Journal of Psychosomatic Research 84 (2016) 52–55

Contents lists available at ScienceDirect

Journal of Psychosomatic Research

Biological and psychological correlates of self-reported and objective sleep measures

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ARTICLE INFO

Article history:
Received 12 February 2016
Received in revised form 17 March 2016
Accepted 20 March 2016

Keywords:
Sleep
Measurement
Cortisol
Blood pressure
Psychological wellbeing

ABSTRACT

Objective: Objective and self-reported sleep are only moderately correlated and it is uncertain if these two types of sleep measures are associated with distinct biological and psychological outcomes.
Methods: Participants were 119 healthy women aged 26 years on average. Cortisol and blood pressure assessed over one day were the measures of biological function. Psychological variables included optimism, life satisfaction, positive and negative affect as well as emotional distress. Sleep was assessed with the Pittsburgh Quality Index (PSQI), wrist actigraphy and sleep diaries.
Results: Global sleep ratings on the PSQI were unrelated to objective sleep efficiency, duration or latency. Sleep duration derived from sleep diaries was highly correlated with objective duration but was unrelated to the PSQI measure. More disturbed sleep on the PSQI was associated with lower psychological wellbeing, as indicated by reduced levels of optimism, life satisfaction and positive affect as well as greater negative affect and emotional distress. Objective sleep efficiency was reduced among participants with lower positive and higher negative affect but there were no other associations between objective sleep indicators and psychological variables tested in our study. Participants with poorer self-reported sleep had lower cortisol awakening response while those with longer objective sleep latency had higher diastolic blood pressure, independently of covariates.
Conclusion: Our study reveals that self-reported and objective sleep measures, in particular those regarding sleep quality, are weakly associated but have different psychological and biological correlates. This suggests that findings relating self-reported sleep may not necessarily be corroborated by objective sleep indicators.

1. Introduction

The majority of studies relating sleep with disease risk has relied on self-report. This is partly due to ease of measuring and reduced participant burden. Moreover, in large prospective studies the use of objective sleep indices, such as polysomnography or actigraphy, is often impractical or not feasible financially.

However, when compared with objective sleep indicators, such as actigraphy, self-reported ratings can be imprecise. For example, in the CARDIA study sleep duration was on average overestimated by 48 min [1]. Estimations of sleep quality are imprecise as well and may include over- and underestimations [2,3].

Factors that may influence people's perception of sleep have not been systematically explored but fewer years of education, age, lower self-rated health, social support as well as work stress have been implicated [1,2].

Although objective and self-reported sleep are only moderately correlated it remains uncertain if these two sleep measures are associated with distinct psychological and biological outcomes. For example, in Cleveland Family Study long self-reported sleep duration was associated with elevated levels of C-reactive protein and interleukin-6 while short objective sleep duration was linked to higher tumour necrosis factor alpha [4]. Jackowska et al. [2] reported that lower self-reported sleep quality was correlated with depressive symptoms, poorer perceived health, lower levels of social support and work stress but no such associations were found for objective sleep measure.

Using psychological factors and objective markers of biological function collected over one day the aim of this study was, therefore, to test if

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http://dx.doi.org/10.1016/j.jpsychores.2016.03.017
0022-3999/

associations with self-reported sleep measures would be corroborated by objective sleep data. Blood pressure and cortisol were the measures of biological function selected based on their associations with sleep [5,6].

2. Method

2.1. Participants

Participants were 119 women recruited from University College London and neighbouring institutions. This article is based on baseline data derived from a positive wellbeing study described in detail previously [7]. Briefly, women older than 45 years old were not invited to take part since sleep patterns change with age [15]. Women suffering from or diagnosed with a medical or psychiatric condition within the last two years, or those undergoing an early menopause, were also excluded from participation in the study. All participants provided informed consent and the study was approved by UCL Research Ethics Committee.

2.2. Measures

Demographic information (e.g. education, age) was assessed by questionnaire. Body mass index (BMI) was measured based on participants' weight and height. Psychological variables described here include optimism, life satisfaction, positive and negative affect as well as emotional distress. The Revised Life Orientation Test [8] was used to measure optimism, life satisfaction was indexed with the Satisfaction with Life Scale [9]. Positive and negative affect and emotional distress were assessed with the Scale of Positive and Negative Experience [10] and the Hospital Anxiety and Depression Scale [11], respectively.

Global subjective sleep was indexed with the Pittsburgh Quality Index (PSQI) [12]. Objective sleep was measured with the ActiGraph GT3X (ActiGraph, Pensacola, Florida, US) over 7 nights, and for the purpose of this article sleep efficiency (calculated as the total proportion of the time the person spent sleeping), latency and duration were computed excluding first and last night. Using sleep diaries participants also provided daily sleep duration which was averaged over 5 days, again excluding nights 1 and 7.

Biological data described here included cortisol and blood pressure (BP) measures. Briefly, cortisol was obtained by taking 7 saliva samples over the day and evening using Salivette plastic tubes (Sarstedt, Leicester, UK). Cortisol output was analysed by computing the cortisol awakening response (CAR) [13], and total cortisol output across the day as the area under the curve (AUC) [14]. The cortisol AUC was log transformed prior to analysis. Blood pressure was measured with the SpaceLabs 90217 ambulatory blood pressure monitor (Redmond, WA). The monitor was fitted on a participant's arm; the device was programmed to take readings every 30 min and was worn for at least 10 h over a single day. Systolic and diastolic BP values were averaged across the recording period.

2.3. Statistical approach

Associations between self-reported sleep and psychological variables were tested with partial correlations adjusting for age since this is related to both sleep and psychological wellbeing [15,16]. The analyses of biological variables included BMI as an additional covariate as it is related to BP and cortisol [17,18]. Analyses relating objective sleep were conducted in the same fashion. Data were analysed using SPSS v.21 and results are presented as Pearson correlation coefficients (r) and p-values.

3. Results

Participants were on average 26 years old, over one third was married or cohabiting and over 70% of the sample was white. The majority of participants were in full-time postgraduate education while the reminder of the sample was in full-time work. The average BMI was 22.4.

3.1. Characteristics of sleep measures

The PSQI was on average 6.5 and daily sleep duration (derived from sleep diaries) was 7.5 h. Objective sleep duration was 7.0 h, and sleep efficiency was high (88.1%). Objective sleep latency was on average 5.7 min (SD = 6.0) indicating large variations within the sample with regards to how long participants took to fall asleep (see Table 1).

Global sleep ratings on the PSQI were unrelated to objective sleep efficiency ($r = -0.07$ $p = 0.49$), duration ($r = 0.08$ $p = 0.42$) or latency ($r = 0.002$, $p = 0.99$). Daily sleep duration was highly correlated with objective duration ($r = 0.71$, $p < 0.001$) but was unrelated to the PSQI measure ($r = -0.07$ $p = 0.46$). Daily sleep duration (obtained from sleep diaries) was associated with duration derived from the PSQI ($r = 0.43$, $p < 0.001$), but the size of this association was smaller than between daily and objective sleep duration (see also Supplementary Table 1).

3.2. Sleep measures and psychological characteristics

As depicted in Table 2 global ratings of sleep disturbance were associated with lower levels of optimism, life satisfaction and positive affect and greater mood disturbance, independently of age. Associations with objective sleep measures corroborated these findings only with regards to sleep efficiency which was correlated with lower positive and higher negative affect. Self-reported and objective sleep duration as well as sleep latency were unrelated to psychological variables in these data.

Table 1
Participants characteristics.

Variable	Mean (SD)/frequency (%)
Age	26 (4.9)
Relationship status	
Married/cohabiting	40 (33.6)
Single	75 (63)
Divorced/separated/widowed	2 (1.6)
Ethnicity	
White British/Irish/other	86 (72.3)
Other	33 (27.7)
Employment status	
Full-time postgraduate student	103 (86.6)
Full-time employment	16 (13.4)
BMI	22.4 (3.2)
PSQI	6.5 (2.8)
Daily sleep duration	7.5 (1.0)
Sleep efficiency (%)	88.1 (6.8)
Duration	7.0 (0.9)
Sleep latency (minutes)	5.7 (6.0)
Optimism (range:1–24)	14.7 (5.1)
Life satisfaction (range:5–35)	22.6 (6.5)
Positive affect (range:1.8–4.8)	3.3 (0.7)
Negative affect (range:1.0–4.2)	2.4 (0.7)
Depressive symptoms (range:3–26)	13.3 (5.7)
Cortisol awakening response (nmol/l) (range: −18.7–36.7)	7.6 (10.0)
Cortisol AUC (nmol/l) (range: 6511.2–36,730.1)[a]	14682.3 (5182.6)[a]
Systolic BP (mm Hg) (range: 90.0–132.0)	113.4 (7.8)
Diastolic BP (mm Hg) (range: 58.9–90.7)	73.9 (6.2)

[a] Untransformed data.