# Sleep Duration and Waking Activities

Subjects: Primary Health Care

Contributor: Alina Rodriguez

Optimal sleep duration is crucial as both short and long sleep duration are associated with physical and mental health problems. For example, sleep duration that is considered to be too short has been linked with an increased risk of obesity, hypertension, cardiovascular disease, and type II diabetes, whereas sleep duration that is too long has been associated with an increased risk of poor health-related quality of life, multiple sclerosis, cardiovascular disease, and stroke.

Keywords: sleep duration ; waking activities ; time use ; suboptimal sleep ; excessive sleep ; recommendations

## 1. Overview

The objective was to investigate the association between time spent on waking activities and sleep duration in a representative sample of the US population. We analysed time use data from the American Time Use Survey (ATUS), 2015–2017 (*N* = 31,621). National Sleep Foundation (NSF) age-specific sleep recommendations were used to define recommended sleep duration. The balanced, repeated, replicate variance estimation method was applied to the ATUS data to calculate weighted estimates. Less than half of the US population had a sleep duration that mapped onto the NSF recommendations and alignment was higher on weekdays (45%) than at weekends (33%). The proportion sleeping longer than the recommended duration was higher than those sleeping shorter on both weekdays and weekends ($p < 0.001$). Time spent on work, personal care, socialising, travel, TV watching, education, and total screen time was associated with nonalignment to the sleep recommendations. In comparison to the appropriate recommended sleep group, those with a shorter sleep duration spent more time on work, travel, socialising, relaxing, and leisure. By contrast, those who slept longer than recommended spent relatively less time on each of these activities. The findings indicate that sleep duration among the US population does not map onto the NSF sleep recommendations, mostly because of a higher proportion of long sleepers compared to short sleepers. More time spent on work, travel, and socialising and relaxing activities is strongly associated with an increased risk of nonalignment to NSF sleep duration recommendations.

## 2. Optimal Sleep Duration

Optimal sleep duration is crucial as both short and long sleep duration are associated with physical and mental health problems [1][2][3]. For example, sleep duration that is considered to be too short has been linked with an increased risk of obesity [4][5], hypertension [6], cardiovascular disease [7], and type II diabetes [8], whereas sleep duration that is too long has been associated with an increased risk of poor health-related quality of life [9], multiple sclerosis [10], cardiovascular disease, and stroke [11]. However, the thresholds for understanding optimal sleep durations are fuzzy and vary across studies [8][12][13], impeding comparisons, especially considering that the physiological demand for longer sleep declines with age [14]. In response to this concern, the United States National Sleep Foundation (NSF) defined age-specific recommendations for sleep duration in 2015 based on population-based data and index literature published between 2004 and 2014 [15]. These sleep durations guidelines provide detailed recommendations for nine age groups (Table 1).

**Table 1.** The National Sleep Foundation's age-specific guidelines for sleep duration in hours (h).

| Age | Appropriate, Recommended Duration (AR) | Appropriate But Short (AS) | Appropriate But Long (AL) | Not Recommended: Too Short (NRS) | Not Recommended: Too Long (NRL) |
|---|---|---|---|---|---|
| **New-borns** | | | | | |
| **0–3 month** | **14–17** | **11–<14** | **>17–19** | **<11** | **>19** |
| **Infants** | | | | | |
| **4–11 month** | **12–15** | **10–<12** | **>15–18** | **<10** | **>18** |
| **Toddlers** | | | | | |

| Age | Appropriate, Recommended Duration (AR) | Appropriate But Short (AS) | Appropriate But Long (AL) | Not Recommended: Too Short (NRS) | Not Recommended: Too Long (NRL) |
|---|---|---|---|---|---|
| 1–2 years | 11–14 | 9–<11 | >14–16 | <9 | >16 |
| **Pre-schoolers** | | | | | |
| 3–5 years | 10–13 | 8–<10 | >13–14 | <8 | >14 |
| **School-aged children** | | | | | |
| 6–13 years | 9–11 | 7–<9 | >11–12 | <7 | >12 |
| **Teens** | | | | | |
| 14–17 years | 8–10 | 7–<8 | >10–11 | <7 | >11 |
| **Young adults** | | | | | |
| 18–25 years | 7–9 | 6–<7 | >9–11 | <6 | >11 |
| **Adults** | | | | | |
| 26–64 years | 7–9 | 6–<7 | >9–10 | <6 | >10 |
| **Older adults** | | | | | |
| ≥65 years | 7–8 | 5–<7 | >8–9 | <5 | >9 |

AR—appropriate: recommended duration; AS—appropriate: but short; AL—appropriate: but long; NRS—not recommended: too short; NRL—not recommended: too long. Adapted with permission from Hirshkowitz, Whiton, Albert, et al. National Sleep Foundation's sleep time duration recommendations: methodology and results summary. Sleep Health. 2015;1(1):40–43. doi:10.1016/j.sleh.2014.12.010 [15].

Here, we use these recommended guidelines to study sleep patterns in a population-based sample of over 31,000 US residents from the American Time Use Survey (ATUS) from 2015 to 2017 [16]. As previously indicated [17], habitual sleep duration represents a trade-off with waking activities. While the nature of waking-related activities, such as the stressfulness of work, type of diet, and the intensity of physical activity, can influence sleep [18][19][20], the time spent on these waking activities also competes with sleep duration in a 24 h world [17][21], warranting the need to maintain sleep and wakefulness [22].

Previous work using the ATUS examined sleep–wake time; however, the authors could not compare the prevalence of sleep duration to the NSF guidelines as these were published eight years later. Because waking activities are likely to have changed since the original report was published in 2007 [17], we provide an update and extend the analysis by comparing reported sleep duration with NSF age-specific guidelines, while examining sociodemographic factors. We also examine how time spent on waking activities relates to the aligned sleep duration with NSF guidelines.

## 3. Discussion

Our findings show that less than half of the US population met the number of hours of sleep recommended in the NSF age-appropriate guidelines. Sleep duration among the US population mapped onto the NSF recommendations mostly on weekdays (among 45%) rather than at weekends (among 33%). Further, after controlling for sociodemographic variables, time spent on each of the following waking activities: work, personal care, socialising, relaxing, leisure, travel, TV watching, education, and screen time was inversely associated with sleeping the recommended number of hours, in general. These waking activities remained significantly associated with sleep duration when analysis was restricted to weekdays. On weekends, however, all but education remained significantly associated (by at least a 15 min difference) with sleep duration outside of the recommended number of hours. In addition, time spent on household activities on weekends was associated with sleep duration.

To our knowledge, this is the largest study using time-use survey data from a population representative sample in the US to describe reported sleep duration in relation to NSF age-specific recommendations among adults. Sleep duration in relation to recommendations in adult populations is rather limited as the NSF guidelines were published only five years ago. We show that about 60% of the US adult population's sleep duration does not map onto the NSF recommendations on sleep duration when age-specific thresholds are applied. Sleeping duration outside of the recommendations was more common on weekdays than on weekends. Adding to the debate about global decline in sleep duration [23][24], this study reveals that the proportion of people sleeping longer than the recommended duration exceeds those sleeping less than

the recommended duration even on weekdays. We show that the disparity between weekday and weekend sleep habits previously reported [25][26] is also evident at the population level. Longer sleep duration at weekends relative to weekdays may be explained by either later wake times to catch up on lost sleep during workdays [27] or a combination of later sleep time and later wake time at weekends. The former, i.e., attempted catch-up sleep at weekends, has been shown to be associated with an increased risk of poor health-related quality of life and anxiety/depression [28], while the latter, often referred to as social jetlag, has been linked with an increased risk of obesity, type 2 diabetes mellitus, and impaired metabolic control in noncommunicable diseases [29][30][31][32].

In the US population, time spent on waking activities—time spent on work, travel, personal care, socialising, relaxing, leisure, watching TV, and education—differed for those who slept the recommend number of hours and those who did not. Thus, the kinds of activities that are traded for sleep among the United States population have not changed over the past decade [17]. Using ATUS data from 2003 to 2005, Basner et al. [17] identified the same activities to be associated with sleep time (in hour intervals). However, in the present study, work and travel remained the only activities for which the linear gradient in its duration across the various sleep duration categories was significant both on weekdays and at weekends. We were unable to compare the observed consistent gradients with the findings of Basner et al. [17], who reported a similar declining gradient in the duration of waking activities, with increasing sleep time due to the use of different sleep duration categories and the absence of the level of significance for each individual sleep category in relation to the reference category. Similarly, a recent research study of daily time use among the UK adolescent population revealed that more time spent on personal care, travel, and education was associated with an increased risk of short sleep [21]. Nevertheless, the trends reported in the present study, including the lack of any visible gradient in TV watching across the various sleep categories, remain consistent with previous findings [17].

A strength of our study is that we directly mapped reported sleep duration to the NSF sleep recommendations using nationally representative data. The use of the age-specific sleep recommendation categories permitted the standardisation of sleep duration. In addition, we accounted for potential confounding variables in our regression analysis. The ATUS uses a probabilistic sampling technique in which every eligible individual has equal opportunity of being a participant, making the sample representative of the US teenage and adult population. Oversampling of minority ethnic groups and data collection during weekends were corrected with sampling weights provided by the ATUS. Further, the use of survey-specific statistical analysis permitted the estimation of population parameters rather than sampling statistics; thus, findings from this study can be extrapolated to the US population.

A limitation of this study is the cross-sectional nature of the data which does not allow for temporal and causal associations to be made between adherence to sleep recommendation and time spent on waking activities. The 24 h recall method used in collecting activity data for the ATUS does not take into account any prior activities (e.g., sleep deprivation on previous day) that could have influenced the time spent on activities during the interview period, thus opening the possibility of reverse causation. Although relatively low, recall bias remains an issue in the retrospective data collection format used in the ATUS. Further, the response rate of eligible participants in the ATUS was low for all three years, although this is not different from the ATUS response rate in earlier years. Investigations conducted on earlier cohorts revealed that nonrespondents were more likely to be weakly integrated in their communities [33]. A recent evaluation of the association between nonresponse propensity and the quality of the ATUS data revealed that ATUS nonrespondents had more missing data and rounded their responses in the parent survey, CPS, from which the ATUS sample is drawn [34]. Thus, data provided by ATUS respondents are more likely to provide an accurate picture even in the absence of data from the nonrespondents. In addition, secondary activities (i.e., activities occurring simultaneously with others) or activities of other household members were not recorded in the ATUS, so emphasis was only placed on each respondent's choice of primary activity. In this article, sleep duration was computed from total sleep time during the day and as a result includes daytime napping. Whereas this may be a limitation, it permits the inclusion of shift workers whose nighttime sleep duration may not be reflective of their total sleep time. Additionally, the data are limited to a single 24 h recall; however, more precise measures such as polysomnography data are not feasible for such large population-based surveys. While the NSF guidelines provide a good indication of sleep duration recommendations, the data from which these recommendations are drawn may have often not included daytime naps for older adults, hence explaining the lower sleep duration expected for this group. In addition, results on screen use should be interpreted carefully since ATUS questionnaires do not accurately capture portable screen use. As a result, the measure of screen use in this paper is heavily indicative of television use rather than other commonly used screen devices, such as smartphones, and tablets which have been shown to be associated with poor sleep [35][36]. Further, other direct factors that may influence sleep times, such as exposure bright light, which have a direct influence on the physiological onset of sleep [27][37][38][39] and could mediate time spent on some waking activities, were also not considered in this study.

The present study has implications in promoting a balance between time spent on waking activities, particularly work-related activities, and time spent sleeping. While management of sleep and waking activities will vary greatly across professions and age groups, the ability to maintain healthy levels of sleep remains a problem in the current 24 h society [22][40][41].

## 4. Conclusions

This study shows that on a typical day, people whose sleep is very short and below the NSF recommendations spend more time on work, socialising, relaxing and leisure, personal care, and travel, whereas those whose sleep is above the NSF recommendations spend less time on all these activities both on weekdays and at weekends. This study shows that less than half of the US population's sleep duration maps onto the age-specific recommendations. A significant portion of the population “catch up” on sleep deficits at weekends, warranting further study of the potential health implications of this behaviour.

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