Published in final edited form as:

Sleep Med. 2020 February ; 66: 260–261. doi:10.1016/j.sleep.2019.08.004.

Author response: concussion assessment tools – A possible measure of sleepiness?

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We would like to thank Stevens et al., for their comments regarding our article: “Insomnia and daytime sleepiness: risk factors for sports-related concussion” [1]. In our study, we identified self-reported moderate-to-severe insomnia and frequent daytime sleepiness as independent risk factors for sustaining a future diagnosed sports-related concussion within the next year, even after controlling for traditionally identified critical risk factors (eg, past concussion history, sport type). In their letter, the authors raised several excellent points that we would like to address.

First, the authors stated that it was difficult to identify potential mechanisms explaining our results because we did not describe how concussions were measured or the association between sleep complaints and concussion severity. To clarify, suspected concussions were clinically assessed in the presence of (1) a mechanism of injury that may have resulted in a concussion (eg, direct or indirect forces acting on the head) and (2) signs and symptoms indicative of a potential concussion that were unexplained by other factors (eg, drugs, alcohol, comorbidities) [2,3]. Clinical sports medicine professionals made final diagnoses, integrating clinical tools (ImPACT®, BESS, symptom checklist, etc.) with patient presentation and clinical judgment, in accordance with best practices [2,3]. Details related to specific factors leading to the concussion diagnosis were beyond the scope of our data collection, but were based on injury history and clinical presentation. Therefore, our

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Conflict of interest

The ICMJE Uniform Disclosure Form for Potential Conflicts of Interest associated with this article can be viewed by clicking on the following link: <https://doi.org/10.1016/j.sleep.2019.08.004>.

analyses and interpretations reflected the increased risk for a clinical concussion diagnosis (in accordance with best practices) in the year following a self-report of moderate-to-severe insomnia and/or frequent daytime sleepiness.

Second, the authors noted that sleep affects many of the functional domains assessed by commercially available concussion assessment tools. Indeed, earlier work has identified that the previous night's sleep affects multiple domains of function measured by clinical assessment methods (eg, CogState® and ImPACT®) both pre- and post-injury [4–6]. Given the impairments imparted by sub-optimal sleep, test administration and interpretation should incorporate comprehensive information about not only the previous night's sleep (already generally collected) but also habitual sleep. This would allow clinicians to better contextualize test scores both pre- and post-injury.

Stevens et al., further suggested that concussion assessment tools may be more sensitively targeting individuals with sleep struggles rather than specifically identifying those who sustained a concussion. While possible, these tools are only indicated for use by trained professionals who suspect a potential concussion on the basis of a mechanism of injury and clinical presentation (as noted above). Thus, we agree that recent and habitual sleep may influence the magnitude of deficits observed during the evaluation of a suspected concussion, as well as subsequent follow-ups, but not the actual clinical diagnosis; as this should always include additional factors beyond cognitive deficits. In the end, this is an empirical question that can be answered. Finally, future research is warranted to more fully explain the bidirectional sleep and concussion relationship and the influence of sleep on current clinical tools [7].

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