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## Association of sleep duration and sleep quality with the physical, social, and emotional functioning among Australian adults<sup>☆</sup>

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## ABSTRACT

**Objectives:** We aimed to evaluate the interaction of two key determinants of sleep health, quantity and quality, with physical, emotional, and social functioning, in the general population.

**Design:** Nationally representative Australian cross-sectional study.

**Setting:** General population.

**Participants:** 14,571 people aged 15 or older in Household, Income and Labor Dynamics in Australia (HILDA) in 2013.

**Measurements:** The associations of sleep quality (good/poor) in combination with mid-range (6–8 hours), short (<6) or long (>8) sleep duration with functioning, determined from the SF-36, were evaluated using logistic regression adjusting for sociodemographic, relationships, health behaviors, obesity, pain, and mental and physical illness confounders.

**Results:** After adjusting for gender, and age, poor sleep quality in combination with short, mid-range and long sleep was associated with worse physical, emotional and social functioning. Pain and comorbid illness explained much of these associations, while attenuation from other covariates was minor. The associations of poor sleep quality with worse functioning remained after full adjustment regardless of sleep duration, while among people with good quality sleep, only those with long sleep duration reported poorer functioning.

**Conclusions:** Poor sleep quality has robust associations with worse functioning regardless of total duration in the general population. There appears to be a substantial number of functional short sleepers with good quality sleep.

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## Introduction

Sleep health can be conceptualized as having several different dimensions e.g. the five proposed by Buysse<sup>1</sup> and each may have different effects upon human function. The associations between sleep duration and health, work ability, and mortality have been studied in many different cohorts, with the results providing strong and

relatively consistent evidence that short and long sleep duration increase the risk of adverse health outcomes.<sup>2,3</sup> Other studies have focused on sleep quality, typically characterized as insomnia, with similar consistency of evidence for its impact on health.<sup>4,5</sup> Although sleep duration (both objectively measured and subjectively reported) shows high inter-individual variability the vast majority of public health messages focus on everyone achieving a certain number of hours of sleep,<sup>6</sup> only recently have these messages attempted to capture the risks related to poor sleep quality.<sup>7</sup>

With few exceptions most of the studies have not considered the interaction of sleep duration and quality contributing to health functioning. Where assessed together, sleep quality and quantity have

<sup>☆</sup> To Sleep Health.

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been jointly associated with ill-health, increased work disability and deficits in neuropsychological and psychomotor performance, with the most pronounced risks typically found among people with poor sleep quality and short sleep.<sup>8–14</sup> In such studies on sleep quality and sleep duration, mid-range and long sleep durations have often been combined.<sup>8,14</sup> This is somewhat surprising, as even the first study published on the association between sleep duration and mortality showed that the risks are highest in both extreme ends of sleep duration distribution, i.e., among short and long sleepers.<sup>2</sup> Moreover, both short and long sleepers report poorer sleep quality which suggests that each of these groups could be distinguished from people with sleep duration within population mean range.<sup>15,16</sup> Findings from The Penn State Cohort suggest for instance that understanding the impact of sleep disturbance on cognition requires knowledge and consideration of both dimensions simultaneously,<sup>14</sup> but that study also combined mid-range and long sleep duration. Combining mid-range and long sleep assumes a linear correlation between sleep duration and health, despite consistent evidence that the association is actually curvilinear or U-shaped.<sup>17,18</sup>

To address the above gaps, we aimed to examine how combinations of sleep quality and sleep duration are associated with different dimensions of health functioning. The associations were examined in a population-based nationally representative Australian dataset with the ability to address potential confounders behind any such relationship such as pain, sociodemographic factors, health behaviors, and health. Based on the previous literature, it was expected that both poor sleep quality and short and long sleep duration contribute to poor health functioning, and that the most dysfunctional groups are people with poor sleep quality in combination with short or long sleep.

## Participants and methods

### Data

Data for this study were derived from the ongoing Household, Income and Labor Dynamics in Australia (HILDA) panel survey.<sup>19,20</sup> The primary aims of the survey are to explore the dynamics of family and households, income and welfare and the labor market and as such respondents are less aware of health-related analyses. The data are nationally representative, with the initial reference population for wave 1 being all residents of Australia living in private dwellings.<sup>20</sup> A multi-stage sampling approach was applied. Altogether 7682 households and 19,914 individuals participated at wave 1. The response rate at baseline was 66%. In 2011, 2153 households, and 5451 persons were added to the cohort (response rate 69%).

Cross-sectional data from wave 13 collected in 2013 were used for this study ( $n = 17,501$ ), as sleep questions were first introduced in that survey. More than 95% of previous-wave respondents participated at wave 13.<sup>19</sup> We excluded those who died in 2013 and 2014 ( $n = 90$ ) to reduce the effects of severe illnesses on reports of sleep and functioning (near death approach), leaving 14,551 participants, who provided data for the variables of interest, i.e., sleep, functioning and covariates.

### Sleep

Sleep duration was self-reported in hours. It was asked separately from those currently employed and not employed. Both groups were also asked to separately report their sleep for weekdays/work day nights and weekends/non-work nights. From the responses, a sum variable of total sleep duration per week was computed, and this was divided by seven to get mean daily sleep duration for each participant, as we could not assume a 5:2 work:weekend split. The questions specifically asked about “How many hours of actual sleep do

you usually get?” (on a work day night/ non-work night, weekdays and weekends), and are assumed to reflect actual sleep duration and not time in bed. Daily mean sleep duration was classified into short sleep (less than 6 hours per night), mid-range sleep (6 to 8 hours per night) and long sleep (more than 8 hours per night), mid-range broadly reflecting current adult recommendations.<sup>21</sup> A more detailed classification was not feasible due to low numbers in the extreme ends of sleep duration combined with sleep quality.

Self-reported sleep quality was based on two core insomnia symptoms reflecting difficulties initiating or maintaining sleep (DIMS): reporting “trouble sleeping because cannot get to sleep within 30 minutes” and “trouble sleeping because wake up in the middle of the night or early in the morning”, in addition to overall rating of sleep quality, reflecting daytime consequence of these insomnia symptoms. Five response alternatives ranged from “not during the past month” to “at least five times a week during past month” for insomnia symptoms, and from “very good” to “very bad” for overall sleep quality. Participants were considered to have poor sleep quality if they reported either difficulty initiating OR maintaining sleep at least three times or more per week during the past month AND rated their overall sleep quality as either “fairly bad” or “very bad”.

A categorical variable was then made classifying people into good or poor sleep quality and one of the three sleep duration categories, forming six groups (categories in the Appendix 1 and Table 2). Those with good quality and mid-range duration sleep served as a reference group.

### Covariates

Covariates were all self-reported and comprised key sociodemographic factors, health behaviors, obesity, pain, physical and mental illnesses. These variables were identified a priori due to their established associations with sleep and functioning in these data and elsewhere.<sup>22–26</sup> For the descriptive analyses, age was classified into two groups: 15 to 44 years, and 45 years or more, as poor sleep quality tends to increase particularly in midlife<sup>23,27</sup> alongside declines in health and functioning.<sup>26</sup> In the multivariable analyses, we included age as a continuous variable. Employment status was dichotomized into those working (all current employees, employers or those self-employed, and employees of their own business and <1% who were unpaid family workers) and not working. Descriptive analysis was stratified by employment status, and the dummy variable was adjusted for in all the models, as sleep duration and sleep quality vary by employment status.<sup>23</sup> This also better allows comparisons for previous studies that have mainly included employed people and have focused on work disability.<sup>8,10,11</sup> Marital status was defined as being married/de facto, with those separated, divorced, widowed or single combined to another category. Education was classified into three hierarchical groups: high (masters or doctorate, graduate diploma, graduate certificate, bachelor or honors), intermediate (advanced diploma, diploma, Certificate III or IV, completed high school) and low (less than high school). We also considered whether the participant was living with children aged 0–4 years (no/yes), as this might affect sleep.<sup>19,23</sup> Social connections were defined based on how often participants reported they “got together socially with friends or relatives that were not living with them”. Seven response alternatives ranged from “every day” to “less often than once every 3 months”.

Smoking was classified into three groups: never smokers, ex-smokers and current smokers. Alcohol use was defined similarly based on current and former drinking patterns: never drinkers, former drinkers, drinking alcohol 1–2 times a week or less, and drinking alcohol 3 times a week or more often. Body mass index (BMI) was based on self-reported weight and height ( $\text{kg}/\text{m}^2$ ), with participants

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