HHS Public Access

Author manuscript

J Emerg Crit Care Med. Author manuscript; available in PMC 2021 June 09.

Published in final edited form as:

J Emerg Crit Care Med. 2019 May ; 3: 24. doi:10.21037/jeccm.2019.05.02.

Napping: is it really a means by which short sleepers can have their cake and eat it too?

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Short sleep duration is pervasive worldwide. It is recognized that short sleep duration, but also long sleep duration, may increase one's risk of coronary heart disease, type 2 diabetes, and stroke (1). In a recent issue of the *European Heart Journal*, Wang and colleagues present evidence of increased risk of mortality and cardiovascular events in adults reporting both short and long sleep duration (2). This study is noteworthy because it followed a large population from 21 countries around the world over a period of approximately 8 years. Participants answered simple questions about their sleeping habits: usual bed time and wake time during the longest or nocturnal sleep period, and napping habits. This study, however, did not assess objective sleep duration which, arguably, would be difficult in such a large sample of over 116,000 adults, sleep quality, or frequency of napping. The authors conclude that total daily sleep duration of 6–8 h was associated with the lowest risk of death and cardiovascular events. They also suggest that napping during the daytime could mitigate the risks of nocturnal short sleep. We challenge this interpretation of the results.

Wang and colleagues note that adults who report ≤6 h of time in bed/d had a non-significant trend for an increase in all-cause mortality and major cardiovascular events [HR 1.09; 95% confidence interval (CI), 0.99–1.20] in their fully adjusted model (2). Similarly, all-cause mortality and cardiovascular events tended to be increased in the fully adjusted model for short sleepers who nap [≤6 h of time in bed/d + usual daytime napping, HR 1.11 (95% CI, 0.99– 1.25)]. Despite similar HR, in the first instance, the authors emphasize a non-significant trend towards increased risk, yet in the latter, conclude to a potential protective effect of napping in short sleepers. However, these data suggest that, just as short self-reported sleep tends to be associated with increased risk of mortality and cardiovascular events, any napping, whether occurring in short, normal, or long sleepers, also tends to be accompanied with increased risk. Moreover, Fine-Gray models showed trends for increased risk of adverse cardiovascular outcomes in participants reporting naps of 0–1 h/d (HR 1.09; 95% CI, 0.95–1.24) and >1 h/d (HR 1.18; 95% CI, 0.98–1.42) in fully adjusted models. It is

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Provenance: This is an invited article commissioned by Section Editor Yibing Zhu (Department of Critical Care Medicine, Fuxing Hospital, Capital Medical University, Beijing, China).

Comment on: Wang C, Bangdiwala SI, Rangarajan S, *et al.* Association of estimated sleep duration and naps with mortality and cardiovascular events: a study of 116 632 people from 21 countries. Eur Heart J 2018. [Epub ahead of print].

Conflicts of Interest: The authors have no conflicts of interest to declare.

also worth noting that napping was reported mostly in low- and middle-income countries, with Middle East and China having the largest percent of their population reporting naps [60.5% and 48% respectively, compared to 20.3–35.5% in the other 5 geographic locations (North America/Europe, South America, South Asia, Southeast Asia, and Africa)].

Several shortcomings of this paper deserve attention. First, time in bed, rather than sleep, was assessed. We have shown that taking time to fall asleep into consideration when estimating sleep duration from questions on bedtime and waketime improves the accuracy of the estimate (3). Interestingly, average reported sleep duration and prevalence of short sleep were longer and lower, respectively, than reported in the literature. For example, average sleep duration in North America/Europe reported by Wang *et al.* was 7.9 h/night with 6.1% reporting sleep ≤6 h/night (2). Ford *et al.* reported average sleep duration of 7.2 h with prevalence of short sleep of 29.2% in the US (4) and similar results have been reported for Canada (5). China had the longest reported sleep duration, 8.2 h/night, with 1.4% prevalence of sleep ≤6 h/night, as reported by Wang *et al.* (2). Data from the Chinese Kailuan Study show average sleep of 7.1 h/night and prevalence of sleep ≤6 h/night of 7.1% (6). This over-reporting of sleep duration is problematic as it would result in short sleepers being included in the reference category which, at 6–8 h/night, already allows short sleepers. Indeed, adequate sleep duration has been accepted as an average of at least 7 h/night (7). The inclusion of short sleepers in the reference group could explain the non-significant trend observed for short sleep as a risk of all-cause mortality and cardiovascular events.

As expected, people who slept >9 h/night were older, poorer, more ill and more depressed (2). Despite all adjustments, this constellation makes long sleep less likely a causative factor for cardiovascular events and mortality and more likely a side-effect of the concomitant poor lifestyle and co-morbidities. Oversleeping is likely a marker for elevated cardiovascular risk factors and/or other health problems (8). Given the observational nature of this study, causation cannot be inferred and unmeasured confounders may play an important role in this association.

Finally, the prevalence of napping varied widely by region (20–60%) (2). The investigators did not query the intention or frequency of napping. Therefore, it is unclear how the purpose of the nap may have influenced the observed associations. Whether the increased risk associated with napping is due to something unique about the act of napping or can be attributed to excessive sleepiness driving daytime sleep is unknown. A biological mechanism linking napping to sympathetic nervous system activation and prothrombic effects has been proposed (9). A meta-analysis reported an increased risk of hypertension associated with napping and suggested that this may be due to a second sympathetic surge occurring in the afternoon upon awakening from a nap (10). This would stimulate the renin-angiotensin system and lead to a rise in blood pressure and increased risk of cardiovascular disease.

We are aware of 3 meta-analyses assessing the relation between daytime napping and mortality (9,11,12). These meta-analyses include 7–9 studies involving approximately 100,000 to >150,000 adults. All found a significantly increased risk of mortality with daytime napping, with significant heterogeneity. Zhong *et al.* reported on 3 studies that

included an assessment of sleep duration and found no difference in risk of mortality for nappers across duration of nighttime sleep (11). The other 2 found that nap duration mattered, with increased risk of mortality and cardiovascular mortality in those with naps of at least 60 min (9,12). On the other hand, Li and colleagues reported that both short (0–1 h) and long (≥1 h) naps were associated with increased risk of stroke in both short and long sleepers (<7 and ≥9 h sleep, respectively) (13). In both cross-sectional and longitudinal analyses, the risk was greatest for those reporting long naps in the context of long sleep. However, naps in the context of short sleep also increased the risk compared to those who reported not napping and habitual sleep of 7–8 h/night.

Further supporting a lack of protective effect of napping against the deleterious health consequences of inadequate sleep are studies showing an increased risk in the incidence of type 2 diabetes (14), prevalence of incident cardiovascular disease (15) and prevalence of metabolic syndrome among nappers (16). In the EPIC-Norfolk Study, long sleep duration was associated with an increased risk of developing type 2 diabetes regardless of napping status but the association between short sleep and type 2 diabetes was much stronger among nappers than non-nappers (14).

Self-reports are usual methods to determine sleep duration and napping status and duration. One study used objective measures of nocturnal sleep and daytime napping to assess the relation between napping and inflammation in men (17). In a sample of ~250 Black and White males, higher interleukin-6 concentrations were associated with more actigraphy-measured days with napping and average nap time across the 7-day measurement period. More days with naps and longer napping time were associated with higher interleukin-6 concentrations specifically in men with the shortest sleep duration but not in those at the median or longest sleep durations. The authors concluded that naps should not be used to counterbalance the effects of short sleep on health but rather that nocturnal sleep duration should be lengthened to achieve sleep adequacy. This is our stance as well and one that we understand is supported by the data by Wang and colleagues (2).

The paper by Wang and colleagues contributes evidence showing an interaction exists between napping and sleep duration (2). Our interpretation is that the addition of napping to all categories of suboptimal sleep duration is associated with increased risk of all-cause mortality and cardiovascular events. Although some have suggested that a distinction should be made between napping due to daytime sleepiness and potential underlying disease (e.g., depression, obstructive sleep apnea, insomnia, cancer) versus napping that is simply a daily ritual due to culture or other factors, the evidence to date does not seem to support the existence of a distinguishing factor. Studies from populations from all over the world, that include naps as a cultural tradition and not, find increased risk from napping. A meta-analysis that compared the relation between napping and mortality or cardiovascular disease by region has not shown differences between countries where naps are typical and those where naps are not (9); in another, data were variable depending on the outcome and countries included (12). What may be more important, however, is the longitudinal pattern of napping. In one study from Singapore, changes in sleep and napping patterns were associated with allcause mortality (18). Compared with those who had constant adequate sleep (7–8 h/night), risk of mortality was increased in those who increased their sleep

duration from short (≤6 h) to long (≥9 h), reduced sleep duration from long to short, or had constant long sleep. Compared to those who did not nap at each study visit, risk of mortality was increased in those who became nappers; risk was not different for those who stopped napping. In nappers, going from short (≤1 h) to long (>1 h) naps or long to short naps also increased the risk of mortality, independent of sleep duration.

Lastly, it is becoming apparent that sleep is a complex behavior. Studies should objectively and subjectively evaluate both nighttime and daytime sleeping patterns with regards to duration and quality along with the underlying motivation for daytime sleep. At this time, it is premature to suggest that daytime napping be used to mitigate the risks of chronic diseases associated with inadequate sleep at night.

Acknowledgements

Funding: The authors report funding from American Heart Association Go Red for Women Strategically Focused Research Network grants [16SFRN27880000 (St-Onge), 16SFRN27950012 (St-Onge), 16SFRN27960011 (Aggarwal), 16SFRN2905000 (Jelic)] and the National Institutes of Health [R01HL128226 (St-Onge) and R01HL106041 (Jelic)].

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