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Obesity and poor sleep quality – prevalences and risk factors from the LIFE-adult-study

Sarah J. Tacke · Alexander Pabst · Melanie Luppa · Janine Stein · Christoph Engel · Heide Glaesmer · Andreas Hinz · Toralf Kirsten · Markus Löffler · Matthias Nüchter · Nigar Reyes · Christian Sander · Kerstin Wirkner · A. Veronica Witte · Maryam Yahiaoui-Doktor · Silke Zachariae · Steffi G. Riedel-Heller · Margrit Löbner · Franziska D. Welzel

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Abstract

Research has linked obesity to poor sleep. Yet, comprehensive large-scale studies are lacking. This study provides prevalence estimates of poor sleep quality among individuals with obesity and associated risk factors. The study sample comprised 1,416 individuals with obesity from the German population-based LIFE-Adult-Study. Assessments included age, sex, body mass index (BMI), socioeconomic status (SES), alcohol, tobacco, caffeine, depressive/anxiety symptoms and fatigue, health-related quality of life. Sleep quality was measured with the Pittsburgh Sleep Quality Index (PSQI). Associations between poor sleep and potential risk factors were analyzed using logistic regression. Poor sleep was reported by 43.5% with prevalence presenting an inverted U-shaped pattern across age groups, peaking at age 50–59 years. Poor sleep quality was associated with female sex (OR = 1.53, 95% CI = 1.15–2.03), low SES (OR = 1.65, 95% CI = 1.08–2.52), smoking (OR = 1.39, 95% CI = 1.01–1.93), frequent caffeine intake (OR = 1.60, 95% CI = 1.23–2.09), depressive symptoms (OR = 1.05, 95% CI = 1.02–1.08), symptoms of anxiety (OR = 1.15, 95% CI = 1.08–1.22) and fatigue (OR = 1.03, 95% CI = 1.01–1.04). Poor sleep quality is highly prevalent among individuals with obesity. Several additional associated factors were identified, highlighting particularly vulnerable subgroups.

Keywords Sleep quality · Obesity · Risk factors · Epidemiology · Pittsburgh Sleep Quality Index

Margrit Löbner and Franziska D. Welzel: These authors jointly supervised to this work.

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Introduction

Obesity is a growing global health issue and has reached pandemic levels with over 890 million adults affected in 2022, according to the World Health Organization (WHO)[1]. In Germany, obesity has risen steadily, with representative data showing an increase in adults with obesity from 12.2% to 19.7% between 2003 and 2023[2]. Obesity is associated with numerous health risks, including type 2 diabetes, cardiovascular disease, cancer and musculoskeletal disorders[3–6]. Additionally, obesity has been shown to contribute to sleep disturbances, partly via increased risk of sleep disordered breathing[7].

Adequate sleep duration and quality are critical for maintaining physiological homeostasis, cognitive performance and emotional regulation[8–12]. Similar to obesity, poor sleep quality has been linked to numerous adverse health outcomes. Previous studies have demonstrated associations between insufficient sleep and increased risks for obesity, type 2 diabetes, cardiovascular disease, various cancers and impaired immune function[11–16]. Sleep is essential for metabolic regulation, supporting glucose homeostasis and insulin sensitivity. Sleep restriction potentially lowers leptin and raises ghrelin, disrupting appetite control and promoting weight gain[11,12]. Irregular sleep can also disturb cortisol rhythms, affecting stress responses and glucose metabolism[8]. In addition, poor sleep is associated with depressive symptoms, symptoms of anxiety and fatigue[9,17].

Sleep quality may independently influence obesity[18–22], though evidence remains inconclusive[23–25]. Estimating the public health burden of poor sleep quality requires robust prevalence data, yet evidence among individuals with obesity is limited and inconsistent. Reported prevalences vary, ranging from 45% in a Dutch cohort awaiting bariatric surgery[26] to 74.8% in a UK sample with extreme obesity[27], with other studies reporting around 50 to 65% across populations with obesity in China, Korea and Iran[20,25,28]. Previous studies have been limited by small sample sizes, non-standardized sleep assessments and inadequate adjustment for potential confounders. Ultimately, sleep quality in individuals with obesity remains under-investigated.

The aim of this study was to determine age- and sex-specific prevalences of poor sleep quality in individuals with obesity and to identify possible risk factors for poor sleep quality within this group using data from a representative large cohort sample.

Methods

Study population

The present study used data of the LIFE-Adult Study, a population-based cohort study with a representative sample of 10,000 randomly selected inhabitants of the city of Leipzig in Germany, conducted by the Leipzig Centre for Civilization Diseases (LIFE). Baseline assessments (BL) were conducted between 2011 and 2014. Participants ranged in age from 18 to 80 years, with a focus on those aged 40–80 years. Further details regarding the study design have been published previously[29].

The sample selection procedure is shown in Fig. 1. Of the $n = 10{,}000$ participants at BL, $n = 2{,}437$ individuals were identified as obese. $N = 36$ participants were excluded due to missing data on body weight and height. An additional $n = 1{,}057$ participants were excluded due to missing data on variables indicating potential risk factors, with missing data on sleep quality assessment ($n = 736$) representing the largest group. The final analytical sample comprised $n = 1{,}416$ individuals with obesity.

Ethics approval and consent to participate

The study protocol of the LIFE-Adult Study was approved by the Ethics Committee of the University Leipzig (approval numbers 263–2009–14122009, 263/09-ff, 201/17-ek) and all participants provided written informed

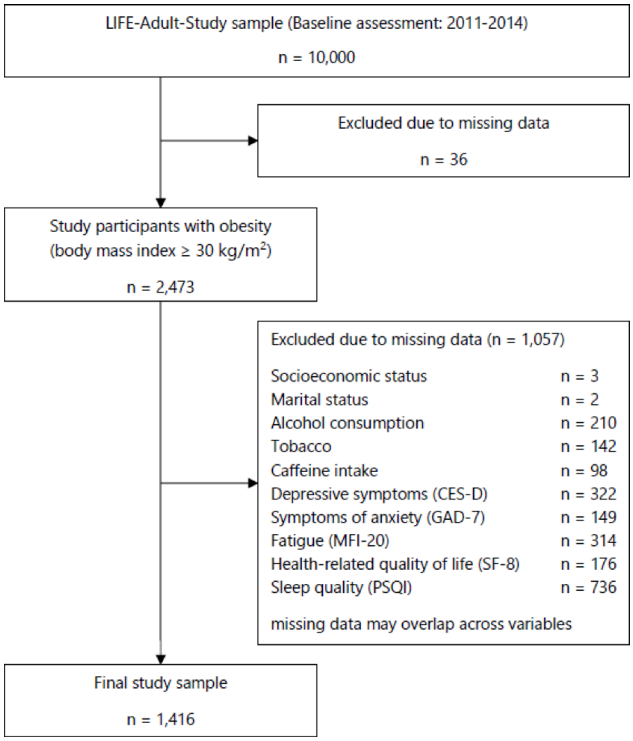

Fig. 1 Workflow of the sample selection. Thirty-six individuals were excluded due to missing data on body weight and height. After identifying two thousand, four hundred seventy-three individuals with obesity, another one thousand fifty-seven individuals were excluded because of missing data in at least one key category potentially influencing sleep quality. Abbreviations: CES-D = Center for Epidemiologic Studies Depression Scale, GAD-7 = Generalized Anxiety Disorder Scale-7, MFI-20 = Multidimensional Fatigue Inventory, SF-8 = Short Form Health Survey, PSQI = Pittsburgh Sleep Quality Index.

consent[29]. All research activities were conducted in accordance with the Declaration of Helsinki and Good Clinical Practice guidelines.

Instruments

Information was collected through structured interviews, standardized questionnaires and physical examination. Body weight (in kilograms, measured with electronic scale SECA 701, Seca Gmbh & Co KG accurate to 0.01 kg) and height (in meters, measured with stadiometer SECA 240 accurate to 0.1 cm) were assessed according to standardized procedures by trained study nurses and therefrom BMI was calculated as weight divided by height squared (kg/m^2)[29]. Obesity was defined as a BMI $\geq$ 30 kg/m^2 according to WHO standard[1]. The socioeconomic status (SES) was categorized in three levels (low, middle, high) based on education, employment status and income[30]. Marital status was classified as married, never married, divorced or widowed.

Alcohol consumption was estimated as the average daily intake in grams (g) over the past year, based on the frequency and quantity of various alcoholic beverages consumed. Smoking status was categorized as current smoker or current non-smoker. Caffeine intake was classified as either daily or less often, or several times a day.

The Pittsburgh Sleep Quality Index (PSQI) is a validated self-report questionnaire assessing sleep quality within the previous month. It consists of 19 items generating 7 component scores (subjective sleep quality, sleep latency, sleep duration, sleep efficiency, sleep disturbances, use of sleep medication and daytime dysfunction) with a score between 0 and 3 each. Overall sleep quality is determined by summing the scores of all components, resulting in a range from 0 to 21. A score higher than 5 is the recommended cut-off indicating poor sleep quality[31]. Accordingly, participants with a PSQI score of 5 or below were classified as having good sleep quality, whereas those with a PSQI score greater than 5 were classified as having poor sleep quality in this study.

Depressive symptoms were assessed using the German version of the Centre of Epidemiologic Studies Depression Scale (CES-D). It consists of 20 items examining depressive symptoms, administered using a 4-point Likert scale based on how often the respondent has experienced the symptom during the past week. All items are scored from 0 to 3, with a sum score ranging from 0 to 60. Higher values indicate more severe depressive symptoms[32].

Symptoms of anxiety were evaluated using the Generalized Anxiety Disorder Screener (GAD-7), which comprises 7 items answered on a 4-point Likert scale from 'Not at all' to 'Nearly every day'. A total score ranging from 0 to 21 is calculated with higher values indicating more severe anxiety symptoms[33].

The Multidimensional Fatigue Inventory (MFI-20) was used to measure fatigue. The instrument consists of 20 items, each rated on a 5-point Likert scale from 'Yes, that is true' to 'No, that is not true', with a total fatigue score ranging from 20 to 100. Higher scores indicate greater levels of fatigue[34].

Health-related quality of life (HRQoL) was assessed using the Short Form Health Survey (SF-8), a brief version of the original SF-36. It includes 8 items that assess perceived health within the past 4 weeks across physical, mental and social domains[35]. A two-dimensional model was applied to generate two uncorrelated component summary scores (physical and mental component summary of HRQoL) using factor loadings. Higher values indicate better HRQoL[36].

Statistical analyses

A post-stratification weighting factor based on the 2011 German census was applied to all analyses to adjust the sample distribution for age and sex and thereby improve representativeness of the study sample. Individuals with missing data in at least one variable of interest were excluded from all statistical analyses.

Categorical variables are presented as unweighted counts and weighted percentages, and continuous variables as weighted means (M) ± standard deviation (SD). Statistical differences between good and poor sleepers, as well as across age and gender, were assessed using χ^2 tests for categorical variables, and independent samples t-tests for continuous variables.

Logistic regression analysis was conducted to examine the association between poor sleep quality (versus good sleep quality) and potential risk factors (age, sex, BMI, SES, marital status, alcohol consumption, smoking status, caffeine intake, depressive symptoms, symptoms of anxiety and fatigue, HRQoL). To preserve data richness, metric variables were treated as continuous in the analysis. Three models were computed: Model 1 included sociodemographic variables (age, sex, BMI, SES, marital status). Model 2 additionally included lifestyle factors (alcohol consumption, smoking status, caffeine intake). Model 3 further incorporated indicators of depressive symptoms, symptoms of anxiety and fatigue and HRQoL. Odds ratios (OR) with corresponding 95% confidence intervals (95% CI) are shown to indicate effects. Wald tests were used to assess the overall significance of categorical variables with more than two categories.

IBM SPSS Statistics 25 (SPSS Inc., Chicago, IL, USA) was used for all calculations. Values of $p<0.05$ were considered statistically significant.

Results

Sample characteristics

The characteristics of the study sample are shown in Table 1.. The mean age was 52.1 years (SD = 13.5), 47.1% were female. 20.5% of participants were classified as having a high SES. The majority of the sample (56.9%) fell into the middle SES category, while 22.6% were categorized as having low SES. The mean BMI was 34.0 kg/m^2 (SD = 3.9).

A sensitivity analysis was conducted to examine differences between included and excluded individuals, assessing potential selection bias regarding sex, age and SES. Excluded individuals were more often female (IN: 47.1% female vs. EX: 55.5% female, χ^2 (1) = 12.72, $p<0.001$), older (IN: M = 52.1 years vs. EX: M = 62.7 years, t (1704) = −18.29, $p<0.001$), and had a lower SES (IN: 22.6% low SES, 56.9% middle SES, 20.5% high SES vs. EX: 34.7% low SES, 57.6% middle SES, 7.7% high SES, χ^2 (2) = 71.25, $p<0.001$) compared to included participants.

Table 1 Sociodemographic characteristics of the study sample.

	Total sample (n = 1,416)	PSQI ≤ 5 Good sleep quality (n = 795)	PSQI > 5 Poor sleep quality (n = 621)	p_a
Age, years				
Mean ± SD	52.1 ± 13.5	52.2 ± 13.5	52.0 ± 13.4	0.815
Range	20–79	23–79	20–79	
Sex, n (%)				
Male	708 (52.9)	451 (58.3)	257 (45.8)	< 0.001
Female	708 (47.1)	344 (41.7)	364 (54.2)	
Body mass index, kg/m^2				
Mean ± SD	34.0 ± 3.9	33.8 ± 3.8	34.2 ± 4.0	0.057
Socioeconomic status, n (%)				
High	290 (20.5)	192 (24.6)	98 (15.2)	< 0.001
Middle	858 (56.9)	483 (58.6)	375 (54.6)	
Low	268 (22.6)	120 (16.7)	148 (30.2)	
Marital status, n (%)				
Married	928 (56.7)	544 (58.6)	384 (54.3)	0.361
Never married	224 (27.3)	119 (26.8)	105 (27.8)	
Divorced	194 (12.4)	96 (11.3)	98 (13.8)	
Widowed	70 (3.6)	36 (3.3)	34 (4.0)	
Alcohol consumption, g/day				
Mean ± SD	12.7 ± 19.7	13.8 ± 20.8	11.1 ± 18.2	0.017
Tobacco, n (%)				
Current non-smoker	1,151 (76.5)	667 (79.6)	484 (72.4)	0.003
Current smoker	265 (23.5)	128 (20.4)	137 (27.6)	
Caffeine intake, n (%)				
Daily or less often	747 (52.7)	440 (57.0)	307 (47.1)	0.001
Several times a day	669 (47.3)	355 (43.0)	314 (52.9)	
Sleep quality (PSQI), mean ± SD	5.8 ± 3.1	3.6 ± 1.2	8.6 ± 2.6	< 0.001
Depressive symptoms (CES-D), mean ± SD	11.0 ± 7.1	8.8 ± 5.3	13.9 ± 8.1	< 0.001
Symptoms of anxiety (GAD-7), mean ± SD	3.5 ± 3.3	2.5 ± 2.8	4.8 ± 3.5	< 0.001
Fatigue (MFI-20), mean ± SD	43.8 ± 14.1	39.5 ± 12.1	49.4 ± 14.6	< 0.001
Physical HRQoL (SF-8), mean ± SD	46.0 ± 8.6	47.6 ± 7.9	44.0 ± 8.9	< 0.001
Mental HRQoL (SF-8), mean ± SD	52.4 ± 8.5	54.4 ± 7.0	49.8 ± 9.6	< 0.001

Of the total 1,416 participants, 621 (43.5%) were classified as poor sleepers. The mean global PSQI score was 5.8 (SD = 3.1). In univariate analysis, poor sleepers were significantly more likely to be female (54.2% vs. 41.7%, $p < 0.001$), had a lower SES (30.2% vs. 16.7% low SES, $p < 0.001$), consuming less alcohol (M = 11.1 g/day vs. M = 13.8 g/day, $p = 0.017$), more often currently smoking (27.6% vs. 20.4%, $p = 0.003$) and consuming caffeine several times a day (52.9% vs. 43.0%, $p = 0.001$). Individuals classified as poor sleepers showed significantly more depressive symptoms (M = 13.9 vs. M = 8.8, $p < 0.001$), symptoms of anxiety (M = 4.8 vs. 2.5, $p < 0.001$), fatigue (M = 49.4 vs. 39.5, $p < 0.001$) and scored lower in both physical (M = 44.0 vs. 47.6, $p < 0.001$) and mental (M = 49.8 vs. 54.4, $p < 0.001$) HRQoL. Notably, the two groups did not differ in age, BMI and marital status.

Prevalence of poor sleep quality

Table 2 displays age- and sex-specific prevalences of poor sleep quality. Overall, 43.5% (95% CI = 40.7–46.3) of participants were classified as poor sleepers. Specifically, 37.7% (95% CI = 33.9–41.5) of men and 50.0% (95%

Table 2 Prevalence of poor sleep quality (PSQI > 5) among German adults with obesity stratified by age and sex.

	Total		Men		Women		p_a
	n/*N*	% (95% CI)	*n*/*N*	% (95% CI)	*n*/*N*	% (95% CI)	
Total	621/1,416	43.5 (40.7–46.3)	257/708	37.7 (33.9–41.5)	364/708	50.0 (45.9–54.1)	< 0.001
Age group (years)							
≤ 39	12/34	38.4 (31.8–45.0)	7/21	37.0 (29.0–46.0)	5/13	40.5 (30.8–51.7)	0.634
40–49	153/348	43.5 (38.1–49.1)	64/163	39.3 (31.9–47.0)	89/185	47.9 (40.1–56.0)	0.121
50–59	209/409	50.9 (45.5–56.4)	86/192	45.2 (37.7–52.8)	123/217	57.0 (48.9–64.4)	0.038
60–69	170/429	39.3 (33.6–45.7)	60/208	29.0 (21.6–37.4)	110/221	49.6 (40.9–58.3)	0.001
≥ 70	77/196	40.7 (31.4–49.4)	40/124	32.2 (21.6–44.5)	37/72	51.3 (37.3–64.6)	0.046

a Group differences between men and women were tested using χ^2 test. Significance level 0.05.

N = unweighted total count, n = unweighted count of poor sleep quality, % = percentages weighted by age and sex according to the 2011 census data, CI = confidence interval.

CI = 45.9–54.1) of women reported poor sleep quality. Women presented a higher prevalence of poor sleep quality compared to men in total ($p < 0.001$).

The prevalence of poor sleep quality followed an inverted U-shaped pattern across age groups. The highest prevalence was observed in midlife (50–59 years), where 50.9% (95% CI = 45.5–56.4) reported poor sleep quality. The lowest prevalence was found in the youngest age group (≤ 39 years) at 38.4% (95% CI = 31.8–45.0).

The same trend can be seen in both men and women. Among women, the prevalence of poor sleep quality increased progressively from those aged ≤ 39 years (40.5%, 95% CI = 30.8–51.7) to 50–59 years (57.0%, 95% CI = 48.9–64.4). In men, increasing prevalence of poor sleep quality from age group ≤ 39 years (37.0%, 95% CI = 29.0–46.0) to 50–59 years (45.2%, 95% CI = 37.7–52.8) can be found as well. Among individuals aged 50–59 years and older, women reported poor sleep quality more often than men (50–59 years: $p = 0.038$, 60–69 years: $p = 0.001$, ≥ 70 years: $p = 0.046$). No comparable effect of sex is evident in younger age groups.

Associations of risk factors with poor sleep quality

Table 3 shows the detailed results of the logistic regression analysis across the three models. In Model 1, female sex (OR = 1.52, 95% CI = 1.20–1.93) and lower SES (low SES: OR = 2.68, 95% CI = 1.85–3.89, middle SES: OR = 1.41, 95% CI = 1.03–1.93) were independently associated with poor sleep quality. After including lifestyle factors in Model 2, female sex (OR = 1.56, 95% CI = 1.21–2.02), lower SES (low SES: OR = 2.66, 95% CI = 1.82–3.89, middle SES: OR = 1.47, 95% CI = 1.07–2.02) and frequent caffeine intake (several times per day, OR = 1.53, 95% CI = 1.20–1.95) were identified as significant predictors of poor sleep quality. Model 3 additionally included depressive symptoms, symptoms of anxiety, fatigue and HRQoL. In this model, female sex (OR = 1.53, 95% CI = 1.15–2.03), low SES (OR = 1.65, 95% CI = 1.08–2.52), active smoking (OR = 1.39, 95% CI = 1.01–1.93), frequent caffeine intake (OR = 1.60, 95% CI = 1.23–2.09), depressive symptoms (OR = 1.05, 95% CI = 1.02–1.08), symptoms of anxiety (OR = 1.15, 95% CI = 1.08–1.22) and fatigue (OR = 1.03, 95% CI = 1.01–1.04) were found to be independently associated with poor sleep quality. Notably, a statistically significant association between active smoking and sleep quality emerged only in Model 3.

The CES-D included one item related to sleep ("My sleep was restless"). To evaluate the potential influence of the sleep related item on the observed association between depressive symptoms and poor sleep quality, a sensitivity analysis was performed for Model 3. The results of this sensitivity analysis can be found as Supplementary Table S1 online. Following the exclusion of this item, depressive symptoms were no longer significantly associated with poor sleep quality (OR = 1.01, 95% CI = 0.98–1.04).

Sleep quality was unrelated to age, BMI, marital status, alcohol consumption, physical or mental HRQoL in either model.

Table 3 Logistic regression analysis of the association of poor sleep quality and potential risk factors in German adults with obesity.

Variables	Model 1		Model 2		Model 3	
	OR (95% CI)	*p*	OR (95% CI)	*p*	OR (95% CI)	*p*
Age	1.00 (0.99–1.01)	0.705	1.00 (0.99–1.02)	0.409	1.01 (1.00–1.02)	0.191
Sex	Ref.	0.001	Ref.	0.001	Ref.	0.004
Male	1.52 (1.20–1.93)		1.56 (1.21–2.02)		1.53 (1.15–2.03)	
Female						
Body mass index	1.01 (0.98–1.05)	0.342	1.01 (0.98–1.05)	0.392	0.99 (0.96–1.03)	0.692
Socioeconomic status	Wald $X^2=29.26$	<0.001	Wald $X^2=26.80$	<0.001	Wald $X^2=7.20$	0.027
High	Ref.	0.030	Ref.	0.017	Ref.	0.631
Middle	1.41 (1.03–1.93)	<0.001	1.47 (1.07–2.02)	<0.001	1.09 (0.77–1.55)	0.021
Low	2.68 (1.85–3.89)		2.66 (1.82–3.89)		1.65 (1.08–2.52)	
Marital status	Wald $X^2=0.19$	0.980	Wald $X^2=0.14$	0.987	Wald $X^2=0.20$	0.977
Married	Ref.	0.904	Ref.	0.869	Ref.	0.737
Never married	1.02 (0.73–1.43)	0.695	1.03 (0.73–1.44)	0.762	0.94 (0.65–1.36)	0.722
Divorced	1.08 (0.74–1.56)	0.825	1.06 (0.73–1.54)	0.822	0.93 (0.61–1.40)	0.962
Widowed	1.07 (0.57–2.03)		1.08 (0.57–2.05)		1.02 (0.50–2.07)	
Alcohol consumption			1.00 (0.99–1.01)	0.718	1.00 (0.99–1.01)	0.937
Tobacco			Ref.	0.058	Ref.	0.046
Current non-smoker			1.33 (0.99–1.79)		1.39 (1.01–1.93)	
Current smoker						
Caffeine intake			Ref.	0.001	Ref.	<0.001
Daily or less often			1.53 (1.20–1.95)		1.60 (1.23–2.09)	
Several times a day						
Depressive symptoms (CES-D)					1.05 (1.02–1.08)	0.003
Symptoms of anxiety (GAD-7)					1.15 (1.08–1.22)	<0.001
Fatigue (MFI-20)					1.03 (1.01–1.04)	<0.001
Physical HRQoL (SF-8)					0.99 (0.97–1.01)	0.269
Mental HRQoL (SF-8)					1.01 (0.99–1.04)	0.381

Significance level 0.05. OR = odds ratio, CI = confidence interval, Ref. = reference category, CES-D = Center for Epidemiologic Studies Depression Scale, GAD-7 = Generalized Anxiety Disorder Scale-7, MFI-20 = Multidimensional Fatigue Inventory, SF-8 = Short Form Health Survey, HRQoL = health-related quality of life.

Discussion

The aim of the present study was to assess sleep quality in adults with obesity and to identify risk factors associated with poor sleep quality. Prevalence of poor sleep quality was 43.5% in adults with obesity, and revealed an inverted U-shaped pattern across age groups with the highest prevalence in age group 50–59 years. Women presented significantly higher prevalences overall and specifically among those aged 50 years and older. Multivariate logistic regression analysis revealed female sex, lower SES, active smoking, frequent caffeine intake and mental health burden (specifically anxiety symptoms and fatigue) as risk factors for poor sleep quality.

Previous studies have reported prevalence estimates of poor sleep quality ranging from 45%[26] to 74.8%[27], with the majority estimating prevalences close to 65%[20,25,28]. The in comparison to previous studies lower prevalence observed in the present study may be attributed to differences in sample characteristics. This study analyzed a large, population-based sample, offering a broader and representative perspective compared to previous research that often focused on smaller cohorts in specific subgroups. Although these findings indicate lower prevalences compared to other studies involving individuals with obesity, they remain high, underscoring the widespread nature of sleep impairment within this group.

Obesity in adults is frequently associated with sleep disturbances, including reduced sleep quality[18–22]. Sleep restriction has been associated with alterations in key hormones involved in energy homeostasis, comprising decreased leptin and increased ghrelin, impaired insulin sensitivity and elevated evening cortisol levels[8,10–12]. Such hormonal changes may enhance appetite, reduce satiety, promote adiposity and contribute to chronic

low-grade inflammation[11,12]. These factors parallel and potentially exacerbate the metabolic profile observed in obesity[4]. Furthermore, the resultant neuroendocrine alterations may impede weight loss efforts, perpetuating a cycle of poor sleep and weight gain[37,38].

Age is an established risk factor for poor sleep quality with increasing age being positively associated with sleep disturbances[39]. The peak prevalence of poor sleep quality among individuals aged 50–59 years may reflect age-related physiological and psychosocial changes. This age group often experiences the onset of chronic health conditions[40] and menopausal transitions in women[41], which can negatively impact sleep, especially along with work-related stress, which may act as a mediating factor[8].

Women showed higher prevalences of poor sleep quality in total and among individuals aged 50 and above. A combination of biological, psychological and sociocultural factors may contribute to sex-based differences in sleep patterns and disturbances[42]. Hormonal fluctuations across the menstrual cycle and menopause can disrupt sleep patterns[41,43]. Additionally, women are more likely to experience anxiety and depression[44,45], both of which are linked to sleep disturbances[9]. Social roles and caregiving responsibilities may also contribute to reduced sleep duration and quality[46].

In line with previous research, the present study observed a link between lower SES and reduced sleep quality[10,47]. The relationship may be mediated by factors such as adverse lifestyle behaviors, a higher burden of chronic disease, elevated psychological stress and limited access to healthcare[47]. Interestingly, BMI was not significantly associated with poor sleep quality in this sample, indicating that body weight may not be a key determinant of sleep quality once obesity is established.

Lifestyle factors and behavior play a key role in the development and progression of both obesity and poor sleep quality[11]. By blocking the neuromodulator adenosine, which typically promotes sleep pressure, caffeine increases alertness and delays sleep onset, particularly when consumed later in the day[48]. The observed inverse association between alcohol consumption and poor sleep quality may reflect the short-term sedative effects of alcohol. However, the association in univariate analysis was not confirmed by the logistic regression analysis, suggesting that other variables may serve as more important predictors. Smoking was associated with poor sleep quality only in Model 3, which included measures of mental well-being. This may indicate a close relationship with shared underlying factors between smoking and mental health, as individuals with psychological conditions are more likely to engage in smoking behavior[49].

A growing body of evidence suggests that impaired sleep and elevated depressive and anxiety symptoms are closely interconnected[9,50]. Individuals experiencing depressive symptoms often report difficulties initiating and maintaining sleep, as well as non-restorative sleep[51]. Similarly, anxiety is associated with heightened physiological arousal and cognitive hyper activation[52], which can interfere with the ability to fall or stay asleep. Fatigue has been reported alongside poor sleep and may serve both as a symptom and a contributing factor[17]. Accordingly, this study demonstrates an association of psychological distress and poor sleep quality. Notably, after excluding the sleep related item from the CES-D, depressive symptoms showed no significant association with poor sleep quality. This finding suggests that the initially observed association may be attributable to conceptual overlap between sleep disturbances as a depressive symptom and the sleep quality outcome measure. It further indicates that depressive symptoms, independent of sleep disturbances, may not be sufficient to predict poor sleep quality in this sample. Yet, the cross-sectional design of this study does not allow causal interferences. Future longitudinal analyses are needed to clarify the temporal relationship between psychological symptoms and sleep. Previous longitudinal studies suggest that mental health-related symptoms may contribute to sleep disturbances, whereas impaired sleep can contribute to the onset or worsening of psychological symptom severity[9,50,53]. Such reciprocal effects may result in a cyclical mechanism in which both conditions mutually influence each other, potentially increasing symptom burden and impairing recovery.

Further research is needed to clarify underlying pathophysiological mechanisms and causal pathways, including the role of additional potential confounding and mediating factors. Moreover, studies in more diverse populations are necessary to obtain a more comprehensive understanding of human health.

Strengths and limitations

This study has several strengths. The large cohort enhances statistical power and supports robust subgroup analyses. Representativeness is improved through the application of a weighting factor, validated instruments were used to ensure reliable measurement. Additionally, the study accounts for important sociodemographic information, behavioral factors and other potential influences on sleep quality to strengthen the validity of the findings.

The limitations of this study include the potential for selection bias resulting from the exclusion of individuals with missing data on key outcome variables. Since the excluded group shares similar characteristics with the group of higher risk for poor sleep quality, the observed associations may be conservative, potentially underestimating the true effect. Individuals under the age of 40 years were considerably underrepresented due to the LIFE-Adult-Study design[29]. As obstructive sleep apnea (OSA) was not assessed within the scope of the LIFE-Adult-Study, the relationship between obesity, OSA and sleep quality could not be investigated. Future studies are needed to clarify the potential causal pathway underlying these associations. Another limitation is the use of self-report assessments. Prevalence and magnitude may differ between self-reported and objectively measured data. However, the study applied validated instruments, which provide reliable estimates in large-scale cohorts where objective measurement is impractical. Finally, no causal relationships can be established due to the cross-sectional design of the study.

Conclusion

In summary, sleep quality among adults with obesity in Germany appears to be low. More than 40% of the participants with obesity in this population-based cohort reported poor sleep quality. Factors associated with poor sleep quality included female sex, low SES, active smoking, frequent caffeine intake and poor mental health, most notably symptoms of anxiety and fatigue. These findings underscore the increased vulnerability of individuals with obesity to disturbed sleep. Given the important role of sleep in obesity development and management, greater attention should be directed toward sleep quality in both clinical and public health settings. Routine assessment of sleep disturbances in individuals with obesity or at risk for obesity may support more effective prevention and treatment strategies by addressing a potential bidirectional relationship. This may also reduce the risk of obesity-related comorbidities, including cardiovascular diseases, type 2 diabetes and psychological distress.

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Data availability The datasets generated and/or analysed during the current study are not publicly available due to privacy protection but are available from the LIFE-Adult-Study to researchers who submit a written proposal, including objectives, measures, names of all researchers involved, and how results and newly generated data will be returned for further use. Inquiries should be submitted to info-life@lists.uni-leipzig.de.

Declarations

Competing interests The authors declare no competing interests.

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Authors and Affiliations

Sarah J. Tacke[1] · Alexander Pabst[1] · Melanie Luppa[1] · Janine Stein[1] · Christoph Engel[3] · Heide Glaesmer[4] · Andreas Hinz[4] · Toralf Kirsten[5] · Markus Löffler[3] · Matthias Nüchter[6] · Nigar Reyes[3] · Christian Sander[6,7] · Kerstin Wirkner[6] · A. Veronica Witte[2,8,9] · Maryam Yahiaoui-Doktor[10] · Silke Zachariae[3,6] · Steffi G. Riedel-Heller[1,2] · Margrit Löbner[1,2] · Franziska D. Welzel[1]

✉ Sarah J. Tacke
sarah.tacke@mailbox.org

[1] Institute of Social Medicine, Occupational Health and Public Health, Medical Faculty, University of Leipzig, Leipzig, Germany

[2] LeiCeM – Leipzig Center of Metabolism, University of Leipzig, Leipzig, Germany

[3] Institute for Medical Informatics, Statistics and Epidemiology, University of Leipzig, Leipzig, Germany

[4] Department of Medical Psychology and Medical Sociology, University of Leipzig, Leipzig, Germany

[5] Department Medical Data Science at the Medical Informatics Center, University of Leipzig, Leipzig, Germany

[6] Leipzig Research Centre for Civilization Diseases (LIFE), University of Leipzig, Leipzig, Germany

[7] Department of Psychiatry and Psychotherapy, University of Leipzig Medical Center, Leipzig, Germany

[8] Department of Neurology, Max Planck Institute for Human Cognitive and Brain Sciences, Leipzig, Germany

[9] Clinic for Cognitive Neurology, University of Leipzig Medical Center, Leipzig, Germany

[10] TÜV Thüringen e.V, Fuggerstr. 1d, 04158 Leipzig, Germany