Review

A narrative review of sleep deprivation in ultra-endurance cycling

Improving mental health awareness and regulatory emphasis

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Abstract: *Introduction:* The popularity of ultra-endurance cycling is increasing. Amongst race participants, sleep deprivation and periods of intermittent or acutely short sleep are common. Scientific research has typically focussed on the physiological or competitive performance based impact of these sleep-related paradigms. However, there is limited evidence about the mental health effects of sleep patterns in ultra-endurance cycling, despite established links between sleep deprivation and psychiatric and psychological issues. *Methods:* We conducted a narrative review synthesising extant empirical literature about sleep deprivation in ultra-endurance cycling. *Results*: Based on our search criteria, seven papers were identified discussing sleep patterns in ultra-endurance races. Each of these indicate that sleep deprivation is a prominent aspect of ultra-endurance competitions, with varying implications for riders. *Discussion:* Using these findings, we highlight the possible mental health consequences of sleep deprivation in these races, with reference to general scientific literature and other ultra-endurance sports. We also advocate for increased knowledge exchanges, regulatory emphasis, and additional research. *Conclusion:* Sleep deprivation and extreme sleep patterns are a substantial issue in elite-level cycling competitions, raising potential mental health concerns. More attention to this topic is necessary amongst organisers, participants, researchers, and community-level platforms, like the Global Cycling Network.

Keywords: sleep deprivation, mental health and ultra-endurance cycling

Introduction

Internationally, ultra-endurance sporting events are increasing in popularity and participation rates [1]. This is pertinent in ultra-endurance cycling, where anecdotal and media reports reflect a burgeoning interest [2]. As terrain, distance, elevation, and difficulty can vary, specific definitions of ultra-endurance cycling events are semantically challenging. Nonetheless, the World Ultracycling Association (WUCA) describes them as "any bicycle ride that is more than 200 kilometres (125 miles) in length or six hours in duration, completed as a single effort" [3]. Whereas elite-level cycling is overseen by the Union Cycliste Internationale, who enforce regulations and issue rider licenses [4], ultra-endurance events lack a single sporting federation and organisers vary from private individuals to commercial entities. In lieu of a specific governing body, WUCA aims to optimise "standards for excellence and achievement in ultracycling" through "various activities (race support, results, record attempts, etc.)" [5].

Ultra-endurance cycling can encompass single- or multi-day events over set stages or continual timeframes. A notable example is the Race Across America (RAAM) (distance ~4,800 km, elevation gain ~53 km); riders will generally complete this course within 10 days (with no official stages or rest breaks) [2], as compared to the Tour de France (distance ~3,500 km, elevation gain ~48 km) that comprises 21 stages across 23 days. Furthermore, certain competitions, like the Transcontinental Race and the IncaDivide, necessitate unsupported participation without team assistance.

Ultra-cycling entails intensive and sustained physical exertion. In some events, riders are solely responsible for the timing and duration of their rest breaks. Resultantly, acute sleep deprivation is a prevalent phenomenon and races are often characterised by irregular or short sleep intervals [2]. Scientific literature has generally focussed on the physiological or competitive performance based impact of these conditions. However, to the authors' knowledge, there is scant awareness about their possible mental

Table 1. Reviewed articles 2012–2022 and their sleep-related findings in ultra-endurance cycling

Reference	Year	Sample size	Description of findings
Nédélec M, Chauvineau M, Guilhem G [10]	2022	N=1	Examined sleep behaviour in a simulated ultra-endurance event. Substantial reduction in sleep duration and alterations in sleep architecture were observed intra-competition, though competitive performance was unaffected.
Serra T, Francia P, Ferri-Marini C, Micheli L, Lucterini F, Federici A. [11]	2021	N=1	Prior to and during four Everesting bike events, body composition and mood was tracked. Significant reduction in sleep quality was evident, alongside increased fatigue and decreased vigour, although rate of perceived effort was medium-low at the end of each event.
Netzer N, Rausch L, Gatterer H, Burtscher M, Eliasson A, Pramsohler S. [12]	2021	N=1	Explored performance effects of sleep quality for a cyclist who participated and won RAAM. Rider slept for 7 hours and 52 minutes across a period of 8.5 days, with average nap time of 8.8 minutes and average sleep duration of 64.2 minutes. Competitive performance was unaffected.
Brayson D, Frigiola A, Clark JE. [13]	2019	N=1	Tracked a participant in the TransContinental Race. Sleep was monitored through a wearable device. The rider experienced less sleep and less consistent sleep, though the amount of sleep did not correlate with competitive performance.
Lahart IM, Lane AM, Hulton A, et al. [14]	2013	N=4	Examined a four-man team competing in RAAM. Riders reported > 1 hour of continuous sleep during a sleep episode, alongside high sleep latency. Riders reported poor emotional state for 50% of race duration. Sleep deprivation and emotional disturbance worsened progressively intra-race.
Knechtle B, Wirth A, Knechtle P, Rüst CA, Rosemann T. [15]	2012	N=84	Followed Swiss Cycling Marathon finishers over distances of 600 km (n=54) or 720 km (n=30) in relation to anthropometry and training approaches. Sleep deprivation was a prevalent factor amongst these samples.
Knechtle B, Wirth A, Knechtle P, Rüst CA, Rosemann T, Lepers R. [16]	2012	N=54	Study explored links between naps and race performance. Sample included fifty-four finishers in the Swiss Cycling Marathon. From this, twenty-three athletes did not sleep and finished the race significantly faster than the thirty-one who did sleep.

health effects. This is alarming given the well-established correlations between sleep deprivation and psychiatric and psychological issues (e.g., [6, 7, 8, 9]). Accordingly, we conducted a narrative review to synthesise current evidence about sleep patterns in ultra-endurance cycling. Using extant literature, we explore potential mental health implications and argue for additional research, regulatory emphasis, and psychoeducational exchanges.

Methodology

We searched two academic databases for relevant papers on sleep deprivation and sleep patterns in ultra-endurance cycling events, namely Scopus and PubMed. Our review was confined to the previous ten years (2012–2022) to capture recent evidence. We searched using the terms "ultracycling", "ultra-endurance cycling", "sleep", "sleep deprivation", "sleep disturbance", and "extreme sleep". We then manually scanned reference lists for other pertinent articles. We removed papers that did not report primary empirical observations, alongside duplicates and articles that did not specifically focus on ultra-endurance cycling.

Results

Based on our search criteria, we identified seven relevant papers between 2012 and 2022 that provide evidence about extreme sleep patterns in ultra-endurance cycling events; sample sizes tended to be limited and larger scale studies investigating this issue were scarce. Articles included in our review are summarised in Table 1 in year-descending order with a brief description of their sleep-related findings.

Discussion

Sleep deprivation and mental health in ultra-endurance cycling

Based on these studies, acute sleep deprivation and extreme sleeping patterns are a prominent feature of ultra-endurance cycling. All of the papers included in our review indicate that ultra-endurance riders may experience sleep deprivation and intermittent or acutely short sleep periods. First-hand accounts from ultra-endurance cycling events support this; for instance, certain RAAM athletes revealed an 8-hour total sleep time across the entire event [2], as have participants in other ultra-endurance races [17]. Entrenched sociocultural attitudes amongst ultra-endurance riders could shape attendant behaviours. Whilst accentuating the importance of sleep, multiple-time winner of the Transcontinental Race, James Hayden, illustrated how deleterious perspectives still persist; sleep can be perceived as "wasting time" as compared to the "glorification" of sleep avoidance [18].

This evidence aligns with simulated Grand Tour events in elite-level cycling [19], alongside studies on ultra-endurance sporting events that span multiple days of competition. For instance, ultra-triathletes experienced severely reduced sleep and a subsequent decline in performance during a three-day race [20]. In ultramarathons, participants experienced severe sleep deprivation and hallucinations whilst competing in multiple races exceeding 322 km; a hesitancy to sleep was prevalent among these runners [21]. Further, restricted sleep was associated with a decrease in vigour in an arctic ultramarathon [22], and during the Finnmarkslop, a six-day dog sled race [23]. Lapses in attention and other deficits in cognitive function were evident in multisport endurance athletes after 36 hours of sleep-restricted competition [24].

Given the documented paradigms of extreme sleep in our review, ultra-endurance cyclists could be increasingly at-risk for negative cognitive effects and psychosocial concerns. The articles we identified primarily explored sleep deprivation in competitive performance or ergometric contexts. However, several papers did note sizable implications for riders' mood, including increased fatigue and decreased vigour [11], alongside emotional disturbances [14]. Again, this correlates with other findings in ultra-endurance sport, which show that mood alterations can last up to a month post-race [25]. Significantly, sleep deprivation has associations with neurocognitive deficits, emotional dysregulation, and suicidality in general literature [6]. Others highlight connections between sleep deprivation, heightened stress responsivity, emotional reactivity, and impaired executive functioning and decision-making [7]. Specific environmental factors may aggravate these effects for ultra-endurance riders; intra-race, sustained exposure to physical exertion in unfamiliar terrains and adverse conditions will likely negate stress reduction strategies. Additionally, mood state can be altered by dehydration in ultra-endurance cycling competitions [26]. Further, impaired decision-making, attention, and reaction time due to sleep deprivation might enhance the possibilities for serious accidents. These scenarios could have medicolegal or forensic-psychiatric intersections, particularly if a rider is held liable for injuring fellow competitors.

From a clinical perspective, sleep deprivation can induce symptoms of mania or psychosis, like hallucinations and delusions [8, 27]. Ultra-endurance cyclists have previously reported analogous experiences [2]. Notably, in other circumstances, hallucinations from sleep deprivation have required psychopharmacological interventions and in-patient care [27]. Moreover, sleep deprivation and disrupted circadian rhythms can exacerbate pre-existing psychiatric symptoms [9, 28] and may have causal relationships with mental health issues and increased symptomatology [29]. This is significant since ultra-endurance athletes might already be vulnerable to psychopathology and distinctive risk factors; prior psychiatric diagnoses were found to be more prevalent in this community compared to the general population [30]. Thus, in our view, periods of intensive exposure to deprived or extreme patterns of sleep in ultra-endurance cycling could lead to developing or recurring psychiatric disorders.

Psychoeducation and knowledge exchanges

With these potential cognitive and psychiatric effects, we believe that increased regulatory endeavours and knowledge exchanges are necessary to uphold rider wellbeing; for us, race organisers have a duty of care to their participants. Nevertheless, the management of ultra-cycling competitions can vary from private individuals to commercial entities. This heterogeneity creates disparities, with races adopting different rubrics and policies. To counter this, WUCA has developed "Model Race Rules" [31] for race organisers. Despite containing "no restrictions on how many hours a racer may ride without off-bike rest", these guidelines allow officials to request sleep breaks if athlete safety is compromised [31].

Researchers have underlined the importance of mental preparation for ultra-endurance cycling events [14], and companies have produced dedicated resources about sleep management (e.g., [32, 33]). However, in research about other ultra-endurance competitions, only 21% of participants indicated that they had sleep strategies intra-race [34]. For safeguarding purposes, greater efforts should be made to develop scientific consensus on the topic of intra-race sleep in ultra-endurance cycling, similar to the heat training initiatives of the International Olympic Committee [35], which also constitutes a significant hazard during ultra-endurance events. Standardised educational materials should be made available on race websites, as well as disseminated in the pre-race period as a mandatory part of the signup process. Presently, as our review illustrates, studies about the psychiatric and psychological effects of sleep patterns in ultra-endurance cycling are scarce and extant research tends to have limited sample sizes. Accordingly, more longitudinal research and larger scale studies are needed to understand how sleep deprivation affects the mental health and cognitive function of athletes, both intra-race and post-race. Such investigations are necessary to inform evidence-based approaches, event regulations, and institutional support, especially as different race durations may require tailored guidelines.

We further advise that all ultra-endurance cycling events should be staffed with qualified mental healthcare practitioners, who could be called upon to help both athlete and

crew assess potential risks due to sleep deprivation. To the authors' knowledge, there is no definitive evidence base directly correlating increased intra-race sleep with faster race times (several studies in our review suggest that competitive performance levels were unaffected [10,12,13,16]). Resultantly in our opinion, it is unlikely that riders will be motivated to voluntarily prioritise their mental health during races, although it has been found that athletes can still have successful race results in ultra-endurance cycling with an increased emphasis on sleep [36]. Therefore, we recommend that relevant governing bodies could consider prioritising the physical and mental wellbeing of racers by implementing regulations such as set stages for multi-day cycling events.

Given the associated risks of ultra-endurance cycling, notions of individual responsibility and personal choice are significant. Since sleep patterns may be an important variable in predicting sporting success in these races, a lack of knowledge could increase possibilities for psychotropic self-medication to alter sleeping habits, potentially leading to longer-term health problems for athletes. Moreover, improving comprehension about the psychopathological paradigms of sleep deprivation may influence individual decisions to join these events and could prevent psychiatrically vulnerable individuals from participating. That said, mental health stigma persists in competitive environments [30], as do negative conceptions about sleep in ultra-endurance cycling [18], which may undermine awareness campaigns. Akin to other sports, entrenched sociocultural perspectives are often difficult to modulate [37]. Nonetheless, increased knowledge exchanges, alongside bespoke educational campaigns, could enhance mental health literacy in ultra-endurance riders; to that end, community-relevant platforms, like the Global Cycling Network, could help promote these issues [38]. This may stimulate open discussions about balancing healthy sleeping and competitive performance.

Limitations

We considered our search strategy to be the best-available method to investigate this underexamined topic, as connections between sleep deprivation and mental health in ultra-endurance cycling are limited. Nonetheless, our narrative review has several limitations.

Evidence scarcity commonly prevents comprehensive systematic reviews [39], but our non-systematic approach may have neglected certain studies. Further, narrative reviews are prone to selection bias [40] and reproducibility concerns [41], which cannot be disregarded within our methods. By only including studies with empirical observations, we may have introduced potential biases or excluded other relevant scientific contributions. However, this was done with the aim of holistically collating papers based on primary evidence. The articles captured in our review tend to have a small sample size, but this reflects the scarcity of comprehensive research in this area; large scale investigations are required to inform requisite guidelines and initiatives, as we have discussed. Additionally, given we adopted a ten-year timeframe some studies could have been overlooked. Yet, in our opinion, this ensured that we captured up-to-date evidence in this area.

Conclusion

We conducted a narrative review into sleep patterns in ultra-endurance cycling events. As our results show, extreme sleep patterns are a prominent aspect of these races. Whilst general scientific research has substantiated the psychiatric consequences and cognitive effects, there is limited recognition about how sleep deprivation and intermittent or acutely short periods of sleep could affect an ultra-endurance rider's mental health. For us, increased knowledge exchanges, regulatory emphasis, and psychoeducation can provide impetus for sociocultural dialogues. A rigorous evidence-base in sports psychiatry is required to support these initiatives, which we have also highlighted. As event popularity grows, we believe it is essential that ultra-endurance riders prioritise their mental health over their finishing time and engage in open discussions about healthy sleeping habits in-competition.

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