THE IMPACT OF TOTAL SLEEP TIME ON SUBJECTIVE HEALTH RATINGS IN A NATURALISTIC SETTING

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Both short and long sleep duration has earlier been linked to negative health outcomes and mortality. The aim of this study was to investigate how total sleep time (TST) of three days in a natural setting might affect self-rated health (SRH) and to examine what impact negative affectivity at baseline could have on this relationship. Fifty healthy participants filled out a survey at baseline. During 42 days, sleep, subjective health, negative affectivity and fatigue were reported. SRH did not differ significantly between the three levels of TST; short, medium and long. There was no significant interaction between negative affectivity at baseline and daily reports of SRH. However, higher negative affectivity at baseline was related to poorer subjective health on all three levels of TST. It was concluded that TST of three days in a real-life context did not affect subjective health ratings. Negative affectivity was not shown to be a moderator in this relationship, but a determinant for lower SRH.

Good sleep fosters good health as it is central in mental and physical recuperation (Banks & Dinges, 2007). As we experience higher pressure on our daily time schedule and decreasing hours of sleep (SCB, 2011), it is important and urgent to investigate how sleep duration in a natural context affects our well-being. The relationship between sleep time and health has previously been investigated through a one-item measure, often referred to as self-rated health (SRH).

The effects of sleep deprivation have been widely studied and poor sleep has been shown to strongly impair human functioning (Pilcher & Huffcutt, 1996). Suboptimal sleep will affect both cognitive and physical states (Bonnet & Arand, 1996; Durmer & Dinges, 2005; Killgore, 2010; Lyuster, Strollo, Zee, & Walsh, 2012; Patel et al., 2006; Pilcher & Huffcutt, 1996) and could lead to enhanced neuroendocrine stress functioning, impaired memory, reduced performance and increased fatigue (Abel & Bäuml, 2013; Dinges et al., 1997; Durmer & Dinges, 2005; Lekander et al., in review; Luyster et al., 2012; Meerlo, Sgoifo, & Suchecki, 2008). Even long sleep duration (>8h) might have negative impact on health as it has been shown to be a significant predictor to mortality (Cappuccio, D’Elia, Strazzullo, & Miller, 2010; Grandner, Hale, Moore & Patel, 2010).

Self-rated health has been widely used in epidemiological studies as a proxy of actual health. Subjective health ratings have been shown to follow changes in both self-reported physical symptoms and objective health measures (Perrucio, Badley, Hogg-Johnsson & Davis, 2010; Winter, 2007). In studies from different countries SRH has been a recurrent predictor of cardiovascular disease and all-cause mortality (DeSalvo et al. 2006; Idler & Benyamini, 1997; Møller, Kristensen, & Hollnagel, 1996).
Furthermore, self-rated health is a broadly inclusive measure of health (Idler & Benyamini, 1997). It reflects physical states, as well as mental and social well-being (Singh-Manoux et al., 2006; Undén & Elofsson, 2001). Among other factors, pain and low energy strongly affect subjective health ratings, as moderate pain, severe anxiety, moderate depressive symptoms and low energy have been shown to be the most prevalent symptoms in the subjective health reporting (Stewart, Woodward, Rosen & Cutler, 2008). Poor SRH has also been shown to have a significant relationship with higher levels of inflammatory markers (Andreasson et al., 2012; Undén et al., 2007).

Short or poor sleep has repeatedly been shown to be an important factor in poor subjective health (Geiger, Sabanayagam & Shankar, 2012; Lekander et al., in review; Nakata, 2012; Steptoe, Peacey & Wardle, 2006). Lekander et al. (in review) found through a longitudinal experimental setting that five days of sleep restriction progressively lead to lower subjective health ratings, as three days of recovery sleep made the ratings go back to baseline. Subjective health was thus differently rated after manipulation of one of its determinants, namely sleep duration. Cross-sectional studies have shown associations between self-reported insufficient sleep during the past month and poor subjective health ratings (Geiger, et al. 2012) as well as between self-reported short sleep durations (for both 6-7 h and <6 h per night) and low subjective health ratings (Steptoe et al., 2006). However, short sleep (<7 h/day) in relation to poor health may be more of a concern than long sleep, since long sleep (>8h/day) did not show significant association with SRH (Steptoe et al., 2006).

Poor sleep has been shown to affect neurobehavioral domains, which in turn might play a role in the relationship between poor sleep and lower subjective health ratings. Previous studies have found vigilance, affectivity, tension/anxiety, depression, anger, sleepiness and fatigue to be affected by suboptimal sleep (Bonnet & Arand, 1996; Franzen, Siegle & Buysse, 2008). Fatigue was found to be a mediating factor between restricted sleep and poor SRH in an experimental setting (Lekander et al., in review), where fatigue had a negative impact on subjective health ratings. Åkerstedt et al., (2012), who investigated the relationship on a day-to-day basis (on the same sample as the present study) found that total sleep time and SRH respectively predicted sleepiness during the day, even though an identification of cause and effect needed to be done.

Furthermore, negative affectivity, known as a measure of subjective distress, which comprises a broad range of mood states, such as depression, anxiety and hostility (Watson, 1988) could be measured either as a mood state or as a stable individual difference in affectivity. According to Watson and Clark (1984) individuals with a high stable state of negative affectivity tend to experience discomfort at all times and across situations. Negative affectivity, both as a trait and state variable has been shown to be associated with an increased number of subsequent health complaints (Cohen, et al., 1995). Subjective health ratings are sensitive to states of affectivity, where negative affectivity is associated with poorer self-rated health (Winter, 2007) and moderate depressive symptoms are prevalent factors in SRH (Stewart et al., 2008). Additionally, negative affectivity as a trait may play a role in how we rate our perceived health (Kressin, Spiro & Skinner, 2000).
The present study

Self-rated health is a dynamic and broad measure of health, as it has previously shown to reflect both physical and mental states (Perrucio et al., 2010; Singh-Manoux et al., 2006; Stewart et al., 2008; Undén & Elofsson, 2001; Winter, 2007). I am only aware of one experimental study that has investigated the variability of SRH as a response on sleep duration (Lekander et al., in review) and it shows a cumulative decrease in subjective health ratings succeeding sleep deprivation. However, very little is known about self-rated health and its changes on naturally occurring variations in sleep duration. Therefore, the main purpose of this study was to investigate what impact short or long total sleep times across three consecutive days in a naturalistic setting have on the individual’s subjective health rating. In order to catch variation over time, an analysis of each individual’s shortest, longest and medium sleep duration (over a period of six weeks) was conducted to detect variances in subjective health ratings as a response on short or long sleep duration.

Furthermore, negative affectivity (as a dimension of neuroticism) has been shown to be a strong predictor of poor health and comorbidity (Lahey, 2009), making negative affectivity as a trait-like variable at baseline in the present study a potential vulnerability factor in the response of SRH on different sleep durations. Therefore, another aim was to investigate negative affectivity at baseline as a moderator in the relationship between different total sleep time levels and daily self-rated health.

Peersman, Cambier, De Maeseneer and Willems (2012) argue that SRH has different meanings in different socio-demographic groups. Age and gender differences have been reported in subjective health ratings, where older seem to report lower levels of subjective health than younger and the female sex has been associated with poorer SRH (Darviri et al., 2012; Franks, Gold & Fiscella, 2003; Layes, Asada & Kephart, 2012). Consequently, cross-sectional baseline relationships between subjective general health ratings, negative affectivity, fatigue and background factors such as age and gender were mapped out in the present study, in order to replicate earlier findings of those relationships.

The present research questions were: (i) Are subjective health ratings affected by short, medium and long total sleep time (TST) of a 72-hour period in a naturalistic setting? (ii) What impact does negative affectivity at baseline have on the relationship between sleep duration and daily subjective health ratings? (iii) What are the relationships between subjective general health ratings, negative affectivity at baseline, fatigue at baseline and background factors such as age and gender? The hypotheses connected to these questions are based on earlier research findings: Since sleep duration affects health, the rating of subjective health should change when sleep duration changes. Negative affectivity at baseline, was expected to interact as a moderator in the relationship between sleep duration and the daily ratings of subjective health. Subjects with high negative affectivity at baseline should be more vulnerable to short or long sleep duration, leading to greater changes in subjective health ratings as compared to subjects with low negative affectivity at baseline. Furthermore, poor subjective general health should be associated with high negative affectivity at baseline and high fatigue at baseline as well as with older age and female gender.
Participants and procedure
Data was collected in 1999 and a total of 50 healthy subjects participated. Participants were recruited through advertisement and contacts at the Karolinska Institute, where employees were encouraged to ask friends and family to participate. All subjects were initially screened by a physician. Twelve percent were excluded due to depression, insomnia or heavy snoring.

The age range of participants was 18–69 years ($m = 42.10; SD = 16.84$) and 56% were women. They all gave written informed consent and received approximately $180 as an economic compensation. The study was approved by the Karolinska Institute ethical committee.

At the start a background questionnaire was completed by each participant. In order to capture within-subject variation in naturally occurring events, data was collected daily during 42 to 49 days. Each morning throughout the study, sleep time was noted by participants in a sleep diary and each evening they filled out a wake diary reporting on health symptoms and subjective health rating.

Measurements
The background questionnaire included questions about demographics and health. General subjective health was rated at baseline on a 5-graded Likert-scale, asking “How would you rate your general health over the past year?”, ranging from 1 (Poor) to 5 (Very good). Ratings of how often feelings of depression/sadness and feelings of fatigue respectively had occurred during the last six weeks were also performed, in order to get a measure of negative affectivity and of fatigue at baseline. The scale ranged from 1 (Never) to 5 (Always). For the analysis negative affectivity at baseline was dichotomized into Low (1-2) and High (3-5). After analyzing the distribution of the variable, this cut-off was chosen in order to create as equal group sizes as possible.

Each day, the Karolinska Sleep Diary (KSD; Åkerstedt, Hume, Minors & Waterhouse, 1994b) was completed by each participant right after awakening, where, among others, the following items were used: Bedtime (h), Time of awakening (h) and Sleep latency (h), as from which a measure of diary total sleep time (TST) was derived for each day. In the evening, a daily measure of subjective health was rated in the wake diary (Åkerstedt et al., 2013) using the question “How would you rate your state of health for the day?”. The daily measure of subjective health was rated on a 7-graded Likert-scale, in contrast to the 5-graded scale at baseline, in order to catch minor variations of the day to day ratings. The 7-graded scale ranged from 1 (Very poor) to 7 (Excellent). Feelings of negative affectivity and fatigue were rated daily in the wake diary as well, although on a 5-graded Likert-scale, ranging from 1 (Not at all) to 5 (Largely).

Statistical analyses
Blocks of three cumulative days and nights were created with data from the sleep diary. Each participant’s total sleep time including napping, was added from Monday to Wednesday, from Tuesday to Thursday, from Wednesday to Friday and so on, and a
total sleep time of 72 hours (TST-72) was calculated for each block. Each TST-72 was then analyzed together with SRH-ratings from the wake diary of day three in each block. See example in Figure 1.

**Figure 1. Creation of blocks; an example from one participant of the 1st week**

<table>
<thead>
<tr>
<th></th>
<th>Mon</th>
<th>Tues</th>
<th>Wed</th>
<th>Block 1.</th>
</tr>
</thead>
<tbody>
<tr>
<td>TST</td>
<td>5 h</td>
<td>7 h</td>
<td>9 h</td>
<td>TST-72 21 h</td>
</tr>
<tr>
<td>SRH</td>
<td>5</td>
<td></td>
<td></td>
<td>SRH 5</td>
</tr>
</tbody>
</table>

Blocks including use of sleeping drugs, presence of fever, feelings of sickness and/or asthma/allergy were excluded, which means that controlling for those variables in further analyses would not be necessary. Altogether 1672 blocks were created, with a different number of remaining blocks for each participant.

An analysis of range and median values of TST-72 for each participant gave one value of their shortest block of TST-72, one value of their medium block of TST-72 and one value of the longest block of TST-72. Every value of TST-72 short, medium and long gave a value of SRH corresponding to these blocks, called SRH short, SRH medium and SRH long.

In order to examine mean differences of SRH short, SRH medium and SRH long (intra-individual variance), an analysis of variance (ANOVA) was used. Further, ANOVA was used with the dichotomized variable of negative affectivity at baseline as a grouping variable (inter-individual variance) on the three levels of SRH. Results were controlled for through ANCOVA (analysis of covariance) with age and gender as covariates. The relationships between age, gender, general SRH, negative affectivity and fatigue at baseline were examined through Pearson product-moment correlation coefficients (r).

**Results**

At baseline, mean level of self-rated general health was very close to 4,0 on a scale ranging from 1 (poor) to 5 (very good). Negative affectivity at baseline had a mean value close to 2,0 on a scale from 1 (never) to 5 (very often). No one rated 5 in negative affectivity at baseline. Fatigue at baseline showed a mean value slightly under 2,5 on a scale from 1 (never) to 5 (very often) (see Table 1.).

The mean value of all participants’ blocks with short sleep was 18,44 hours over a period of three days (SD = 2,44). For blocks with medium sleep the mean value was \( m = 22,58 \) hours (SD = 2,11) and for the long sleep blocks the mean value was 27,24 hours (SD = 2,88). The shortest observed sleep block showed a TST-72 of 13,50 hours.
and the longest showed a TST-72 of 36.58 hours. The three sleep blocks (TST short, medium and long) differed significantly in terms of sleep duration ($F_{1,49} = 285.71; p < 0.001$) (Table 1.).

Table 1. Descriptive data and results from analyses of variance (ANOVA).

<table>
<thead>
<tr>
<th>DESCRIPITIVES</th>
<th>N</th>
<th>Min</th>
<th>Max</th>
<th>Range</th>
<th>Mean</th>
<th>SD</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>50</td>
<td>18</td>
<td>69</td>
<td>51</td>
<td>42.10</td>
<td>16.84</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SRH at baseline</td>
<td>48</td>
<td>1</td>
<td>5</td>
<td>4</td>
<td>4.06</td>
<td>0.81</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neg. Aff. at baseline</td>
<td>47</td>
<td>1</td>
<td>4</td>
<td>3</td>
<td>2.11</td>
<td>0.89</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fatigue at baseline</td>
<td>47</td>
<td>1</td>
<td>5</td>
<td>4</td>
<td>2.40</td>
<td>1.04</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TST-72 short</td>
<td>50</td>
<td>13.50</td>
<td>25.58</td>
<td>12.08</td>
<td>18.44</td>
<td>2.44</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TST-72 medium</td>
<td>50</td>
<td>18.08</td>
<td>28.84</td>
<td>10.76</td>
<td>22.58</td>
<td>2.11</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TST-72 long</td>
<td>50</td>
<td>22.33</td>
<td>36.58</td>
<td>14.25</td>
<td>27.24</td>
<td>2.88</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SRH when TST short</td>
<td>50</td>
<td>2</td>
<td>7</td>
<td>5</td>
<td>5.18</td>
<td>1.30</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SRH when TST med</td>
<td>50</td>
<td>2</td>
<td>7</td>
<td>5</td>
<td>5.55</td>
<td>1.13</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SRH when TST long</td>
<td>50</td>
<td>1</td>
<td>7</td>
<td>6</td>
<td>5.44</td>
<td>1.31</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neg. aff when TST short</td>
<td>50</td>
<td>2</td>
<td>5</td>
<td>3</td>
<td>1.32</td>
<td>0.79</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neg. aff when TST med</td>
<td>50</td>
<td>3</td>
<td>5</td>
<td>2</td>
<td>1.25</td>
<td>0.56</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neg. aff when TST long</td>
<td>50</td>
<td>1</td>
<td>5</td>
<td>4</td>
<td>1.34</td>
<td>0.87</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fatigue when TST short</td>
<td>50</td>
<td>1</td>
<td>5</td>
<td>4</td>
<td>1.90</td>
<td>1.16</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fatigue when TST med</td>
<td>50</td>
<td>1</td>
<td>5</td>
<td>4</td>
<td>1.89</td>
<td>1.18</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fatigue when TST long</td>
<td>50</td>
<td>1</td>
<td>5</td>
<td>4</td>
<td>1.60</td>
<td>0.99</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The daily subjective health was rated using a seven-point scale where 1 = Very poor and 7 = Very good. Small and non-significant differences in daily subjective health ratings between the sleeping blocks were found ($F_{1,49} = 2.09; p = 0.129$). Negative affectivity and fatigue was rated daily on a five-point scale where 1 = Not at all and 5 = Largely. No significant differences between the ratings at the various sleeping blocks were found in negative affectivity ($F_{1,49} = 0.24; p = 0.778$) or fatigue ($F_{1,49} = 1.89; p = 0.157$) (Table 1.).

There was a significant correlation between gender and general subjective health ratings at baseline ($r = -0.29; p = 0.043$), indicating lower reported self-rated health of women ($m = 3.81; SD = 0.85$), compared to men ($m = 4.27; SD = 0.77$). Supplementary t-tests were computed in order to identify eventual gender differences in all baseline ratings. There were significant differences in how women ($m = 2.36; SD$...
= 0.99) and men (m = 1.82; SD = 0.66) respectively rated their feelings of negative affectivity at baseline (t_{45} = - 2.16; p = 0.036). Similarly, women (m = 2.72; SD = 1.02) reported higher levels than men (m = 2.05; SD = 0.95) in fatigue at baseline (t_{45} = - 2.33; p = 0.024). However, gender differences in general health ratings at baseline were just above the non-significance level (t_{45} = 1.98; p = 0.054).

Furthermore, general SRH at baseline had a negative significant association with negative affectivity at baseline (r = - 0.38; p = 0.009) and with fatigue at baseline (r = - 0.36; p = 0.014). A positive significant correlation was found between negative affectivity and fatigue at baseline (r = 0.495; p = 0.000). Age had no significant relationship with any of the measured variables.

Supplementary correlations were computed between general subjective health and the daily measures of SRH when TST was short, when TST was medium and when TST was long. Significant, positive correlations were found between the four variables (Table 2.). Furthermore, correlations computed on all 1672 blocks showed moderate relationships between the daily ratings of subjective health and negative affectivity (r = -0.407; p = 0.000) as well as for daily ratings of subjective health and fatigue (r = -0.527; p = 0.000). Similarly, correlations between general subjective health and daily ratings of subjective health on all 1672 blocks showed a positive relationship (r = 0.456; p = 0.000).

**Table 2. Correlations of general SRH at baseline and daily SRH on the three different sleep time levels (short, medium and long).**

<table>
<thead>
<tr>
<th></th>
<th>SRH when TST short</th>
<th>SRH when TST medium</th>
<th>SRH when TST long</th>
</tr>
</thead>
<tbody>
<tr>
<td>General SRH at baseline</td>
<td>r 0.467**</td>
<td>0.331*</td>
<td>0.582**</td>
</tr>
<tr>
<td></td>
<td>p-value 0.001</td>
<td>0.021</td>
<td>0.000</td>
</tr>
<tr>
<td></td>
<td>N 48</td>
<td>48</td>
<td>48</td>
</tr>
<tr>
<td>SRH when TST short</td>
<td>r -</td>
<td>0.550**</td>
<td>0.442**</td>
</tr>
<tr>
<td></td>
<td>p-value -</td>
<td>0.000</td>
<td>0.001</td>
</tr>
<tr>
<td></td>
<td>N -</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>SRH when TST medium</td>
<td>r -</td>
<td>-</td>
<td>0.365**</td>
</tr>
<tr>
<td></td>
<td>p-value -</td>
<td>-</td>
<td>0.009</td>
</tr>
<tr>
<td></td>
<td>N -</td>
<td>-</td>
<td>50</td>
</tr>
</tbody>
</table>

* p<0.05  ** p<0.01
To analyze whether the individuals with different levels of negative affectivity at baseline scored differently on the daily measure of SRH, an analysis of variance for repeated measures (ANOVA) was conducted with daily measures of SRH at short, medium and long sleep as the dependent variable and the dichotomized values of negative affectivity at baseline as a grouping variable. A distribution of the mean values and standard deviations is shown in Table 3.

Table 3. Descriptives of the variables included in the ANOVA; SRH when TST was short, medium and long (ranging from 1-7) and negative affectivity at baseline (dichotomized into Low and High).

<table>
<thead>
<tr>
<th>SRH when TST</th>
<th>Negative affectivity</th>
<th>m</th>
<th>SD</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Short</td>
<td>Low</td>
<td>5.53</td>
<td>1.11</td>
<td>32</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>4.53</td>
<td>1.46</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>5.21</td>
<td>1.30</td>
<td>47</td>
</tr>
<tr>
<td>Medium</td>
<td>Low</td>
<td>5.86</td>
<td>0.98</td>
<td>32</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>4.93</td>
<td>1.28</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>5.56</td>
<td>1.15</td>
<td>47</td>
</tr>
<tr>
<td>Long</td>
<td>Low</td>
<td>5.66</td>
<td>1.18</td>
<td>32</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>5.07</td>
<td>1.44</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>5.47</td>
<td>1.28</td>
<td>47</td>
</tr>
</tbody>
</table>

The ANOVA showed that there was no difference in how the individuals rated their health over the different sleep block levels ($F_{1,45} = 1.84; p = 0.165; η^2 = 0.039$) (Figure 2.). Similarly, the interaction effect between the daily measured SRH and negative affectivity at baseline was non-significant ($F_{1,45} = 0.54; p = 0.584; η^2 = 0.012$), meaning that subjects with higher vs lower negative affectivity rated similarly in subjective health in response to shorter and longer sleep duration (Table 2.). However, there was a significant main effect of group ($F_{1,45} = 8.67; p = 0.005; η^2 = 0.162$). It is thus indicated that the daily ratings of subjective health were higher in individuals with low negative affectivity, regardless of sleep duration (Figure 2.).

An additional analysis of variance for repeated measures was conducted with age and gender as covariates (ANCOVA). Again, there was no main effect of SRH at the different levels of TST ($F_{1,45} = 0.145; p = 0.865; η^2 = 0.003$). Similarly, the interaction effect remained non-significant ($F_{1,45} = 0.528; p = 0.584; η^2 = 0.015$). Gender ($F_{1,45} = 1.443; p = 0.242$) and age ($F_{1,45} = 0.415; p = 0.662$) accounted for 3.2% and 1.0% of within-subject variance. Furthermore, the main effect of group was still significant ($F_{1,45} = 4.71; p = 0.036; η^2 = 0.099$). Gender ($F_{1,45} = 1.77; p = 0.190$) and age ($F_{1,45} = 0.033; p = 0.856$) explained 4.0% and 0.1% of the between-subject variance, indicating that these variables had a weak effect in this model (Figure 3.).
Figure 2. ANOVA of SRH when TST short, medium and long, with negative affectivity at baseline (dichotomized) as grouping variable.

Figure 3. ANCOVA of SRH when TST was short, medium and long, with negative affectivity at baseline as grouping variable and age and gender as covariates.
This study was designed in order to investigate how subjective health ratings are affected by naturally occurring differences in total sleep time (TST) of the three preceding nights. Another aim was to investigate the impact of negative affectivity at baseline on the relationship between sleep duration and daily ratings of subjective health and to map out the relationships at baseline between subjective general health ratings, negative affectivity, fatigue and background factors such as age and gender.

In the present study it was shown that different sleep duration (short, medium and long) over three consecutive days did not affect how individuals rated their subjective health. Thus, there was no effect of sleep duration on SRH in this healthy sample and it might be that three days of poor or long sleep is not enough to affect how we perceive our health in a naturalistic setting.

This result is not consistent with the proposed hypothesis, based on Lekander et als. study, (in review) where it was found that sleep restriction had a cumulative negative effect on subjective health. However, their study was conducted in an experimental setting and sleep restriction was set on 4 hours of sleep per night. The present study was performed in a naturalistic setting, and the mean value of TST-72 short over three days was 18.44 hours (SD = 2.44), which means about three nights of 6 hours of sleep each. In the study by Lekander et al. (in review) the corresponding value of three nights was 12 hours (4 hours per night). Thus, even the shortest sleep block in this study (13.50 hours) contained more sleep. Other studies use <7 hours or <6 hours per night, as a measure of short sleep, (Grandner et al., 2010; Nakata, 2012; Steptoe et al., 2006) which is about the same amount of sleep as the short blocks in this study. Even though there were significant differences between TST-72 short, medium and long in the present study, a greater range of variation of total sleep time may have affected subjective health ratings more strongly. In addition, since sleep blocks which included use of sleeping drugs, presence of fever, feelings of sickness and/or asthma/allergy were excluded before analyzing data, some effect of sleep duration on subjective health ratings might have been taken away.

In a non-controlled naturalistic setting, as in the present study, times of recovery might have followed eventual sleep deprivation. Recovery could have occurred either through napping (which was however included in TST-72) or through a night of longer sleep duration after two nights of shorter sleep. The distribution of the sleep included in TST-72 has not been mapped out, which means that subjects could have slept their longest night the day prior to the SRH rating, even though total sleep time over three days was short. Previous studies have found a direct response on subsequent recovery sleep on SRH and fatigue (Lekander et al, in review), on stress system activity (Meerlo et al., 2008), vigor and fatigue (Bonnet & Arand, 1996) and on neurobehavioral outcomes (Banks & Dinges, 2010; Dinges et al., 1997). Consistent with this, Tucker, Dinges and Van Dongen (2007) found that subjects recovering from induced sleep deprivation slept an average of 1.8 hours longer than they did at baseline. These are findings that strengthen the notion that recovery could be one of the possible explanations to why we are not sensitive in terms of subjective health ratings, to different levels of total sleep time over three days in a naturalistic setting.
Furthermore, sleep duration over three days in the present study did not have an impact on how participants rated their negative affectivity or fatigue for the day. The same arguments as mentioned above could be applied to these findings, as supplementary correlations on all 1672 blocks showed moderate relationships between the daily ratings of subjective health and negative affectivity as well as for daily ratings of subjective health and fatigue. Those variables are related to each other, even though the direction of cause and effect is not established. However, other factors than sleep duration, such as sleep quality could have an impact on feelings of negative affectivity or fatigue (MacCrue et al., 2008; Nicassio, Moxham, Shuman & Gevirtz, 2002), which could explain that daily ratings of negative affectivity or fatigue did not follow the different levels of total sleep time over three days in the present study.

Different levels of sleep duration did not affect those individuals with high negative affectivity at baseline differently, compared to subjects reporting low negative affectivity at baseline. Thus, negative affectivity was not shown to be a moderator in the relationship between total sleep time and self-rated health. This is not in line with the proposed hypothesis, since negative affectivity as a stable state was believed to have an impact as a vulnerability factor in the response of SRH on sleep duration. However, some limitations in the present work should be noticed. Firstly, there were uneven group sizes in the dichotomized negative affectivity variable. This fact might have affected the statistical power. Further on, the variable at baseline was highly skewed and no one had rated 5 at negative affectivity. Finally, a measure of negative affectivity from a validated scale, such as HADS (Zigmond & Snaith, 1983) or POMS (Profile Of Mood States) could have been a more reliable measure and should also have given more baseline information, such as positive affectivity or stress reactions. Lack of such data made the item about feelings of depression or sadness a good replacement measure of negative affectivity at baseline in this study.

It turned out that subjects with high negative affectivity at baseline generally rated their subjective health lower compared to those with low negative affectivity at baseline – irrespective of if they had slept few, normal or many hours over three days. Previous studies have shown similar results in the relationship between negative affectivity and subjective health ratings. Kressin et al. (2000) suggest that negative affectivity as a trait influences subjective health rated quality of life in a negative way. Stewart et al., (2008) found that moderate depressive symptom was one of the most prevalent factors affecting poor self-rated health.

In the present sample women reported lower ratings on general subjective health, as well as higher negative affectivity and fatigue at baseline. In accordance to these findings, several studies show that women reported lower SRH than men (Darviri et al., 2012; Franks et al., 2003; Layes et al., 2012). Although older age has previously been shown to be associated with poor subjective health, (Darviri et al., 2012; Layes et al., 2012), age was not associated to any of the measured variables in the present study. Furthermore, neither gender nor age had any impact on the relationship between daily measures of subjective health and different levels of sleep duration.
Self-rated health was not shown to be sensitive to different levels of total sleep time in the present study and the daily measurement of SRH seemed to be relatively stable over time. Additionally, the general subjective health rating at baseline and the following daily ratings of SRH showed significant moderate correlations. Though, it should be mentioned that in those two estimates, the items were phrased differently. The item of the general measure of subjective health at baseline was about the experience of the general health over the past year, while the daily estimates of health referred to the past day. Daily measures of subjective health, in comparison to ratings of the general health are expected to be a measure more sensitive to short-term changes. However, authors have made different findings in this current question. Perrucio et al., (2010) investigated whether SRH is a spontaneous evaluation of the current health status or a more trait-like perception of the self and found that there is an interaction between both perspectives. Whereas Bailis, Segall, and Chipperfield (2003) described SRH as a rather stable self-concept. However, some studies have proven SRH to be sensitive to changes in total sleep time even over shorter periods (Bonnet & Arand, 1996; Lekander et al., in review). While others have found previous SRH to be the best predictor of current SRH even after changes in health status (Perrucio et al, 2010). Additionally, the test-retest reliability of subjective health ratings has earlier been investigated, indicating that SRH is a moderately stable measure over time (Crossley & Kennedy, 2002; Lundberg & Manderbacka, 1996; Zajacova & Dowd, 2011).

Subjective data was used for all variables in the present study. When it comes to SRH, it has previously been described as a measure of latent health related to individual reporting behavior, such as affectivity, expectations, culture and sensitivity to pain, which means that reporting behavior should be seen as a measure of systematic deviation from latent health (Layes et al., 2012). On the other hand, individuals have previously shown to be aware of their own changes in symptoms and affectivity, which strengthens the ability of SRH to predict health outcomes (Winter et al., 2007). Moreover, misperception of sleep duration has earlier been reported (Fernandez-Mendoza, 2011), although only among insomniacs, who tended to underestimate their total sleep time when TST was short. However, Åkerstedt et al. (2012, 2013) who made analyses on the same data as in this present study found the subjective sleep data to approximate the available objective sleep data (EEG and actigraphy). The mean value of nightly self-reported TST in this sample was 446 minutes and for actigraphy it was 440 minutes. However, due to loss of actigraph data of two weeks for nine persons, subjective data was used in all their statistical analyses.

Furthermore, as all measures in this study were made through self-assessment, the risk of common method bias (Podsakoff, Lee, MacKenzie & Podsakoff, 2003) should be mentioned. Variance could be attributed to a special reporting behavior, which would create a false internal consistency. However, again, since Åkerstedt et al. (2012, 2013) had complementary data which was not collected through self-assessment, but through actigraphy (despite an important data loss) and EEG, this risk of bias is diminished when it comes to the independent variables; sleep. Self-rated health, which is the dependent variable, as well as negative affectivity and fatigue were all on the other hand collected only through the wake diary, which consequently enhance the risk of common method bias.
Despite these limitations, significant strengths should also be considered. The study is made in a naturalistic setting and the sample was a healthy homogeneous sample. This implies high ecological validity, as it approximates the real-world that is being examined. Data was collected longitudinally over a relatively long period with few missing subjective data (only between 0 and 6 %, depending on variable). In addition to this, no other studies following individuals in terms of spontaneous changes in health behaviors such as sleep in relation to health ratings or similar variables are known.

**Conclusion**

In conclusion, total sleep time over three days does not seem to affect subjective health. It might be that three days of poor or long sleep is not enough to affect the subjective health status when variations in sleep length are relatively small. The possibility of present recovery sleep within the block of three days might also explain the stability of self-rated health over the three TST levels. Negative affectivity was not shown to be a vulnerability factor in the reaction to variations in sleep time. However, it was shown that subjects with high negative affectivity at baseline tended to rate lower on the daily measures of SRH. This finding underlines earlier findings of SRH to include even mental dimensions of health.

The present results, which show that there is no effect of sleep duration over three days on SRH, should mainly apply to a healthy population with normal sleep patterns. Attention should be drawn to the fact that data collection was made over thirteen years ago. Since we experience a decreasing number of hours of sleep (SCB, 2011) a random sample of the population today, could present higher variability of TST. Greater range between long and short sleep durations in the population might also affect the pattern of sleep loss, recovery, banking of sleep and gain of resilience to sleep loss. However, it could also imply that all TST values would be shorter (both short, medium and long) which theoretically could make a population of today more sensitive to shorter sleep durations, due to lack of sleep at baseline. Findings in the present study should be updated through a data collection on a greater sample with objective control measures, such as actigraphy and biological correlates and with a thorough evaluation of negative affectivity and other vulnerability-factors of the response to changes in sleep duration.

**References**


