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CORRELATIONS BETWEEN OVERNIGHT BREATHING RATE VARIATION AND SUBJECTIVE SLEEP QUALITY SCORES

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INTRODUCTION

The relationship between objective sleep parameters, derived from polysomnography (PSG), and subjective sleep quality, obtained from questionnaires, has been researched thoroughly in the past. However, inconsistent results were found, the study outcomes differ to which extend above-mentioned variables are correlated and only a few objective parameters were related to the subjective sleep experience. The most profound association was between wake time and subjective sleep quality (r = -.59) [1–3]. New methods to analyze PSG data was proposed by Krystal and Edinger[4]. They suggested to analyze PSG data more at a measure of nature/depth of sleep, such as indices for the frequency content of electroencephalogram (EEG) signals obtained during non-rapid-eye-movement (NREM) sleep, or to look at particular patterns in the NREM sleep and their sequence between NREM sleep patterns, instead of only taking the sleep stage classification. Yet, correlations between other objective measures, such as respiratory parameters, and subjective sleep quality have not been analyzed. We expect that a stable sleep, seen in, for example, a low breathing rate variation overnight, is indicative for a good sleep quality rating. In this preliminary work, we investigated whether respiratory parameters are related to subjective sleep quality the next morning.

METHODS

Data from the SIESTA project was used[5]. The SIESTA project was carried out in seven countries of Europe with as main objective to gather a normative database of healthy and sleep-disturbed patients. In short, at the beginning of the study, participants did an entrance examination, which consisted of a physical examination and medical screening. For two weeks participants wore a wrist actigraphic device that records activity counts and went for two consecutive nights (night 7 and night 8) to a sleep laboratory during which PSG recordings were acquired. Additional questionnaires, like neurocognitive tests, were obtained and are described elsewhere.
Our analyses were based on data of 165 healthy participants, aged from 20 to 95 yrs (mean ± SD: 51.8 ± 19.4 yrs; 77 men). A participant was considered healthy when neither having a sleep disorder and nor a mental or physical disorder.

The Sleep and Awakening questionnaire (SSA) [6] was assessed to determine the subjective sleep quality each morning for the past night. The SSA consists of 27 questions, divided in four parts: sleep quality, awakening quality, somatic complaints and estimates about their sleeping times of last night. A total score can be calculated when taking the first three parts, or a sub score of each part separately can be calculated. The total score range is between 20 and 80. Higher scores indicate worse sleep quality.

For PSG recordings, 16 channels of bio-signals were measured, such as EEG, electromyogram (EMG), electrooculogram (EOG), electrocardiogram (ECG), oxygen saturation and respiratory effort. For objective measurements two respiratory parameters extracted from the overnight respiratory effort signals were considered: mean breathing rate (BR) and mean standard deviation of breathing rates (SDBR).

Spearman rank correlations were conducted to analyze the association between the SSA scores and the two respiratory parameters BR and SDBR. For the respiratory parameters, analyses were performed based on the mean of the whole night, calculated by taking the mean BR and mean SDBR for each sleep stage separately and followed by calculating the mean of those separate means for different sleep stages. This was done so that the final mean variable was not influenced by the differences in the percentages of the sleep stages, serving to purely look at the physiological measures without including information of sleep stages. Furthermore, supplementary analyses were executed to investigate gender and age effects in the abovementioned association. For age analysis, participants were divided in three groups: young: 20 – 39 yrs (n = 52), middle aged: 40 – 69 yrs (n = 69), elderly: ≥ 70 yrs (n = 44).

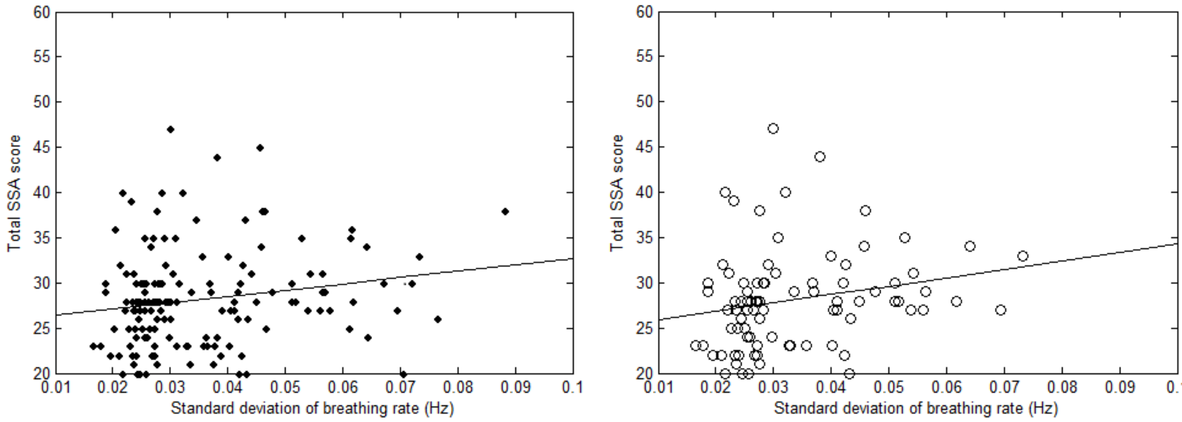
RESULTS AND DISCUSSION

Positive correlations were found between the mean SDBR and the total SSA score [night 7: r = .179, p = .024; night 8: r = .213, p = .007, Figure 1(a)]. This means that a higher variation of breathing rate is associated with worse sleep experience. However, the correlation coefficient was not high, implicating that the association is weak.

A gender effect was observed in both nights, as significant correlations were found between mean SDBR and total score on SSA for females [night 7: r = .263, p = .014; night 8: r = .300, p = .005, Figure 1(b)]. Therefore, a higher mean variation of the breathing rate is associated with worse sleep quality in women. An explanation for this is not clear and needs to be further investigated.

Additionally, moderate correlations were found between the mean BR and the mean SDBR and the total score of the SSA of night 7 in the elderly group (BR: r = .400, p = .008 and SDBR: r = .399, p .008, Figure 2). No significant correlations were observed for the other age groups. This suggests that, especially for elderly persons, a higher breathing rate variation is associated with worse sleep experience. However, these results are not present in the second night (night 8), meaning that these findings might be due to the first-night effect present in this data set[7].

This is a preliminary study and future research with more in-depth analyses of the PSG data is needed to better understand the relationship between objective sleep measurements and subjective sleep quality. Moreover, multiple nights are necessary to assess the night-to-night variability within this relationship.



(a) (b)

Figure 1. Scatterplot of the mean variation of the breathing rate and the total score on the SSA of night 8, (a) for all subjects and (b) for women.

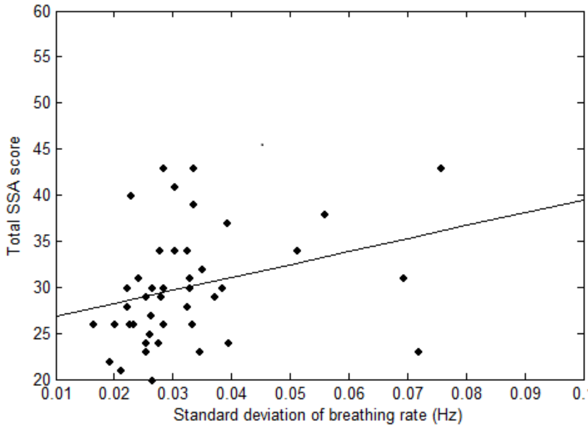


Figure 2. Scatterplot of the mean variation of the breathing rate and the total score on the SSA of night 7 for the elderly group.

CONCLUSIONS

Breathing rate and its variation were found to be correlated with subjective sleep quality rating. The association between the breathing rate variation and the SSA score was more profound for women and seen to a greater extent for the first night in the elderly group. However, these correlations were not as high as we expected. If future research can find a strong relationship between other objective parameters and sleep quality ratings, this would mean a great improvement in the credibility of sleep monitoring devices. Moreover, predictions can be made the next morning about how someone has slept. Additionally, a complete PSG recording would not always be necessary as the insight in other objective sleep parameters improves.

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