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Gender-based differences in the association of self-reported sleep duration with cardiovascular disease and diabetes

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Abstract

Objective Insufficient or prolonged sleep each day may contribute to the onset of cardiovascular disease and diabetes, and there may be some variability between genders; however, current research evidence is limited. We aimed to investigate the effects of gender on self-reported sleep duration and the prevalence of cardiovascular disease and diabetes.

Research design and methods This study is a population-based, cross-sectional analysis. Data from a nationally representative sample of US adults obtained from the National Health and Nutrition Examination Survey (NHANES) (2005–2020), and 13,002 participants, including 6,774men and 6,228women, were obtained by excluding the missing values for each variable self-reported sleep duration data obtained by using a habitual baseline questionnaire. Logistic regression models investigated the associations between gender-specific self-reported sleep duration, CVDs, and diabetes events.

Result In all participants, respectively, compared with sleep 7–8 h/day, the multivariable-adjusted odds ratios significantly associated with < 7 h /day and > 8 h /day were (1.43[1.15, 1.78]) and (1.34[1.01, 1.76]) for CHF, (1.62[1.28, 2.06]) for Angina, (1.42[1.17, 1.71]) for heart attack, (1.38[1.13, 1.70]) and (1.54[1.20, 1.97]) for Stroke, (1.21[1.09, 1.35]) and (1.28[1.11, 1.48]) for diabetes. In men, CHF (1.67[1.21, 2.14]), Angina (1.66[1.18, 2.15]), Stroke (1.55[1.13,1.97]), and diabetes (1.15[1.00, 1.32]) were significantly associated with < 7 h /day, and stroke (1.73[1.16, 2.32]) and diabetes (1.32[1.06, 1.52]) were significantly associated with > 8 h /day. In women, angina(1.83[1.16, 2.50]), heart attack(1.63[1.11, 2.15]), and diabetes (1.32[1.11, 1.54]) were significantly associated with < 7 h /day, while diabetes (1.31[1.03, 1.59]) was significantly associated with > 8 h /day.

Conclusion Self-reported long and short sleep duration was independently associated with partial CVDs and diabetes risk. However, sleep duration and gender did not have multiplicative or additive interactions with the onset of diabetes and CVDs.

Keywords Diabetes, Cardiovascular disease, Gender, Sleep, Regression

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Introduction

It has been widely recognized that sleep is closely related to health, that sleep is necessary for the performance of emotional and physical functions, and that good quality sleep can help the body maintain a high level of energy in daily activities [1, 2]. The American Academy of Sleep Medicine (AASM) and the Society for Sleep Research (SRS) recommend that adults should aim for an optimal self-reported sleep duration of 7–8 h per night [3, 4]. However, recent epidemiological analysis indicates that nearly two-fifths of American adults sleep less than seven hours per night, with only 45% achieving the recommended amount [5].

Gender encompasses biological and sociocultural aspects that differentiate individuals in terms of their constitution, identity, roles, behaviors, and expressions. Recent studies have indicated that inadequate sleep is associated with an increased risk of cardiovascular disease and diabetes [6, 7]. Moreover, studies have shown disparities in the risk of cardiovascular disease and diabetes between men and women. Therefore, further investigation is warranted to determine whether divergent sleep patterns between genders affact susceptibility to cardiovascular disease and diabetes [8, 9]. However, limited research has explored the specific association between self-reported sleep duration and these conditions, particularly in relation to gender-specific differences.

Consequently, we conducted this study using data from the US National Health and Nutrition Examination Survey (NHANES) conducted between 2005 and 2020. This study aimed to examine the relationship between self-reported sleep duration and the risk of cardiovascular disease and diabetes, while also considering the potential gender differences in this association.

Materials and methos

Study design and sample

The National Center for Health Statistics (NCHS) is an ongoing national survey of the health and nutritional status of the general American population. The NCHS Institutional Review Committee approved the NHANES research plan, and all participants provided written informed consent. This study is a population-based, cross-sectional analysis. Data from a nationally representative sample of US adults was obtained from the National Health and Nutrition Examination Survey (NHANES)(2005–2020).

In this study, we excluded participants who did not participate in the recording of cardiovascular disease content ($n=3204$), those who did not record self-reported sleep duration ($n=24557$), and those who did not record diabetes, covariates, and content data loss ($n=35733$). Finally, 13,002 participants were included in this study (Fig. 1).

Cardiovascular disease: outcome

During the personal interviews, a standardized health questionnaire was used to assess various health problems, including heart failure, coronary heart disease, angina pectoris, heart attack, and stroke. "Have doctors or other health professionals ever informed you that you suffer from heart failure/coronary heart disease/angina pectoris/heart disease/stroke?" It was a question for the participants (this was a group of five questions with exact wording). If participants answer "Yes" to any previous questions, these questions will be classified as CVD cases.

Measurement of diabetes

Diabetes status groups were defined as follows: diabetes self-report of a physician or health care professional diagnosis, fasting blood glucose > 7 mmol/L, or HbA1c ≥ 6.5%, confirmed as diabetes.

Self-reported sleep duration

The definition was based on the "sleep disorders" data in the "NHANES Questionnaire." Question SLQ012 asked, "Number of hours usually sleep on weekdays or workdays." The participants answered regarding their self-reported sleep duration and hours rounded to the nearest half-hour. Self-reported sleep duration analysis is both a continuous and a categorical variable. Self-reported sleep duration was classified into three groups: self-reported sleep duration < 7 h/day, 7 h/day ≤ self-reported sleep duration ≤ 8 h/day, and 8 h/day < self-reported sleep duration. The reference average self-reported sleep duration was 7–8 h/day ("short" self-reported sleep duration: <7 h/day; "long" self-reported sleep duration: >8 h/day.

Covariates

According to the statement on the NHANES website, all research centers collected data from trained personnel using standardized procedures. Demographic characteristics included age(years), gender (male, female), race(American Mexican American,

Other Hispanic, non-Hispanic white, non-Hispanic black, and other races), chronic diseases included (hypertension and high cholesterol), lifestyle behavior(drinking and smoking), and examination data (BMI). Gender is defined as gender identity.

Chronic diseases were assessed using self-reported medical history, and participants were asked if a doctor or other health professional told them to have a specific health condition, including hypertension (yes or no) and high cholesterol (yes or no). Participants were asked, 'Do you smoke every day now?' If the participants answer "Yes," they are classified as smokers. Similarly, participants were asked,' Have you ever drunk 4/5 or more alcohol every day?' If participants answer "Yes," they are

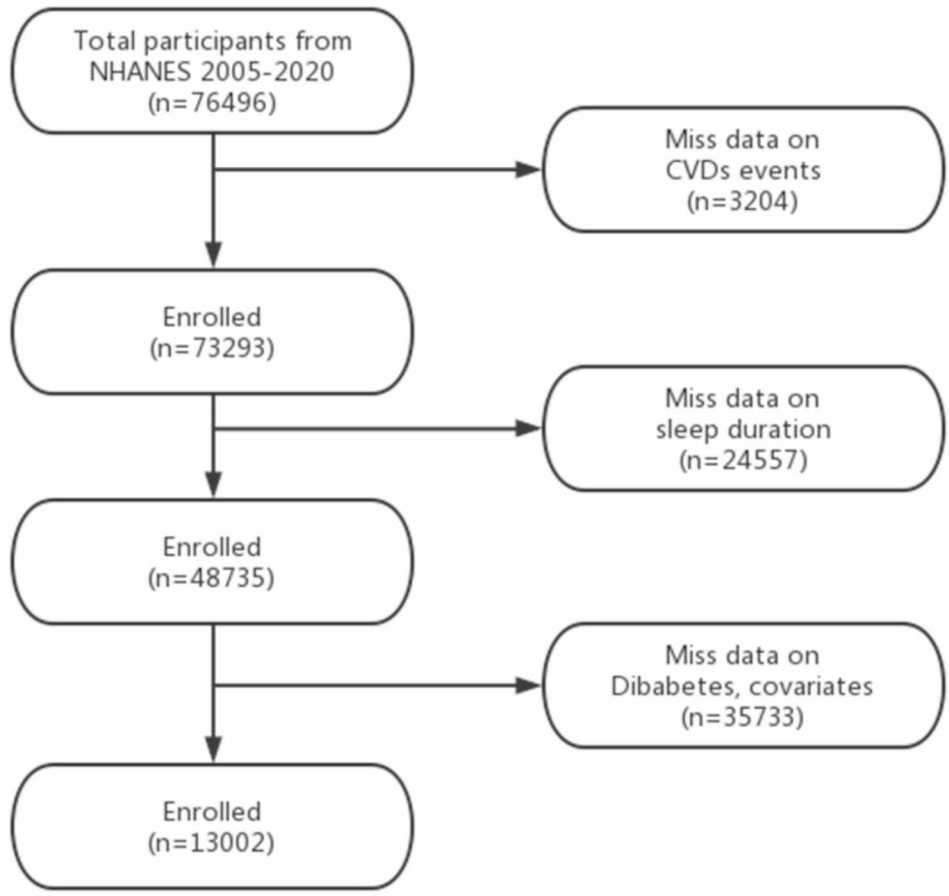

Fig. 1 Flow chart of sample selection

classified as drinkers. Body mass index calculated in kilograms per square meter (kg/m2).

The study employed logistic regression models to adjust for confounding variables such as age, race, gender, BMI, alcohol consumption, diabetes, smoking, and hypertension to examine the overall associations between self-reported sleep duration and CVDs risk.

Statistical analysis

The extraction and merging of NHANES data from 2005 to 2020 used R Studio (version 4.2.2). All analyses used SPSS version 26.0 (IBM Corporation, Armonk, New York, USA) [10].

Non-normally distributed continuous variables are expressed as medians and quartiles and compared using nonparametric tests. For categorical variables, frequencies and percentages were reported, and the chi-square test was used for comparison. The association between Baseline self-reported sleep duration (<7 h/day and >8 h/day) and the risk of CHF, CHD, Angina, Heart attack, Stroke, and Diabetes was examined using a logistic regression risk model, with 7–8 h/day serving as the reference odds ratios(ORs) with 95% confidence intervals (CIs) were estimated from the model after adjusting for confounders. Adjusted confounders included age, race, BMI, drinker, smoker, and hypertension.

Multiplicative interaction analysis using a logistic regression model, additive interaction analysis using R Studio, the relative excess risk of interaction (RERI), the attributable proportion of interaction (AP), and the Synergy Index (SI) were calculated. The 95% CI of RERI and AP did not contain 0, the 95% CI of Si did not contain 1, and the two-sided $P<0.05$ was statistically significant.

Patient and public involvement statement

Collecting, collating, and analyzing sample data from the NHANES database completed this study. While the NHANES database has been collecting patient information, the findings from this survey will be used to determine the prevalence of major diseases and their risk factors. This information can be used to assess nutritional status and its association with health promotion and disease prevention. NHANES findings are also the basis for national measurement standards, such as height, weight, and blood pressure. Epidemiological studies and health sciences research will use data from this survey to help

Table 1 Baseline characteristics of participants by different sexes

	Total (13002)	Male (6774)	Female (6228)	*P*-value
Age, Median(q1-q3)	51.00(37.00–65.00)	52.00(38.00–65.00)	50.00(36.00–63.00)	< 0.001
BMI, Median(q1-q3)	28.30(24.60-32.96)	28.10(24.90–31.90)	28.67(24.23–34.20)	< 0.001
Race(%)				< 0.01
Mecican American	1685(13.0)	903(13.3)	782(12.6)	
Other Hispanic	1276(9.8)	660(9.7)	616(9.9)	
Non-Hispanic white	5902(45.4)	3079(45.5)	2823(45.3)	
Non-Hispanic black	2785(21.4)	1376(20.3)	1409(22.6)	
Other race	1354(10.4)	756(11.2)	598(9.6)	
Drinking(%)				< 0.001
Yes	2115(16.3)	1575(23.3)	540(8.7)	
No	10,887(83.7)	5199(76.7)	5688(91.3)	
Smoking(%)				
Yes	6477(49.8)	3847(56.8)	2630(42.2)	< 0.001
No	6525(50.2)	2927(43.2)	3598(57.8)	
Hypertension(%)				= 0.15
Yes	5108(39.3)	2701(39.9)	2407(38.6)	
No	7894(60.7)	4073(60.1)	3821(61.4)	
High cholesterol(%)				< 0.01
Yes	5004(38.5)	2692(39.7)	2312(37.1)	
No	7998(61.5)	4082(60.3)	3916(61.9)	
Sleep duration(%)				< 0.001
< 7 h/day	4390(33.8)	2389(35.3)	2001(32.1)	
7–8 h/day	6946(53.5)	3596(50.1)	3350(52.8)	
> 8 h/day	1666(12.8)	789(11.6)	877(14.1)	

Abbreviations: NHANES: National Health and Nutrition Examination Survey; BMI: Body mass index; CHF: Congestive heart failure; CHD: Coronary heart disease

P- value for difference between males and females, compared by Non-parametric test for Non-normally distributed continuous variable and chi-squared test for categorical variables, $p < 0.05$ identifies statistical significance

develop sound public health policies, direct and design health programs and services, and expand national health knowledge.

Result

Baseline characteristics

Of the 13,002 participants (6774 men and 6228 women) shown in Tables 1 and 33.76%, 53.42%, and 12.81% reported sleeping < 7, 7–8 and > 8 h/day, respectively. The mean age of eligible participants was 51 ± 13.13 years; women comprised 47.9% of the study population. BMI was available for all participants, and the mean BMI was 29.49 ± 7.16. Self-reported sleep duration identified significant gender differences: women seemed to sleep more than men. Additionally, men had a higher prevalence of diabetes and cardiovascular disease, higher rates of alcohol consumption and smoking, higher cholesterol levels, and lower obesity (Tables 1 and 2).

Table 2 Outcome characteristics of participants by different sexes

	Total(13002)	Male(6774)	Female(6228)	*P*-value
CHF(%)				< 0.01
Yes	451(3.5)	267(3.9)	184(3.0)	
No	12,551(96.5)	6507(96.1)	6044(97.0)	
CHD(%)				< 0.001
Yes	598(4.6)	446(6.6)	152(2.4)	
No	12,404(95.4)	6328(93.4)	6076(97.6)	
Angina(%)				< 0.001
Yes	370(2.8)	231(3.4)	139(2.2)	
No	12,632(97.2)	6543(96.6)	6089(97.8)	
Heart attact(%)				< 0.001
Yes	617(4.7)	424(6.3)	193(3.1)	
No	12,385(95.3)	6350(93.7)	6035(96.9)	
Stroke(%)				= 0.3
Yes	535(4.1)	289(4.3)	246(3.9)	
No	12,467(95.9)	6485(95.7)	5982(96.1)	
Diabetes(%)				< 0.001
Yes	2502(19.2)	1458(21.5)	1044(16.8)	
No	10,500(80.8)	5316(78.5)	5184(83.2)	

Abbreviations: CHF: Congestive heart failure; CHD: Coronary heart disease

P-value for difference between males and females, compared by Non-parametric test for Non-normally distributed continuous variable and chi-squared test for categorical variables, $p < 0.05$ identifies statistical significance

Overall and gender-specific associations between self-reported sleep duration and CVDs risk

Findings revealed that self-reported sleep durations of less than 7 h/day were associated with statistically significant increased risks for all CVDs, except CHD, compared to the reference group of 7–8 h of sleep. The adjusted odds ratios (ORs) for incident CVDs were as follows: (1.43 [1.15, 1.78]) for CHF, (1.62 ([1.28, 2.06]) for angina, (1.42 [1.17, 1.71]) for heart attack, and (1.38 [1.13, 1.70]) for stroke. Self-reported sleep durations exceeding 8 h/day were associated with a 34% higher risk of CHF (1.34 [1.01, 1.76]) and a 54% higher risk of stroke (1.54 [1.20, 1.97]). According to the self-reported sleep duration, there was a U-shaped relationship between CVDs and long sleep duration and short sleep duration (Table 3).

Figure 2 presents the gender-specific associations between self-reported sleep duration and CVDs. Among women, self-reported sleep durations of less than 7 h/day were associated with an 84% higher risk of angina (1.83 [1.16, 2.50]) and a 63% higher risk of heart attack (1.63 [1.11, 2.15]) than the reference group of 7–8 h/day. Conversely, among men, self-reported sleep durations of less than 7 h/day were associated with an increased risk of CHF (1.67 [1.21, 2.14]), angina (1.66 [1.18, 2.15]), heart attack (1.41 [1.09, 1.73]), and stroke (1.55 [1.13, 1.90]).

Table 3 Overall association of sleep duration and CVDs and diabetes

Disease events	Sleep duration(h/day)		
	< 7 h/day	7–8 h/day	> 8 h/day
CHF			
OR(95%CI)	1.43(1.15–1.78)	1.00(1.00–1.00)	1.34(1.01–1.76)
P-value	< 0.001		< 0.05
CHD			
OR(95%CI)	1.17(0.96–1.42)	1.00(1.00–1.00)	1.07(0.84–1.38)
P-value	= 0.12		= 0.5
Angina			
OR(95%CI)	1.62(1.28–2.06)	1.00(1.00–1.00)	1.24(0.91–1.70)
P-Value	< 0.001		= 0.17
Heart attact			
OR(95%CI)	1.42(1.17–1.71)	1.00(1.00–1.00)	1.17(0.91–1.50)
P-value	< 0.001		= 0.2
Stroke			
OR(95%CI)	1.38(1.13–1.70)	1.00(1.00–1.00)	1.54(1.20–1.97)
P-value	< 0.01		< 0.001
Diabetes			
OR(95%CI)	1.21(1.09–1.35)	1.00(1.00–1.00)	1.28(1.11–1.48)
P-value	< 0.001		< 0.001

Abbreviations: CHF: Congestive heart failure; CHD: Coronary heart disease; OR: Odds radio; CI: confidence interval

CVDs models adjusted for age, race, gender BMI, drinker, smoker, diabetes and hypertension

Diabetes model adjusted for age, race, gender BMI, drinker, smoker, and hypertension

Additionally, self-reported sleep durations exceeding 8 h/day were associated with an increased risk of stroke (1.73 [1.16, 2.31]) (Fig. 2).

Overall and gender-specific associations between self-reported sleep duration and diabetes risk

The adjusted odds ratios (ORs) for incident diabetes, compared to sleeping for 7 h/day, were 1.21 (95% CI 1.09, 1.35) for self-reported sleep durations less than 7 h/day and 1.28 (95% CI 1.11, 1.48) for self-reported sleep durations exceeding 8 h/day. According to the self-reported sleep duration, there was a U-shaped relationship between diabetes and long and short sleep duration (Table 3).

Figure 3 illustrates the sex-specific associations between self-reported sleep duration and diabetes. Both men and women demonstrated increased risks of diabetes for self-reported sleep durations less than 7 h/day and greater than 8 h/day, compared to the reference group of 7–8 h/day. When self-reported sleep duration was less than 7 h/day, the risk of diabetes increased by 15% in men and 32% in women. Moreover, self-reported sleep durations exceeding 8 h/day were associated with a 32% higher risk of diabetes in men (1.32 [1.11, 1.54]) and a 31% higher risk in women (1.31 [1.03, 1.59])(Fig. 3).

Analysis of interaction of gender and sleep duration on CVDs and diabetes

The logistic regression model and Rstudio included the product of gender and sleep duration for multiplicative interaction analysis and additive interaction analysis. After adjusting for other relevant factors such as age, race, gender, BMI, drinker, smoker, and hypertension, no multiplicative interaction and additive interaction were found between gender and sleep duration (Tables 4 and 5).

Discussion

Overall, after adjusting for potential confounders, our study revealed a U-shaped relationship between self-reported sleep duration and CVDs and diabetes such that minimum risk was associated with a sleep duration of 7–8 h in a large US population. Participants with shorter self-reported sleep durations had a higher risk of cardiovascular disease and diabetes than those with optimal self-reported sleep duration. After grouping the participants by gender, we observed a stronger association between self-reported sleep duration and cardiovascular events in male participants, with significant increases in the risk of CHF, Angina, Heart attack, and stroke. Among the female participants, shorter self-reported sleep duration was significantly associated with an increased risk of Angina and Heart attack. However, no significant association was found between longer self-reported sleep duration and cardiovascular disease in women, except for stroke in men.

Previous studies have reported associations between self-reported sleep duration and cardiovascular disease and diabetes, supporting our findings [11–13]. For instance, a recent study found that shorter self-reported sleep duration increased the prevalence of various cardiovascular diseases [14, 15]. Another study conducted in China reported an increased risk of cardiovascular mortality with both very short (< 4 h/day) and very long (> 10 h/day) self-reported sleep durations [16]. These findings are consistent with our study, which identified similar associations between different self-reported sleep durations and the risk of cardiovascular disease and diabetes [17, 18]. Various mechanisms have been proposed to explain the relationship between self-reported sleep duration and the development of diabetes and cardiovascular disease. Prolonged sleep has been linked to insulin resistance and decreased insulin sensitivity, leading to endocrine and metabolic disorders and elevated blood sugar levels, which ultimately contribute to the development of diabetes. Moreover, long-term hyperglycemia resulting from diabetes can lead to organ damage and vascular complications, becoming a significant risk factor for cardiovascular disease [19–22]. Other potential mechanisms include hyperactivation of the sympathetic

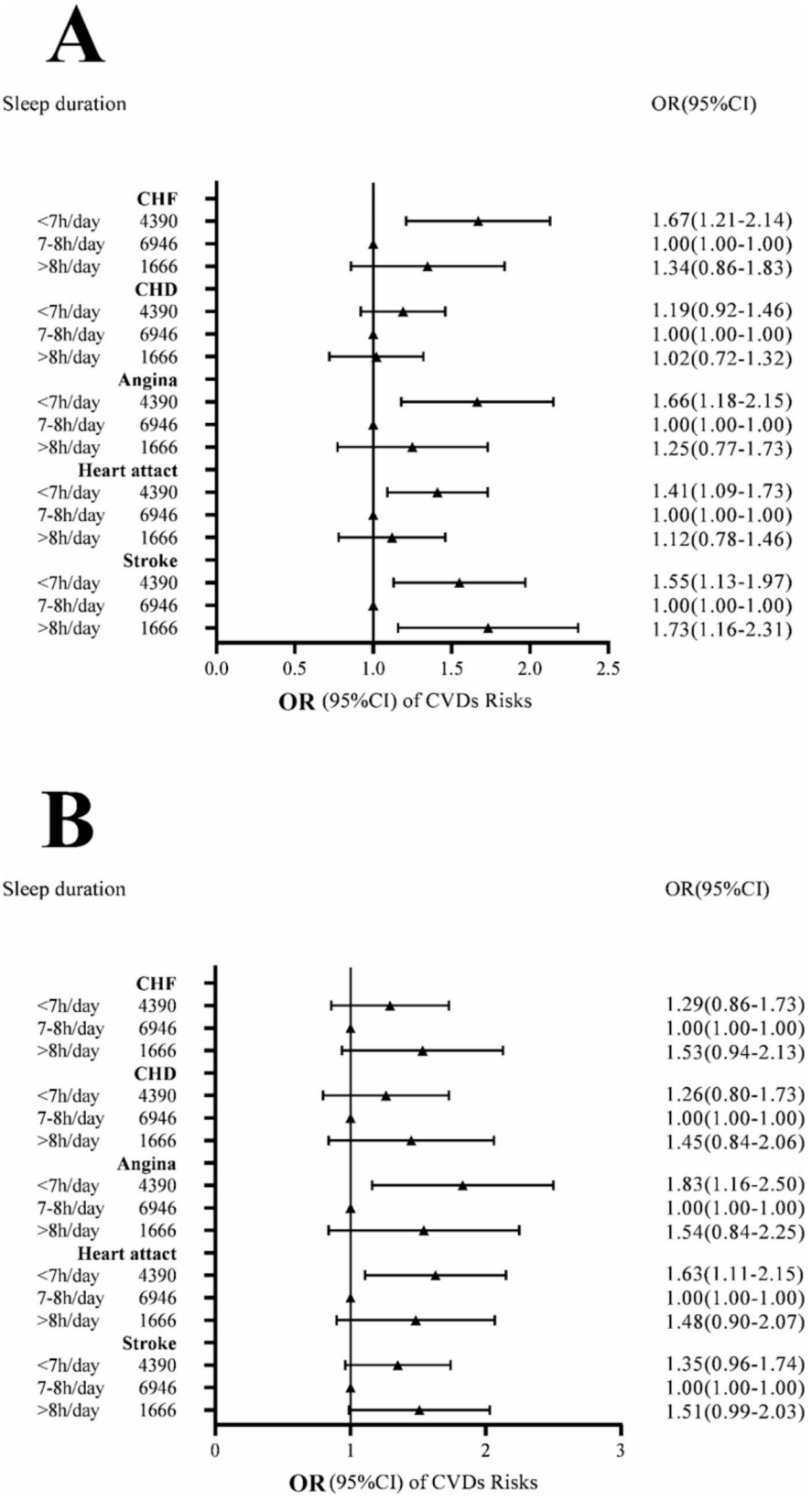

Fig. 2 Sex-specific association between sleep duration and CVDs risk. (**A**) Male; (**B**) Female. Models adjusted for age, race, BMI, drinker, smoker, and hypertension. The points represent the adjusted OR, and the lines represent its 95% confidence interval (95% CI)

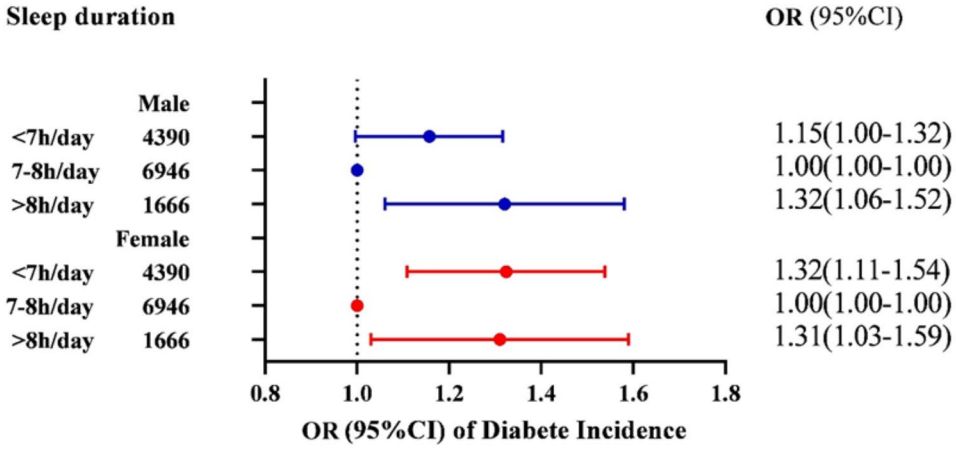

Fig. 3 Sex-specific association between sleep duration and Diabetes. Blue and red boxes represent males and females respectively. Models adjusted for age, race, BMI, drinker, smoker, and hypertension. The points represent the adjusted OR, and the lines represent its 95% confidence interval (95% CI)

Table 4 Multiplicative interaction of gender and sleep duration on CVDs and diabetes

Disease events	Gender	Sleep duration	Gender*Sleep duration
CHF			
Wald X^2	2.83	6.42	0.19
P-value	= 0.09	< 0.01	= 0.66
OR(95%CI)	1.28(0.96–1.71)	1.46(1.09–1.97)	1.09(0.74–1.60)
CHD			
Wald X^2	63.75	0.90	0.18
P-value	< 0.01	= 0.34	= 0.67
OR(95%CI)	2.93(2.25–3.81)	1.17(0.85–1.61)	0.92(0.63–1.34)
Angina			
Wald X^2	9.23	8.16	0.33
P-value	< 0.01	< 0.01	= 0.57
OR(95%CI)	1.66(1.19–2.29)	1.64(1.17–2.31)	0.88(0.57–1.36)
Heart attact			
Wald X^2	38.65	8.33	0.83
P-value	< 0.001	< 0.01	= 0.36
OR(95%CI)	2.28(1.76–2.95)	1.53(1.15–2.04)	0.85(0.60–1.21)
Stroke			
Wald X^2	0.02	6.97	0.92
P-value	= 0.88	< 0.01	= 0.34
OR(95%CI)	0.98(0.75–1.27)	1.41(1.09–1.82)	1.19(0.83–1.68)
Diabete			
Wald X^2	31.467	29.11	1.44
P-value	< 0.001	< 0.001	= 0.23
OR(95%CI)	1.44(1.27–1.63)	1.44(1.26–1.65)	0.90(0.75–1.07)

Abbreviations: CHF: Congestive heart failure; CHD: Coronary heart disease; OR: Odds radio; CI: confidence interval

nervous system during inadequate sleep, increased oxidative stress, and direct damage to the cardiovascular system [23, 24]. Further research is needed to explore and establish the underlying mechanisms connecting self-reported sleep duration with diabetes and cardiovascular disease.

Previous studies have identified gender-related differences in the risk of cardiovascular disease and diabetes, although the impact of self-reported sleep duration on these differences remains largely unexplored. Our study did not observe a significant association between longer self-reported sleep durations and cardiovascular disease in women. However, we found that longer self-reported sleep duration was significantly associated with stroke in men. We hypothesized that the differential association between the effects of shorter or longer sleep duration in men and women might be due to the lack of statistical significance due to the lack of an adequate sample size. We also found that self-reported sleep duration (<7 h/day and >8 h/day) was associated with an increased risk of diabetes in both men and women. Other studies have shown that women are more likely than men to have diabetes, and more women with diabetes are more likely to develop cardiovascular diseases, such as atrial fibrillation and coronary heart disease [8, 14, 25]. Potential contributing factors include the influence of female gender hormones, metabolic conditions, and a higher prevalence of dyslipidemia among women, which may affect the association between self-reported sleep duration, gender, cardiovascular disease, and diabetes [26, 27]. Further analysis of the interaction between gender and self-reported sleep duration revealed that there was neither additive interaction nor multiplicative interaction between the two for diabetes and CVDs; this suggests that the two factors do not have a synergistic effect on the development of CVDs and diabetes, and a literature search revealed that there are few reports of such studies.

Conclusions

In conclusion, our study highlights the gender-specific association between self-reported sleep duration, diabetes, and cardiovascular disease. For men, the shorter the self-reported sleep duration, the higher the risk of heart

Table 5 Additive interaction of gender and sleep duration on CVDs and diabetes

Disease events	OR	95%CI	RERI	95%CI	AP	95%CI	SI	95%CI
CHF	2.04	1.56–2.67	0.30	-0.21-0.80	0.14	-0.10-0.39	1.40	0.70–2.80
CHD	3.16	2.43–4.11	0.06	-0.79-0.91	0.02	-0.25-0.29	1.03	0.69–1.54
Angina	2.40	1.75–3.29	0.10	-0.58-0.78	0.04	-0.24-0.33	1.08	0.64–1.82
Heart attact	2.96	2.29–3.82	0.15	-0.52-0.83	0.05	-0.17-0.28	1.09	0.75–1.57
Stroke	1.64	1.29–2.09	0.25	-0.17-0.68	0.15	-0.10-0.41	1.64	0.54–4.95
Diabete	1.86	1.64–2.11	-0.02	-0.29-0.25	-0.01	-0.16-0.14	0.98	0.72–1.34

Abbreviations: CHF: Congestive heart failure; CHD: Coronary heart disease; OR: Odds radio; CI: confidence interval; RERI: Relative excess risk of interaction; AP: Attributable proportion of interaction; SI: Synergy Index

failure, angina, heart disease, and stroke, and the longer the self-reported sleep duration, the higher the risk of stroke. In women, the shorter the self-reported sleep duration, the higher the risk of angina and heart disease. In addition, self-reported sleep duration (<7 h/day and >8 h/day) was significantly associated with diabetes in both men and women. However, self-reported sleep duration and gender had neither additive nor multiplicative interaction on diabetes and CVDs. Further studies are needed to validate these findings and elucidate the mechanisms underlying these associations.

Strengths and limitations of this study

Strengths First, it utilized the NHANES database, a nationally representative, large-sample survey, to ensure robust data collection criteria. Second, this is the first study to examine the association between self-reported sleep duration and cardiovascular disease and diabetes in a gender-diverse population in the United States using a large sample size. Finally, the study accounted for relevant confounders in the analysis, thus enhancing the validity of the results.

Limitations First, there was a possibility of residual confounding due to unmeasured or unknown factors such as the use of psychotropic medications, which may lead to increased sleep duration, but as this was not the primary objective of this study, it was not taken into account. Second, the study's cross-sectional nature limits our ability to establish causality, necessitating further longitudinal investigations. Third, respiratory diseases such as obstructive sleep apnea can affect sleep quality, which is also a risk factor for cardiovascular disease. Finally, this study did not consider the effect of sleep quality. The outcomes are self-reported, which can potentially lead to either misclassification or misclassification bias, where this misclassification of the outcomes depends on the sleep status, and this study limits the sample to a person with no missing variables and therefore creates a possible biased effect.

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Author contributions

Material preparation and data collection were performed by CYF, YGQ, HT and CYM. Data analysis was performed byCYF. The first draft of the manuscript was written by CYF, article review provided by XR, and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.All authors contributed to the study's conception and design.

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Data availability

Research data supporting this publication are available from the NN repository located at www.cdc.gov/nchs/nhanes/index.htm.

Declarations

Ethics approval and consent to participate

The NHANES research plan was approved by the NCHS Institutional Review Committee and all participants provided written informed consent.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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