapt (Forbes-Robertson et al., 2019).

Athletes are particularly sensitive to disorders caused by jet-lag, as they are often required to travel long distances, such as to the Olympic Games or other international games/competitions (Silva and Paiva, 2015). Participating in a competition in the local time zone often entails athletes competing at a time when the athlete's internal clock is synchronized to nighttime (Thun et al., 2019).

Therefore, as coaches and athletes should become aware of the effects that jet-lag has on athletes, attempts have been made to minimize symptoms, such as moving travel times forward, so that an adjustment to local time can be made beforehand. competition, however, this is often not feasible (Silva and Paiva, 2013a, 2013b).

Thus, circadian desynchronization following a time zone change has been proposed as one of the factors that may lead to lower performance in games, as teams traveling west are playing when their “watch” circadian rhythms are closer to its lowest point.

These smaller time zone changes are not associated with the jet-lag seen in long-distance travel, but gather a cumulative association with poorer performance results for each additional time zone crossed (Simon et al., 2020).

This “circadian disadvantage” caused by circadian desynchronization could explain the trend of increased individual errors, fewer points scored, and lower winning percentages in traveling teams (Simmons et al., 2022).

It is likely that teams that travel west and that cross-time zones will have an advantage over their opponents when the competition is earlier rather than later that day. However, upon returning to school and training schedules, there is a lack of adaptation, especially if the absence occurred for a few weeks (Williams, 2011).

In this sense, coaches must inform schools of the possible effects on schoolwork due to the significant phase delay in sleep (Silva and Paiva, 2013a).

Nutrition, physical exercise, sleep and chronobiology

The abnormal circadian rhythm is associated with lifestyle-related diseases such as diabetes, obesity and cancer (Bray & Young , 2007).

On the contrary, a normal circadian rhythm is related to the best quality of human health (Sato-Mito et al., 2011). Meal and physical activity patterns vary between different athletes. In animals, the frequency of food meals is related to the regulation of the circadian rhythms.

Kudo et al. (2004) observed that in animals, food restriction at a certain time of the day alters the biological clock, motor activity , body temperature and the release of corticosterone.

In addition, physical exercise is an important agent for the circadian rhythm resynchronization, when used at the right time of day (Reilly, 2009).

Athletes can alter their circadian rhythm so that their peak performance pace matches the desirable peak in competition. Although this peak performance is reached at the time of the circadian peak in body temperature, there is still an extended time beyond the peak of maximum performance (Williams, 2011). This aspect is crucial for athletes who have travelled to areas with different time zones, as the time to acclimatize to the new time is often insufficient.

Depending on the time of day of the competition, the number of zones crossed and the time available until the competition, athletes can perform better, if they adjust their travel before the competition (Reilly, 2009).

In fact, physical exercise can have a positive effect on sleep, increasing its quality, as well as on the circadian rhythm activity, helping with new synchronization after the flight (Silva, Paiva, & Silva, 2019). The circadian rhythm that is most related to the practice of physical exercise is core temperature, but there are others, namely the sleep/wake cycle, nutrition, among others.

The sleep/wake cycle vary in phase from individual to individual, according to the circadian rhythm. It is usually assumed that sleep occurs between 11:00 p.m. and 7:00 a.m.; however, many people do not feel comfortable with this interval due to their chronotype (Silva & Paiva, 2015).

Regarding sleep itself, the circadian system regulates the timing of sleep and waking up in each sleep cycle.

The time to fall asleep and wake up are closely related to core temperature and, therefore, when the biological clock is out of synchronization, due to the change in time zone, changes in sleeping habits are due to this relationship between sleep and circadian rhythm. These systems change throughout life, from childhood, through adolescence to adulthood (Silva & Paiva, 2015).

Although the circadian pacemaker is defined internally by the central nervous system and its rhythm is approximately 24 hours, it is also influenced by external factors, as previously mentioned.

Coaches must be aware of factors related to fatigue as a result of training and/or lack of sleep. Chronic lack of sleep is a frequent cause of reduced performance in young athletes who have training schedules that start too early, have multiple training

sessions in a day, and/or have large training volumes throughout the week (Williams, 2011). If sleep is deficient, there is a significant decrease in attention and performance in athletes as they alert system is not adequately prepared to performance daily activities.

Indeed, the author recommends the reading of the book, entitled: “Sleep, nutrition, circadian rhythm, jet-lag and athletic performance” (Figure 1), which was published by the Gymnastics Federation of Portugal, and can support researchers and coaches interested in this theme.

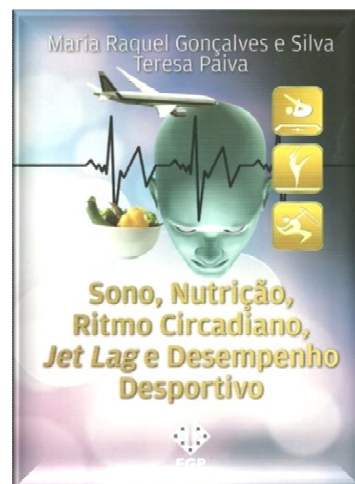


Figure 1. Recommended reading in the subject of this chapter, published by the Gymnastics Federation of Portugal.

Conclusions

Gymnasts at highly competitive levels are subject to a competitive calendar, which does not facilitate the regulation of various functions linked to sleep, appetite and the day-night cycle, due to the travel they have to do between competitions.

Existing studies have shown that performance levels decrease with jet-lag and poor sleep quality, namely the timing of competitions, international flights and the time zones of the competition locations.

It appears to be the result of physiological desynchronization and changes in sleep, which lead to suboptimal values of biological indicators, including muscle strength.

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