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## Sleep and performance in Eathletes: for the win!

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### ABSTRACT

Over the last decade, *Esports*, defined as a form of organized video game competition, has emerged as a global phenomenon. The professional players who compete in Esports, namely, Eathletes, share many similarities with their traditional athlete counterparts. However, in sharp contrast to traditional athletes, there is a paucity of research investigating the factors that influence the performance of Eathletes. This gap in the literature is problematic because Eathletes are unable to make informed and empirically supported decisions about their performance management, unlike traditional athletes. Sleep is an important factor that influences athletic performance in traditional sports, particularly those that require a high level of cognitive demand. Research is yet to examine whether sleep also plays an important function in optimal performance and success of Eathletes in Esports. Accordingly, the aim of this opinion piece is to review the broader sleep and sports medicine literature and provide theoretically grounded suggestions as to how existing findings may apply to Eathletes competing professionally in Esports. Overall, it appears that Eathlete performance may be vulnerable to the deleterious effects of sleep restriction. Furthermore, Eathletes are likely at risk of sleep disturbances due to the unique situations and conditions that characterize Esports.

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Over the last decade, *Esports*, defined as a form of organized video game competition, has emerged as a global phenomenon. Once considered a niche subculture within the broader video gaming industry, Esports now has an annual viewership of 380 million and is expected to reach a market value of 1.4 billion by 2021.<sup>1</sup> Professional leagues have been established globally in a variety of formats, with a particularly strong presence in Asia, Europe, and North America.<sup>2</sup> Concurrently, the number and scope of Esports tournaments have increased significantly, with 588 major Esports events in 2017.<sup>1</sup> In the context of accelerating business, consumer, and professional growth and development, Esports is legitimizing itself as a true form of sporting competition.<sup>2</sup>

The professional players who compete in Esports, namely, Eathletes, share many similarities with their traditional athlete counterparts.<sup>2</sup> For example, Eathletes train rigorously; compete in tournaments; must abide by competition, association, and governing body rules; and can receive salaries and sponsorship.<sup>2</sup> However, in sharp contrast to traditional athletes, there is a paucity of research investigating the factors that influence the performance of Eathletes.

This gap in the literature is problematic because Eathletes are unable to make informed and empirically supported decisions about their performance management, unlike traditional athletes. Furthermore, empirical research focusing on performance management research is critical given the importance of constant performance improvement for success and the high stakes (eg, prize money, prestige) for which Eathletes now compete.

Sleep is an important factor that influences athletic performance in traditional sports,<sup>3</sup> particularly those that require a high level of cognitive demand, such as basketball and baseball.<sup>4</sup> Recently, there has been a surge of interest from athletes, coaches, and trainers regarding the importance of sleep in sport and the implementation of sleep enhancing strategies.<sup>5</sup> Research is yet to examine whether sleep also plays an important function in optimal performance and success of Eathletes in Esports. Accordingly, the aim in this opinion piece is to review the broader sleep and sports medicine literature and provide theoretically grounded suggestions as to how existing findings may apply to Eathletes competing professionally in Esports.

### Sleep and performance in Esports

Whereas athletic performance in traditional sports is determined by a variable combination of physical and cognitive abilities,<sup>4</sup>

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Eathlete performance is more heavily reliant on cognitive abilities.<sup>2</sup> This reliance implicates sleep as a potential key determinant of Eathlete performance given that cognitive deficits are common following sleep restriction (ie, reduced sleep duration).<sup>6</sup> In this section, we discuss the conceivable relationship between sleep and the cognitive abilities that underpin Eathlete performance.

In terms of more rudimentary cognitive processes, Esports involve rapid presentation of new information, and competitive performance depends upon the ability to process this information quickly (i.e., intact information processing speed). For example, Esports can involve rapidly changing information from multiple other human players, together with other in-game elements (e.g., game controlled players/bots). Relatedly, players need to make quick motor movements (which depend upon processing speed) in response to this rapidly changing information. Movements are enacted through visuomotor functioning, the processing of visual information and subsequent enactment of an Eathlete's on-screen avatar movement via physical movements (i.e., keyboard and mouse or console controller). An important component of visuomotor functioning for Eathletes is fine motor control, which involves precise manipulation of the smaller muscles in the hands to manage a complex array of buttons/keys and joystick/mouse manipulations. Furthermore, these manipulations need to be executed with correct timing, in varying sequences, and with no room for error. In other words, Eathletes need to be able to quickly and efficiently process information and then respond appropriately, often with precise, fine motor movements. Importantly, the impact of sleep restriction on more basic cognitive domains is well documented within the literature. There is a broad consensus that sleep restriction results in decreased reaction times,<sup>4,7</sup> reduced processing speed,<sup>8</sup> and slower processing of visual information,<sup>9</sup> leading to impaired visuomotor performance.<sup>10</sup> Taken together, sleep restriction could essentially “slow down” Eathletes, putting them at a competitive disadvantage in the fast-paced world of Esports.

Two additional key cognitive processes involved in Esports are attention and working memory. Given that many Esports matches often go for upwards of 40 minutes,<sup>11</sup> Eathletes are required to sustain their attention for extended periods of time. Thus, effective sustained attention is necessary for competitive Esports performance. Furthermore, to maintain focus on important in-game aspects, Eathletes also need to use efficient selective attention strategies. Selective attention is needed to focus on both relevant in-game elements and to reduce the impact of out-of-game environmental distractions (e.g., spectator noise at arena events). Further complicating gameplay, Eathletes must build a mental model of their opponent to determine and respond to opposing strategies and tactics. Mental models require efficient working memory, as multiple pieces of information need to be stored and analyzed in real time. Working memory is also needed to effectively manage goals in both the short term (e.g., I must retreat from the current battle as I'll die otherwise) and the long term (e.g., playing consistent with a predefined battle plan). Sleep restriction appears to result in performance decrements in selective<sup>9</sup> and sustained attention, as well as working memory.<sup>6</sup> The resultant errors from brief attentional lapses and distractions, and impaired tactical awareness, may mean the difference between success and failure in Esports, particularly for close matches or comparably skilled Eathletes.

In addition to more rudimentary cognitive processes, Eathlete performance also depends upon higher-order executive functioning. *Executive functioning* is a broad term describing a constellation of separable but related cognitive skills, including cognitive flexibility, problem solving, decision making, and metacognition.<sup>12</sup> These skills are often used in service of goal-directed behavior, such as competing to win in Esports. For example, cognitive flexibility is needed because Eathletes are required to anticipate and adapt to continuously

changing variables during Esports gameplay. Moreover, Eathletes must organize, plan, decide, and then implement strategies and tactics to achieve their respective objectives, and often coordinate effectively within the context of a team. Simultaneous to all of these cognitive processes, Eathletes need to monitor their own performance (i.e., metacognition) and regulate their emotions (i.g., if performing poorly). Parallel to the effect of sleep restriction on impairments in lower-order cognitive domains, evidence suggests that executive functioning is also adversely affected. A recent meta-analysis demonstrated that sleep restriction consistently negatively impacted executive functioning.<sup>6</sup> Thus, sleep restriction may compromise Eathletes' ability to effectively engage and modulate aspects of performance related to the aforementioned complex elements of Esports participation, once again highlighting that adequate sleep may be particularly important for optimal Eathlete performance.

### Potential risk factors for sleep disturbances in Eathletes

Despite the need for adequate sleep, sleep disturbances among traditional athletes are common, with a range of possible contributing risk factors.<sup>13</sup> Eathletes are likely exposed to many of the same risk factors as traditional athletes, although others may be unique to the situations and conditions that characterize Esports. In the following section, we outline risk factors for suboptimal sleep that may be pertinent to Eathletes.

#### *Caffeine use*

Caffeine is a well-known ergogenic aid<sup>14</sup> used by traditional athletes across a wide range of sports.<sup>15</sup> However, increased caffeine levels postmatch have been correlated with longer sleep latency and decreased sleep efficiency.<sup>16</sup> Hence, athletes need to take a strategic approach to caffeine use and regulate consumption appropriately to maximize performance gains while minimizing harm to subsequent sleep. Although it currently remains unknown to what extent Eathletes consume caffeine, major energy drink brands such as Red Bull and Monster Energy have been prominent sponsors within the Esports industry for some time.<sup>17,18</sup> Thus, Eathlete exposure to marketing of caffeinated products may be high, but evidence is needed to support this idea.

#### *Air travel*

Sleep disturbances related to air travel can occur because of the effects of jet lag, conflicting habitual sleep-wake schedules and travel times,<sup>13</sup> and travel fatigue caused by being confined, restricted in movement, and possibly dehydrated by dry cabin air.<sup>19</sup> Importantly, for athletes, sleep disturbances related to air travel have been found to compromise athletic performance.<sup>20,21</sup> With the continued growth of the Esports industry, competitions have become more widespread around the world. Although Esports competitions are unique in that it is not always necessary for Eathletes to travel to compete (i.e., they can compete remotely via the Internet), major competitions are centralized and require competitors to be physically present.<sup>2</sup> Hence, many Eathletes are forced to travel long distances to compete, often by plane across multiple time zones.

#### *Precompetition and competition nights*

In their recent meta-analysis, Roberts and Warmington<sup>13</sup> found evidence of reduced sleep duration and efficiency on competition nights. This finding was largely attributed to a delay in bedtime due to a range of potential factors such as elevated cortisol and sympathetic hyperactivity. In comparison, equivocal findings were observed

on precompetition nights, although the authors noted that individual and female athletes might be more prone to precompetition sleep disturbances due to anxiety. Although Esports are male dominated, policies to increase female participation are being implemented.<sup>22</sup> Furthermore, tournaments involving individual competitors are common.<sup>2</sup> Thus, some Eathletes may be susceptible to similar issues experienced by traditional athletes on precompetition and competition nights, resulting in sleep disturbances.

#### Evening use of light emitting devices

Evidence from the general population suggests that evening use of light-emitting devices can interfere with melatonin secretion and consequently negatively impact sleep and daytime performance.<sup>23</sup> In contrast, preliminary results from studies comprising traditional athletes do not reflect these findings.<sup>13,24</sup> However, further research with larger sample sizes and a broader range of cognitive measures is needed before firm conclusions are drawn. Given that light-emitting devices are a core component of Esports, Eathletes may be at an increased risk of sleep disturbances compared to traditional athletes, especially if training or competitive matches occur in the evening.

#### Sleep disorders

Sleep disorders, such as sleep apnea and insomnia, can significantly degrade sleep quality and quantity.<sup>25</sup> The prevalence of sleep disorders among traditional athletes varies between sports, although athletes with particular physical characteristics (e.g., American footballers with high body mass index) may be at increased risk of developing a sleep disorder.<sup>13</sup> Interestingly, given that Eathlete performance is minimally influenced by physical ability, the physical characteristics of the Eathlete population are likely more heterogeneous than traditional athletes. Thus, Eathletes may be less at risk of sleep disorders with specific physical risk factors that arise as a function of competing in Esports. However, there may be physical risk factors for poor sleep that arise as a result of participating in Esports. For example, the sedentary nature of Esports, if managed poorly, could contribute to negative health outcomes (e.g., weight gain, neck pain)<sup>26</sup> and subsequent impaired sleep. Furthermore, given the broad range of diagnosable sleep disorders and their diverse etiologies,<sup>27</sup> sleep disorders remain a plausible issue for Eathletes.

#### Performance enhancing substances

A report by the Esport Integrity Coalition<sup>28</sup> determined that doping was a moderate threat to the integrity of Esports. The report noted that Adderall and Ritalin, both stimulant medications used to treat attention deficit hyperactivity disorder, have instead been used by some Eathletes in an attempt to enhance performance. Although Esport Integrity Coalition has developed an antidoping policy (Anti-Doping Code), there is no systematic detection and enforcement regimen currently in place.<sup>29</sup> Hence, no empirical data exist that can provide further insight with respect to doping prevalence or the types of substances used. From a sleep perspective, some performance-enhancing substances, particularly stimulants, could lead to sleep disturbances.<sup>30</sup>

#### Other risk factors

There are likely other additional risk factors for suboptimal sleep outcomes in the Eathlete population. Informal evidence suggests that this could include inadequate professional support and knowledge about the importance of sleep, competing demands such as work commitments that lead to training at night (particularly for semiprofessionals), and overtraining. However, future empirical research is required to examine these potential risk factors in Eathletes.

## Conclusions and future research directions

This opinion piece is the first to highlight the potential importance of adequate sleep for Eathlete performance. It is well established that sleep restriction impairs cognitive functioning, which may not be conducive for optimal Eathlete performance and therefore compromise the likelihood of competitive success. Indeed, cognitive deficits following sleep restriction may occur across the full spectrum of cognitive abilities that underpin Eathlete performance. Concerningly, similar to traditional athletes, Eathletes likely experience a high level of risk for sleep disturbances due to the unique situations and conditions that characterize Esports. From a practical perspective, these provisional findings have implications for the performance management of Eathletes at all stages of their training and competition schedule.

Our conclusions are limited in that they are based on existing findings drawn from the broader sleep and sports medicine literature. Hence, rigorous scientific research is required to investigate and test our propositions with Eathletes specifically. However, at a time when the Esports industry is experiencing significant growth and popularity, research is notably lagging. We strongly encourage researchers in the field of sleep and sports medicine to invest the time and energy needed to further develop this emerging area of the literature. As a logical next step, future research should focus on the following 3 areas: (1) evaluation of Eathlete sleep patterns, (2) identification of risk factors for suboptimal sleep in Eathletes, and (3) understanding the consequences of sleep restriction on the cognitive abilities that underpin Eathlete performance. Conducting such research would further align Eathletes with traditional athletes professionally, helping them to perform at their peak potential, thereby providing spectators with the best viewing experience possible and enhancing the public profile of Esports on a whole.

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