



## Original Article

# Leisure-time physical activity predicts complaints of snoring in women: a prospective cohort study over 10 years



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## ABSTRACT

**Objective:** We aimed to assess the impact of self-reported physical activity on incidence and remission of snoring complaints in women.

**Methods:** A population-based sample of 4851 women aged >20 years responded to questionnaires in years 2000 and 2010. Based on the responses, the women were categorized into low, medium, or high level of physical activity at baseline and at follow-up.

**Results:** The prevalence of habitual snoring complaints increased from 7.6% at baseline to 9.2% in 2010 ( $P < .0001$ ). After adjusting for age, body mass index (BMI), waist and neck circumference, weight gain, smoking status, alcohol dependence, and snoring status at baseline, reported physical activity level at baseline had a protective effect on habitual snoring complaints at follow-up. The adjusted odds ratio (OR) (95% confidence intervals) for complaints of habitual snoring was 0.7 (0.5–0.9) for the reported medium physical activity level and 0.5 (0.4–0.8) for the high activity level. When subdividing the population by changes in reported physical activity level over the follow-up period, an increase in physical activity was followed by a decrease in the complaint of snoring. Similarly a high level of reported physical activity only had a protective effect on snoring in participants who remained at a high or medium level.

**Conclusions:** A low level of self-reported physical activity is a risk factor for future habitual snoring complaints in women, independent of weight, weight gain, alcohol dependence, and smoking. Increased physical activity can modify the risk.

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## 1. Introduction

Snoring is a health problem affecting 7.6–10% of women [1–3] and 15–24% of men [2–4]. Several studies have reported associations between snoring and morbidity, such as hypertension, stroke, myocardial infarction, and type 2 diabetes mellitus [2,4–11]. These associations are at least partly explained by the fact that snoring is the major marker of obstructive sleep apnea (OSA) [12], a condition with repetitive apneas and desaturations during sleep. Left untreated, OSA confers an increased risk for road traffic accidents [13], impaired quality of life [14], cardiovascular disease, and all-cause mortality [15–20], as well as an increase in socioeconomic costs [21]. However, snoring is highly associated with excessive daytime sleepiness, subjective work performance problems, and traffic accidents, even in the absence of sleep apnea [22–25].

The exact mechanisms behind the development of snoring are not fully understood, but established risk factors include gender

and age [1,4]. The male-to-female ratio is estimated to be approximately 2 to 1 in the general population [26,27]. In addition, overweight [1,3,6,28,29] and central obesity, measured as a large neck [1,28,30] or waist circumference [1,6], are strongly associated with snoring. Weight gain is followed by a higher incidence of snoring [6,29,31], while the absence of obesity is associated with an increased likelihood of remission from habitual snoring [31]. Cross-sectional studies also have revealed an association between snoring and both alcohol consumption [1,3] and smoking [1,3,4]. In contrast to the large number of studies of obesity and snoring, there is still a lack of reports on the impact of physical activity on snoring frequency. A protective effect of physical activity is suggested [32]; however, an independent relationship is reported between leisure-time physical inactivity and snoring in findings from Swedish women with a body mass index (BMI) of  $\geq 30$  kg/m<sup>2</sup> [1]. In a Swedish cohort of men followed over 10 years, no significant association between physical activity level and snoring was found in a cross-sectional analysis [29]. The cohort was followed over 10 years, but the questions regarding physical activity were added

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in the follow-up and did not provide information about the influence of physical activity over time. To the best of our knowledge, no population-based prospective studies have reported on associations between the level of physical activity and snoring incidence and remission in women.

From a public health perspective, it is crucial to identify modifiable risk factors for snoring. Therefore, our aim was to assess the potential impact on incidence and remission of snoring complaints by the level of reported leisure-time physical activity in women. We also studied the role of changes in the level of reported leisure-time physical activity. To achieve this goal, we conducted a population-based prospective cohort study over 10 years.

## 2. Methods

### 2.1. Population and setting

In our study women from the Sleep and Health in Women Study aged  $\geq 20$  years were randomly selected from the population registry in the Municipality of Uppsala, Sweden, and invited to fill in a postal questionnaire in April 2000 [1,33]. Informed consent was obtained from all participants and the study was approved by the Regional Ethics Committee, Uppsala, Sweden (EPN D-no 99-486). The response rate for the baseline questionnaire was 71.6% ( $N = 7051$ ). A new questionnaire was distributed to all responders in April 2010. Our analyses data from those that answered the questions about snoring and leisure-time physical activity level both at baseline and at the 10-year follow-up. All questions used in our study were identical at baseline and follow-up.

### 2.2. Measures

Complaints of snoring were assessed using a 5-point scale. Participants were asked to state the frequency of their loud and disturbing snoring. In the subsequent statistical evaluation, participants with scores of 1 (never) and 2 (seldom) were defined as nonsnoring, those with a score of 3 (sometimes) as occasional snoring, and those with scores of 4 (often) or 5 (very often) as habitual snoring [1,29].

Leisure-time physical activity was assessed using a 4-point scale to describe physical activity during leisure time [34]. For the statistical evaluation, the level of physical activity was categorized into three groups: (1) a low level of physical activity was defined as score 1 and included spending most time watching television, reading, and being sedentary for most of their leisure time; (2) a medium level was defined as score 2 and included some physical activity like walking and cycling at least 4 h a week; and (3) a high physical activity level was defined as scores 3–4 and included those participating regularly in swimming, jogging, playing tennis, and engaging in aerobic exercise (i.e., for 3 h a week or more vigorous exercise on a weekly basis).

The BMI in  $\text{kg}/\text{m}^2$  was calculated from self-reported data on weight and height. Delta ( $\Delta$ ) BMI was calculated as the BMI scores in 2010 minus the BMI scores in 2000. Waist and neck circumference (centimeters) were measured by the participants using a tape measure and instructions provided with the questionnaires. Waist and neck circumference were categorized in accordance with the analysis of the baseline data [1].

Alcohol dependence was investigated using the CAGE (cut down, annoyed by criticism, guilty about drinking, eye-opener drinks?) questionnaire [35]. Answering yes to two of the questions confirmed alcohol dependence. Smoking habits also were assessed. Participants were classified as smokers if they smoked  $\geq 1$  cigarette a day, while nonsmokers were those who had never smoked or stopped before the year 2000.

### 2.3. Statistical analysis

Statistical analysis was performed using Stata 10.0 (Stata Corporation, College Station, TX). In categorical variables, the  $\chi^2$  test was used for comparisons of proportion in prevalence. Continuous variables were compared using the two-sample  $t$  test with equal variances. The results are presented in mean  $\pm$  standard deviation (SD). For simultaneous evaluations of more than two variables, multiple logistic regression analyses were performed, the results of which are presented as adjusted odds ratios (OR) and 95% confidence intervals. The number of participants is reported for each of the analyses. For all statistical tests,  $P \leq .05$  led to the rejection of the null hypothesis.

## 3. Results

### 3.1. Response rate

Of the original cohort ( $N = 7051$ ), 8.5% were lost to follow-up due to death ( $n = 461$ ), emigration ( $n = 130$ ), and unknown addresses ( $n = 5$ ). Therefore, the 10-year follow-up questionnaire was sent to 6455 women (91.6% of the initial cohort) and completed by 80.5% ( $n = 5193$ ). Compared with the responders, the nonresponders were older (mean ages,  $45.0 \pm 16.0$  vs  $43.3 \pm 15.3$  years;  $P < .001$ ), somewhat more obese (mean BMI,  $24.5 \pm 4.3$  vs  $24.0 \pm 4.1$ ;  $P = .0007$ ), and more often smoked cigarettes (21.9% vs 15.9%;  $P < .0001$ ) at baseline. The prevalence of habitual snoring complaints did not differ between responders and nonresponders (7.6% vs 7.8%). However, the nonresponders reported less physical activity at baseline, as 16.3% reported a high level of physical activity and 23.8% reported a low level of physical activity as compared to 21.1% and 15.7% for the responders, respectively ( $P < .001$ ).

To be included in our analyses, answers were needed to questions covering the main outcome (snoring 2010) and potential risk factors at both baseline and follow-up assessments. No imputation for missing data was made. Therefore, the study population comprised those answering the questions about snoring and leisure-time physical activity level on both occasions (93.4%;  $n = 4851$ ) of the responders.

### 3.2. Snoring prevalence and incidence

At baseline, the overall prevalence of habitual snoring complaints was 7.6% ( $n = 370$ ), which increased to 9.2% ( $n = 448$ ) at the 10-year follow-up ( $P < .0001$ ). For the 3622 women who reported no complaints of snoring at baseline, the incidence of habitual snoring complaints 10 years later was 3.3% ( $n = 121$ ). A remission in snoring complaints was reported in 20.3% ( $n = 75$ ) of the 370 women with habitual snoring complaints at baseline (Table 1).

### 3.3. Changes in reported leisure-time physical activity level

During the 10-year period, the self-reported level of leisure-time physical activity somewhat increased in the study population; a high leisure-time physical activity level was reported by 21.7% in the year 2000 and by 22.8% in 2010 ( $P < .0001$ ). The corresponding figures for reporting a low physical activity level were 15.3% in 2000 and 13.7% in 2010 ( $P < .0001$ ). Among women reporting a low physical activity level in 2000, 8.2% ( $n = 61$ ) reported a high physical activity level after 10 years. On the other hand, 3.9% ( $n = 41$ ) reported a low level of physical activity in 2010 among women reporting a high physical activity level in 2000 (Table 2).

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