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Original Article

The impact of obesity and weight gain on development of sleep problems in a population-based sample

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ABSTRACT

Objectives: The objective of this study was to investigate the role of obesity and weight gain in the development of sleep problems in a population-based cohort.
Material and methods: A population-based sample of men ($n = 1896$, aged 40–79 years) and women ($n = 5116$, age ≥20 years) responded to questionnaires at baseline and follow-up after 10–13 years. Sleep problems were assessed through questions about difficulties initiating sleep (DIS), difficulties maintaining sleep (DMS), excessive daytime sleepiness (EDS), and insomnia. Body mass index (BMI) was calculated from self-reported weight and height at both baseline and follow-up, while confounding factors (physical activity, tobacco and alcohol use, somatic disease, and snoring) were based on responses at baseline.
Results: Although overweight and obese subjects reported more sleep problems at baseline, there was no independent association between BMI level at baseline and development of new sleep problems. Subjects in the quartile with the highest rise in BMI with a weight gain exceeding 2.06 kg/m^2 had a higher risk of developing DMS [adjusted odds ratio (OR) 1.58; 95% confidence interval (CI) 1.25–2.01), EDS (2.25; 1.65–3.06], and insomnia (2.78; 1.60–4.82). Weight gain was not associated with the development of DIS.
Conclusions: Weight gain is an independent risk factor for developing several sleep problems and daytime sleepiness. The presence of overweight and weight gain should be considered when treating patients with sleep problems.

1. Introduction

In the general population, approximately 6–10% experience insomnia and 30–39% experience sleep problems, and the prevalence rates are increasing [1–3]. Parallel with this, the worldwide prevalence of obesity is increasing rapidly [4]. Cross-sectional studies reveal that sleep problems and daytime sleepiness are associated with obesity [5–10] and the association is independent of the coexistence of obstructive sleep apnea (OSA) [6,11].

Short and long sleep time [12,13] as well as insomnia and sleep problems are risk factors for weight gain [14,15]. Although weight gain is a well-known risk factor for the development of snoring [16] and sleep apnea [17], the impact of weight gain on other sleep problems is still unknown.

The aim of this study was to investigate the role of obesity and weight gain in the development of sleep problems in a population-based cohort.

2. Material and methods

2.1. Population

Two cohorts in the municipality of Uppsala, Sweden, were assessed. Sleep and Health is an ongoing cohort study focusing on the impact of sleeping habits and sleep disorders on health. The male cohort was first investigated in 1984 when 4021 men aged 30–69 years were randomly selected from the population registry for the Municipality of Uppsala, Sweden. All respondents still alive in 1994 ($n = 3201$) were sent a postal questionnaire, with a response rate of 89.7% ($n = 2668$): this constituted the baseline investigation in the present study. All respondents still alive in 2007 ($n = 2231$) were sent a follow-up questionnaire with a response rate of 91.4% ($n = 2040$).

The female cohort was first investigated in 2000 when a baseline postal questionnaire was sent to a random sample of women aged ≥20 years and living in the same area. Of the 7051 women who responded and who were still alive, 6590 were sent a follow-up

Abbreviations: BMI , body mass index; CI, confidence interval; DIS, difficulties initiating sleep; DMS, difficulties maintaining sleep; EDS, excessive daytime sleepiness; GERD, gastroesophageal reflux disease; OR, odds ratio.

The authors have no conflicts of interest to declare.

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questionnaire in 2010 with a response rate of 80.5 % ($n = 5193$) [18]. All men and women who had participated at both baseline and follow-up and who provided information about their height and weight on both occasions were included in the present study ($n = 7012$).

2.2. Questionnaire

All questions used in the analyses were identical at baseline and follow-up for both men and women.

2.3. Body mass index

The body mass index (BMI) was calculated from self-reported body weight in kilograms divided by self-reported height in meters squared (kg/m^2).

Based on BMI, the subjects were categorized into underweight (BMI < 20), normal weight (BMI 20–24.99), overweight (BMI 25–29.99), and obese (BMI > 30). Delta-BMI (Δ-BMI) was defined as BMI at follow-up minus BMI at baseline. Due to a U-shaped association between weight gain and incident sleep problems, it was not possible to use Δ-BMI as a continuous variable. Δ-BMI was therefore divided into quartiles where quartile 1 was subjects with Δ-BMI <–0.32, quartile 2 was Δ-BMI 0.32 to < 0.76, quartile 3 was Δ-BMI 0.76 to <2.06, and quartile 4 was Δ-BMI ≥2.06.

2.4. Leisure-time physical activity

The subjects reported their level of physical activity during leisure time on a four-point scale [19]. In the statistical analysis, the level of physical activity was categorized into three groups. A low level of physical activity was defined as score 1: spending the most time watching television, reading, and being sedentary for most of their leisure time. A medium level was defined as score 2: some physical activity, such as walking and cycling, at least 4 h a week. A high physical activity level was defined as scores 3–4. This included regular participation for 3 h a week or more vigorous exercise on a weekly basis in, for example, swimming, jogging, tennis, and aerobic exercise.

2.5. Smoking

Smoking habits were assessed by six questions [20], and the number of pack-years was calculated based on the responses. The participants were classified into three categories, never smokers (0 pack-years), those with a smoking history of >0 to 19.99 pack-years, and those with a smoking history of ≥20 pack-years.

2.6. Alcohol dependence

Alcohol dependence was analyzed with the CAGE questionnaire (Cut down, annoyed by criticism, guilt about drinking, eye-opener drinks) [21]. Participants answering yes to at least two of the questions were categorized as alcohol dependent.

2.7. Somatic diseases

Somatic diseases were based on self-reported data. Subjects were asked if they had hypertension, heart disorders, diabetes, and asthma, the response options were “yes” or “no.”

Subjects were also asked on a five-graded scale how often they had gastroesophageal reflux (GERD). If the answer was “sometimes,” “often,” or “very often,” they were considered to be suffering from GERD, in contrast to those who answered “rarely” and “never.”

2.8. Snoring

The frequency of snoring loudly and disturbingly was assessed with a five-graded scale. Those who answered “often” or “very often” were considered as snorers, whereas subjects answering “never,” “rarely,” and “sometimes” were considered as non-snorers.

2.9. Sleep problems

The participants were asked to grade, on a five-grade scale how much problem they had with falling asleep at night, with waking up during the night and with sleepiness at daytime. The response options were “none,” “small,” “moderate,” “severe,” and “very severe.” If the subjects answered “severe” or “very severe,” they were considered positive for difficulties in initiating sleep (DIS), difficulties in maintaining sleep (DMS), and excessive daytime sleepiness (EDS).

The variable “insomnia” was defined here as either, or both, DIS and DMS in combination with EDS.

In the subsequent analyses, subjects who developed DIS, DMS, EDS, and insomnia were identified among those who did not report the respective sleep problem at baseline.

2.10. Statistical analyses

Statistical analyses were performed using Stata 12.1 (StataCorp, College Station, TX, USA).

The differences between groups were compared with the χ^2-test for categorical variables and analysis of variance (ANOVA) for continuous variables. Multiple logistic regression analysis was used to examine the statistical independence of the suggested risk factors for developing sleep disorders. The results are presented as odds ratios (ORs) and 95% confidence interval (95% CI). Interaction analysis was added to the multiple logistic regression analysis to examine whether interaction existed between the degree of weight gain and gender, and age and BMI category at baseline. A p-value of <0.05 was considered statistically significant.

2.11. Ethics

Informed consent was obtained from all participants. The Ethics Committee of the Medical Faculty at Uppsala University, Uppsala, Sweden, approved the study.

3. Results

The prevalence of DMS at baseline increased with increasing weight, whereas the prevalence of DIS, EDS, and insomnia was highest both among those who were underweight and those with obesity (Table 1). The prevalence of all measured sleep problems and daytime sleepiness at baseline was higher among women than

Table 1
Prevalence of sleep problems by BMI at baseline by gender (DIS = difficulties inducing sleep, DMS = difficulties maintaining sleep, EDS = excessive daytime sleepiness, insomnia = DIS and/or DMS in combination with EDS).

		n (%)	DIS	DMS	EDS	Insomnia
Men	All	1896	5.1	9.4	5.7	1.8
	BMI <20	34 (1.8)	8.8	8.8	6.1	3.0
	20 ≤ BMI < 25	878 (46.3)	5.0	7.3	4.8	1.6
	25 ≤ BMI < 30	865 (45.6)	4.6	11.1	6.3	1.9
	BMI ≥ 30	119 (6.3)	7.6	13.6	8.5	1.7
Women	**All**	**5116**	**8.2**	**15.0**	**13.9**	**4.3**
	BMI < 20	550 (10.8)	8.8	12.2	16.6	4.7
	20 ≤ BMI < 25	2949 (57.6)	7.3	13.9	12.9	3.8
	25 ≤ BMI < 30	1195 (23.4)	9.0	17.5	14.7	5.0
	BMI ≥ 30	422 (8.3)	10.9	18.8	14.8	5.3