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Original Article

Women with both sleep problems and snoring show objective impairment of sleep

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ABSTRACT

Objective: Combined insomnia and obstructive sleep apnea has been the focus of considerable research with respect to its health effects. A related issue is whether sleep disturbances in combination with snoring might exert effects on objective sleep variables in the non-clinical general population. The purpose of the present study was to investigate the polysomnographical characteristics of individuals who had sought medical help for both disturbed sleep and for snoring. No previous work of this type has been carried out.

Method: For this study we used a representative set of data of 384 women with one night of in-home PSG. We identified those individuals who had sought medical help for sleep problems (SL), individuals that had sought help for snoring (SN), as well as those that had sought help for either both (Combined), or for neither (Control).

Results: Our results yielded an N of 46, 16, 21, and 301 individuals, respectively. A one-factor analysis of variance showed significant main effects on N1% ($F = 10.2$, $p < 0.001$), N3% ($F = 2.7$, $p < 0.05$), AHI/h ($F = 5.5$, $p < 0.001$), and a delta power measure ($F = 3.8$, $p < 0.05$). The combined group showed significantly higher levels than the other groups for N1% (29% vs < 21%), AHI/h (19/h vs < 10/h) and lower levels for N3%, and a measure of delta power. Reported sleep quality measures did not show the same pattern, since the highest/lowest value were found for either the group presenting snoring alone or sleep problems alone.

Conclusion: We concluded that individuals who had sought help for *both* insomnia and snoring showed impaired sleep in terms of PSG and that this was not reflected in ratings of sleep or health. This suggests that simultaneous sleep disturbances and snoring may potentiate each other to cause impaired sleep, yet the mechanism still needs to be elucidated.

1. Introduction

Sleep complaints are prevalent in the general population [1], yet very few studies have looked at the association with objective sleep (polysomnography [PSG]), and they have found only marginal links [2,3]. This lack of association is also seen in insomnia patients, who usually do not differ from controls on objective (PSG) measures [4–7], even if a meta-analysis has indicated some differences [8]. Snoring is also prevalent in the population, with figures around 20–60%, in men, with slightly lower values in women [9], and it has an association with daytime sleepiness independent of the apnea-hypopnea (AHI) index [10,11]. Snoring has seldom been linked to objective sleep measures, although Nakano et al., [11] showed that a sound measure of snoring was positively correlated with N1, and negatively with N2 and REM.

Nothing is known about the *combined effects* of self-reported problems with both sleep and snoring. However, obstructive sleep apnea (OSA), which is associated with snoring [9], has a 30–50% comorbidity with insomnia [12–14]. Furthermore, in patients diagnosed with OSA, as many as 40–60% report some type of

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insomnia symptom [15,16]. This raises the possibility that a co-occurrence of sleep problems and snoring may contribute to disturbed physiological sleep in the general population.

The purpose of the present study was to investigate the effect of the combination of sleep problems and snoring on sleep architecture in the general population of women. For this purpose we focused on women who have sought medical help for sleep problems, or snoring, or for both problems. The rationale is that having sought medical attention may be assumed to indicate a higher level of problems than merely scoring high on snoring or sleep problem questionnaires. The present study included women only, partly because women have a high level of sleep problems [17].

2. Methods

2.1. Design and participants

This study used a subsample of the Sleep and Health in Women (SHE) study [18] where 400 women had PSG recordings which were specifically focused on women's sleep. Within the SHE study as a whole, a representative sample of 10,000 women were randomly selected from the population registry of the City of Uppsala. They received a sleep/health questionnaire (response rate 71.6%) and a second random sample of 400 (snorers were oversampled) was selected for PSG recordings, [19]. Home PSG (with OSA indicators) was carried out for the 400 selected participants. Mean age was 49.3 ± 11.2(SD) years (22–72 years); BMI was 25.3 ± 4.2; 73% were married/cohabiting; 51.7% had children at home; 44.2% had passed menopause and 24.2% had received hormone treatment (ever).

Treatment for snoring or sleep apnea (CPAP and oral appliances) were withdrawn for ≥3 nights preceding the PSG. This concerned only five cases. The original cohort was reported as a study of normative data on female sleep [18].

2.2. Self-report variables

For information on subjective habitual sleep, the Uppsala Sleep Questionnaire [20] was used with the items: difficulties initiating sleep (DIS), difficulties maintaining sleep (DMS), early morning awakening (EMA), sleepy daytime, and tired daytime. The response was given on a scale from “none” to “very big problem” (1–5). Frequency of snoring was assessed by questions adopted from the Basic Nordic Sleep Questionnaire (BNSQ) [21], with response options 1 (never) – 5 (every or almost every night). Daytime sleepiness was also assessed through the Epworth Sleepiness Scale (ESS) [22]. For anxiety and depression the Hospital Anxiety and Depression scale (HADS) [23] was used. Depression and Anxiety subscales ranged from 1 to 28. Subjective health was rated on a scale from 1 to 5 (very good – very poor health). Hypnotics use was rated on a scale from 1 to 5 (never – most days). Menopausal stage was rated through the question “Have you entered or passed menopause”, with the response alternatives “yes”, “no”, and “don't know”. Moreover, “yes” and “don't know” were combined in the analyses.

2.3. PSG recording

The PSG recording took place in the homes of the participants, using a solid state, portable, sleep recorder (Embla, Flaga, Iceland). Standard electrode (silver/silver chloride) montage was used (C3, C4) referenced versus contralateral mastoids and in addition two sub-mental electrodes and electrodes at the outer canthi of the eyes. To adapt to AASM scoring, F4 was interpolated. Further sensors included electrodes for bilateral anterior tibialis muscles, airflow with a three-port oro-nasal thermistor and a nasal flow pressure sensor, respiratory effort from piezo-electric belts (Resp-EZ, EPM Systems Midlothian, VA, USA), finger pulse oximetry (Embla A10 flex Sensor), electrocardiograms (V5), a piezo vibration sensor for snoring and a body position sensor. A research nurse applied the electrodes, connected the equipment, and gave instructions in the early evening. The equipment was then retrieved the next morning by an experimenter. Data were lost for 1.5% (six out of 400) of the participants; however recording was repeated within a short period of time. For technical reasons, diary information was used to establish lights out and lights on.

Sleep staging, respiratory, and arousal analysis were performed according to the classification criteria of the American Academy of Sleep Medicine [24] using the computer-assisted sleep classification system Somnolyzer 24 × 7 [25,26]. All scoring was checked by a licensed sleep technician. Here the terminology N1, N2 and N3 is used for sleep stages 1–3. Shift from any of the sleep stages to wake is expressed as awakenings per hour. An apnea was defined as a cessation of airflow for at least 10 s while a hypopnea was defined as at least 10 s of 50% reduced nasal pressure, together with at least 3% desaturation. The apnea-hypopnea index (AHI) was defined as the mean number of apneas and hypopneas per hour of sleep. We also introduced a new variable to represent low frequency (0.5–4 Hz or delta) power. The variable was defined as the number of 30 s scoring epochs that contained ≥65% delta power (of total power in the 0.5–32 Hz band) in the epoch, expressed in percent TST. Furthermore, this variable was labeled Delta Density ≥65% (DD65%). Sleep latency was excluded from the analyses because of difficulties to establish the exact start of time in bed.

2.4. Statistical analysis

Based on the responses to the question on whether they had ever seen a physician because of sleep problems (No/Yes) or because of problems with snoring (No-Yes), the study population was categorized into four different groups; (a) Controls (never seen a physician because of sleep problems, or snoring), (b) seen a physician because of sleep problems (SL), (c) seen a physician because of problems with snoring (SN), and (d) seen a physician both because of sleep problems and problems with snoring (combined). Those who had not responded adequately to either of these questions (n = 16) were excluded from the further analyses making the final study population 384 individuals.

The four groups were compared using a one-way analysis of variance adjusted for age, BMI, somatic disease, use of medication and menopausal stage. Since some variables showed heterogenous variance, we also applied the Kruskal–Wallis non-parametric approach for several independent groups. For significant Chi^2 values all pairwise comparisons were tested using the Bonferroni correction. Analyses were carried out using SPSS, version 24. The significance level was set at $p < 0.05$.

3. Results

Table 1 describes the four groups in terms of age, BMI and subjective sleep variables. Significant effects were seen for all variables, except for BMI, ESS and early morning awakening. The highest values for the sleep variables (except early morning awakening), sleepy and tired, use of hypnotics, anxiety, depression, and poor health were seen in the SL group. These were also significantly different from the control group. The SN group showed significantly fewer difficulties falling asleep, less sleepiness, less tiredness, less use of hypnotics, and less anxiety than the SL group. In addition, the SN group showed more frequent snoring and more anxiety than the control group. The combined group showed less