

COMMENTARY

## Sleep restriction and human physiology and behavior: questions posed, answers found?

Commentary on Banks S, Dinges DF. Behavioral and physiological consequences of sleep restriction. *J Clin Sleep Med*. 2007; 3(5):519–528. doi:10.5664/jcsm.26918

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The inclusion of Banks and Dinges’s manuscript, entitled “Behavioral and Physiological Consequences of Sleep Restriction,” in the 15-year anniversary collection of the *Journal of Clinical Sleep Medicine*’s most important work is well deserved.<sup>1</sup> This manuscript crystallized the problem of short sleep from basic science to epidemiology for a generation of sleep specialists and sleep and circadian scientists. Indeed, PubMed shows that annual research articles focused on “sleep restriction” have increased nearly 3-fold since the publication of this landmark work. Upon re-examination of the manuscript through the lens of time, the current authors find it clear that many important questions emanated from this work. Perhaps the body of science over the ensuing 13 years can reveal the long-sought answers.

First, how much sleep is enough? Of course, this depends on the outcome of interest, and thereby the question quickly becomes unwieldy—the number of meaningful outcomes, from molecular “-omics” to human behavior, health, and well-being, is potentially limitless. But if we were to pick one, mortality would be the most encompassing. However, the intervening years since the article was published have brought more questions than answers; variability in sleep duration measurement, the impacts of sociodemographic and health-related factors, and the influence of sleep quality, timing, regularity, and potential sleep disorders cloud the picture to the point that the truth becomes elusive.<sup>2</sup> Epidemiology suggests that both short and long sleep are problematic and associated with increased mortality,<sup>3</sup> but although basic science research has established causal mechanisms for the untoward impact of short sleep on health,<sup>4</sup> we still await studies showing that sleep extension in animal models or healthy individuals impairs physiology or performance. That said, emerging evidence suggests that sleep extension reduces blood pressure<sup>5</sup> and improves neurobehavioral function.<sup>6</sup> As we continue to seek answers to the question of sleep need, the rise of consumer sleep technologies affords new opportunities to obtain population-based, longitudinal, ecologically valid sleep duration measurements, which should help advance this research agenda going forward.<sup>7</sup>

Second, how long does it take to recover from sleep restriction? In most laboratory studies, 2–3 days are allocated to

recovery and would seem to be adequate. However, if restricted individuals are then redeprived of sleep to a degree, then they are much more vulnerable to impairment than if they had never undergone the restriction to begin with.<sup>8</sup> Therefore, the sleep homeostat recovers fairly quickly, but the vulnerability lingers. Allostatic changes in sleep regulation are influenced by prior sleep history<sup>9</sup> and together with genetics<sup>10</sup> and environmental factors define individual differences in physiological and behavioral responses to sleep restriction.<sup>9</sup> Unfortunately, although humans generally have good self-awareness of impairment because of acute sleep deprivation, they lack this insight in the face of chronic sleep restriction<sup>1</sup>; no doubt this dearth of knowledge is a contributing factor to motor vehicle and industrial accidents resulting from sleep restriction. However, sleep load beforehand reduces impairment to future sleep restriction,<sup>6</sup> a useful fact for frontline workers whose jobs require intermittent periods of sleep restriction.

Last, why do we sleep? Although the work of Banks and Dinges<sup>1</sup> also inspired attempts to answer that question,<sup>11</sup> we ran out of room to answer it here. We may have to wait until the 30-year anniversary of the *Journal of Clinical Sleep Medicine* to rejoin that query in the likely circumstance that Banks and Dinges have a manuscript honored in that edition as well.

### CITATION

Watson NF, Van Dongen HPA. Sleep restriction and human physiology and behavior: questions posed, answers found? *J Clin Sleep Med*. 2020;16(suppl\_1):7S–8S.

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### SUBMISSION & CORRESPONDENCE INFORMATION

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### DISCLOSURE STATEMENT

All authors have seen and approved this manuscript. This work was performed at the University of Washington School of Medicine and the Washington State University Elson S. Floyd College of Medicine. Dr. Watson is a member of the scientific advisory board of SleepScore Labs, a consumer sleep technology company. Dr. Van Dongen is a consultant to Jazz Pharmaceuticals and is a fatigue scientist for Federal Express Corporation.