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Association between different modes of physical activity and sleep disorders in young and middle-aged adults: a population-based study

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Abstract

Objectives This study aims to investigate the correlation between different modes of physical activity (PA) and sleep health.

Methods We used data from the National Health and Nutrition Examination Survey (NHANES) database from 2007 to 2014. Logistic regression was used to explore the association between leisure-time PA (LTPA), work-time PA (WTPA), and transportation-time PA (TTPA) and sleep disorders. Restricted Cubic Sample (RCS) plots were drawn to visualize the relationship between LTPA and sleep disorders. Finally, subgroup analyses were conducted to evaluate potential interaction effects across different subgroups.

Results A total of 13,389 participants aged 20–64 years were included in the analysis, of whom 1168 had sleep disorders. After multivariate adjustment, we found a negative association between LTPA and sleep disorders, whereas WTPA and TTPA did not have such an association. The RCS plot visually demonstrates an L-shaped dose–response relationship between LTPA and sleep disorders, indicating that engaging in more than 600 min/week of LTPA does not confer additional benefits for sleep disorders. In addition, subgroups analyses showed no significant effect between groups on this relationship.

Conclusions An L-shaped dose–response relationship was observed between LTPA and sleep disorders. Engaging in 600 min of LTPA per week significantly reduced the prevalence of sleep disorders. In contrast, no significant associations were found between WTPA or TTPA and sleep disorders.

Keywords PA, LTPA, Young and middle-aged, Sleep disorders, NHNAES

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Introduction

Sleep is a stage in the circadian rhythm of the human body and accounts for one-third of a lifetime. Sleep is restorative and eliminates fatigue, and a normal sleep rhythm is important for physical and mental health. Today, most people have sleep problems. A large U.S. research study showed that about three-quarters of adults have a sleep disorder, with women more likely to report difficulty falling asleep or waking up easily and men more likely to report snoring or sleep apnea [1]. There is a correlation between sleep disorders and the occurrence of various diseases, such as stroke, headache, atherosclerosis, etc. [2–5], which affect the quality of life and life and health of people. It is crucial to develop effective interventions to improve sleep quality and thus quality of life and life health.

Today, emerging research links sleep problems to lifestyle behaviors, such as diet type, work stress, mental health, physical activity (PA) [6–11]. Among these behavioral modalities, high PA has been shown to be an important way to improve sleep quality [11]. A cross-sectional study on a university in China showed that high PA reduced the risk of depression and improved sleep quality [11]. A meta-analysis of 66 studies showed that either acute or regular exercise was beneficial for sleep quality [12]. Recent studies have shown that PA in different domains has varying impacts on sleep. PA is primarily categorized into their domains: work-time PA (WTPA), leisure-time PA (LTPA), and transportation-time PA (TTPA). These domains affect health in distinct ways [13–15]. Compared to the high WTPA and low LTPA group, the low WTPA and high LTPA group has a lower prevalence of insomnia, suggesting a stronger association between LTPA and lower rates of sleep issues, while WTPA is associated with higher rates of insomnia [16]. However, the specific effects of different types of PA on sleep disorders in young and middle-aged adults are still unknown, particularly the dose–response relationship between activity duration and sleep disorders.

This study combines data from the National Health and Nutrition Examination Survey (NHANES) for the first time to explore the effects of different domains of PA (WTPA, LTPA, and TTPA) on sleep disorders, to fill this gap. At the same time, we adjusted for multiple factors (e.g., age, sex, underlying disease, diet, etc.) to check the robustness of the association. In addition, we assessed whether there was a dose–response relationship between the two.

Research design and methods

Sample screening

The NHANES database (https://wwwn.cdc.gov/nchs/nhanes/Default.aspx) is a U.S. research program designed to assess the health of adults and children in biennial cycles, obtaining a nationally representative sample of approximately 5000 individuals nationwide each year through a complex sampling approach. We selected participants aged 20–64 years from 2007 to 2014 ($n=$ 17,847) and excluded pregnancies ($n=$ 248) and missing values ($n=$ 4210), resulting in the inclusion of a total of 13,389 participants into the analysis, of whom 1168 had sleep disorders (Fig. 1).

Definition of sleep disorders

Sleep disorders are collected primarily through questionnaires. Respondents will be 16 years of age or older and will answer the following questions: have they ever been told by a doctor that they have a sleep disorder (including sleep apnea, insomnia, restless legs, other).

Physical activity

Subjects were surveyed according to the Global Physical Activity Questionnaire (GPAQ) by NHANES professionals and technicians, including daily, leisure, and sedentary activities. Roughly 3 domains of PA were assessed: WTPA, LTPA, and TTPA. The subjects were grouped according to the weekly exercise time, with 0 min/week as no PA and the rest as PA. To assess the dose–response relationship between PA and sleep disorders, we categorized PA as: 0 min/week, 1–149 min/week, 150–299 min/week, and 300 min/week or more [13, 15, 17].

Covariates

Demographic variables included age group (20–44 or 45–64), sex (male or female), race (White, Black, Mexican or Other), and marriage (Married/Living with Partner, Widowed/Divorced/Separated or Never married). Socioeconomic variables included education level (Lower than high school, High school diploma or More than high school), Poverty Income Ratio (PIR) (< 1.3, 1.3–3.5 or > 3.5), and household insurance (yes or no). Lifestyle behavioral variables included body mass index (BMI) (< 25, 25–30, and ≥ 30), smoking status (never, ever, now), drinking status (yes, no), WTPA (yes, no), LTPA (yes, no), TTPA (yes, no), daily energy intake (< 1511, 1511–2032, 2033–2733, and > 2733), and healthy eating index (HEI) (< 40.03, 40.03–49.25, 49.26–59.09, and > 59.09). Underlying diseases include hypertension (yes, no), stroke (yes, no), cardiovascular disease (CVD) (yes, no), tumors (yes, no) and depressive symptom (yes, no). PIR is defined as the ratio of household income to the federal poverty level (FPL), ranging from 0 (no household income) to 5 (household income at least five times the annual FPL). This metric is typically categorized based on socioeconomic stratification and research objectives. Following a U.S. Department of Agriculture (USDA) report on the

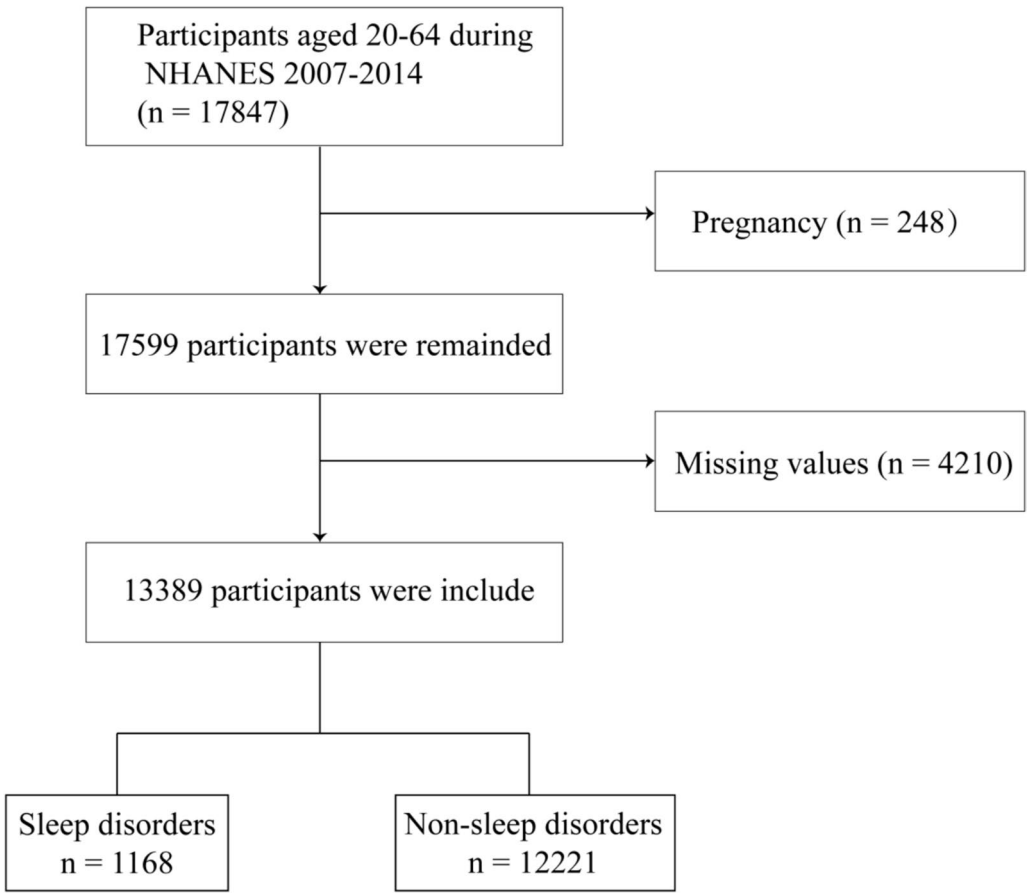

Fig. 1 Process of participants screening

diet–income relationship, we classified PIR into three groups: < 1.3 (low income), 1.3–3.5 (middle income), and > 3.5 (high income) [18–21]. Smoking was categorized as non-smoking, former smoking, and current smoking. They were defined as having smoked fewer than 100 cigarettes in their lifetime, more than 100 in their lifetime, but not currently smoking, and more than 100 cigarettes in their lifetime, and still smoking [22]. Daily energy intake and HEI scores were categorized into quartiles based on their distribution among participants. LTPA levels were stratified according to U.S. PA guidelines and previous studies into four groups: 0 min/week, 1–149 min/week, 150–299 min/week, and ≥ 300 min/week.

Statistical analysis

A total of 4 cycles of data from the NHANES database were included in this study. Appropriate weights (1/4*d$wtdrd1) were selected, and the results of the following statistical analyses were based on the weighting of the data. All statistical analyses were performed using R software version 4.3.2, and $P < 0.05$ (two-sided) was considered statistically significant. Categorical variables were expressed as weighted percentages. We used chi-square tests for between-group comparisons. We then assessed the different domains of PA (WTPA, LTPA, and TTPA) with the odds ratio (OR) for sleep disorders using weighted multivariate logistic regression models and calculated 95% confidence intervals (CI).

We constructed four models for analysis. The crude model did not adjust for any factors. Model 1 adjusted for age group, sex, race, marriage, and education level. Model 2 adjusted for smoking status, drinking status, PIR, and household insurance based on Model 1. Model 3 adjusted for BMI, HEI, daily energy intake, hypertension, stroke, depressive symptom, CVD, and tumors based on Model 2.

We plotted restricted cubic spline (RCS) plots to explore the potential dose–response relationship between PA and sleep disorders. In addition, further subgroup analyses by sex, age group, race, PIR, BMI, and education level were performed to assess whether the above relationships were influenced by underlying factors.

Results

Baseline characteristics

A total of 13,389 participants were included, of which 1168 suffered from sleep disorders. As we can see from Table 1, sleep disorders were more likely to be found in people aged 45–64 years, highly educated, married, and with household insurance, with no significant correlation with gender. This group habitually drank alcohol but never smoked, had no PA in any domain, and tended to be comorbidly obese but free of stroke and depression. In addition, 8735 of them, or approximately 65.24% overall, met the ≥ 150 min per week PA criterion [17].

Relationship between different PAs and sleep disorders

As shown in Table 2, after stepwise adjustment for multiple variables across four models, we observed that among different PA domains, only LTPA demonstrated an inverse association with sleep disorders ($P < 0.05$). The final model revealed that LTPA reduced the odds of experiencing sleep disorders by approximately 32% (OR 0.68, 95% CI 0.56–0.84). In both crude and adjusted models, WTPA and TTPA showed no statistically significant associations with sleep disorders ($P > 0.05$).

Relationship between LTPA and sleep disorders

Consistent with the U.S. PA Guidelines and prior studies, we categorized LTPA duration into four levels: 0 min/week, 1–149 min/week, 150–299 min/week, and 300 min/week or more [13, 15, 17]. From a categorical variable perspective, we explored associations between these incremental LTPA durations and sleep disorders. After adjusting for multiple confounding factors, we ultimately observed that, compared with participants without LTPA, those engaging in 1–149 min/week, 150–299 min/week, and ≥ 300 min/week of LTPA exhibited 25% (OR 0.75, 95% CI 0.57–0.99), 41% (OR 0.59, 95% CI 0.45–0.79), and 32% (OR 0.68, 95% CI 0.49–0.95) reductions in the odds of sleep disorders, respectively. This suggests that young- and middle-aged adults performing 150–299 min/week of LTPA had the lowest prevalence of sleep disorders (Table 3). Meanwhile, leveraging the RCS function, we analyzed LTPA duration as a continuous variable to evaluate potential nonlinear dose–response relationships with sleep disorders. RCS plots (Fig. 2) revealed an overall trend of declining prevalence of sleep disorders with increasing LTPA duration. However, this relationship followed a nonlinear pattern rather than a linear reduction. Subgroup analyses showed this relationship to be robust and unaffected by sex, age, race, PIR, BMI, and education level (Table 4, P for interaction > 0.05). However, in certain subgroups—unmarried individuals, those with high school diploma or above, BMI < 25, and PIR > 3.5—no decreasing trend was observed between incremental LTPA duration and sleep disorders among young and middle-aged adults (Table 3, P for trend > 0.05).

Discussion

We investigated the association between PA and sleep disorders in different domains using the cross-sectional NHANES database. We found that LTPA significantly reduced the prevalence of sleep disorders regardless of socioeconomic status, other lifestyle habits, and the presence of common underlying diseases, with a nonlinear decreasing relationship. In contrast, WTPA and TTPA were not significantly associated with sleep disorders.

The increasing prevalence of sleep disorders is a serious public problem affecting about 20–50% of the world's population [23–25]. Sleep disorders include many forms of sleep problems, such as sleep apnea, insomnia, restless legs, and sleep deprivation, which affect the development of a variety of chronic diseases, such as diabetes, obesity, hypertension, etc., through different pathophysiological mechanisms [26–28]. Sleep disorders place a heavy burden on society and the economy. The 2008–2009 Kansas Employee Wellness Program surveyed approximately 17,334 participants and found that employees spend approximately $3400–$5200 per year for sleep disorders [29]. Improving sleep disorders is beneficial for enhancing human quality of life and reducing socio-economic burdens.

Currently, substantial evidence suggests that PA is beneficial for improving sleep disorders [11, 12, 30]. It may be related to several physiological mechanisms: first, mitochondrial dysfunction is closely related to sleep disorders [31], and exercise improves mitochondrial function and mitochondrial autophagy signaling to improve sleep disorders [32]; second, inflammation can affect sleep rhythms and sleep duration [33, 34], and exercise can reduce inflammation levels to help improve sleep disorders [35, 36]; third, this is related to the thermoregulatory sleep function, PA raises the body and central nervous system temperature to help sleep, and as the body temperature drops it is beneficial in inducing sleep and improving sleep quality [37, 38]; fourth, PA can exercise can stimulate melatonin beneficial to improve the quality of sleep [39].

PA affects sleep disorders differently in different areas. Some studies suggest that excessive commuting may affect workers'mental and physical health causing sleep disorders [40]. The effect of exercise on sleep is influenced by gender, with exercise having a stronger positive effect on sleep in women than in men [41]. In women, moderate to high levels of WTPA, LTPA, and household-time PA are associated with a reduced risk of insomnia. In men, LTPA and household-time PA are negatively

Table 1 Weighted baseline characteristics of all participants in NHANES 2007–2014

Variable	Total	Non-sleep disorders	Sleep disorder	*P* value
Age group (%)				< 0.001
20–44	7347 (54.57)	6887 (55.99)	460 (40.25)	
45–64	6042 (45.43)	5334 (44.01)	708 (59.75)	
Sex (%)				0.1
Female	6693 (49.98)	6111 (50.26)	582 (47.15)	
Male	6696 (50.02)	6110 (49.74)	586 (52.85)	
Marital status (%)				< 0.001
Married/living with partner	7998 (61.46)	7327 (61.40)	671 (62.00)	
Never married	3067 (23.08)	2869 (23.74)	198 (16.54)	
Widowed/divorced/separated	2324 (15.46)	2025 (14.86)	299 (21.46)	
Race (%)				< 0.001
Black	2882 (11.37)	2614 (11.38)	268 (11.24)	
Mexican	2101 (8.79)	1990 (9.16)	111 (5.13)	
Other	2638 (12.35)	2442 (12.50)	196 (10.89)	
White	5768 (67.49)	5175 (66.97)	593 (72.75)	
Education level (%)				0.07
High school diploma	3028 (22.11)	2741 (21.77)	287 (25.58)	
Lower than high school	2906 (14.85)	2679 (15.01)	227 (13.22)	
More than high school	7455 (63.04)	6801 (63.22)	654 (61.20)	
Poverty income ratio (%)				0.16
< 1.3	4468 (23.44)	4012 (23.13)	456 (26.65)	
1.3–3.5	4599 (32.41)	4233 (32.59)	366 (30.54)	
> 3.5	4322 (44.15)	3976 (44.28)	346 (42.81)	
Household insurance (%)				< 0.001
No	3882 (22.56)	3662 (23.17)	220 (16.40)	
Yes	9507 (77.44)	8559 (76.83)	948 (83.60)	
Drinking status (%)				0.46
No	1565 (9.21)	1454 (9.29)	111 (8.46)	
Yes	11,824 (90.79)	10,767 (90.71)	1057 (91.54)	
Smoking status (%)				< 0.001
Former	2577 (20.96)	2287 (20.53)	290 (25.26)	
Never	7481 (55.37)	6955 (56.24)	526 (46.66)	
Now	3331 (23.67)	2979 (23.23)	352 (28.08)	
BMI (kg/m^2) (%)				< 0.001
< 25	3975 (31.17)	3800 (32.56)	175 (17.16)	
25–30	4276 (32.59)	4001 (33.27)	275 (25.75)	
> 30	5138 (36.24)	4420 (34.17)	718 (57.09)	
Hypertension (%)				< 0.001
No	9656 (74.14)	9109 (76.37)	547 (51.68)	
Yes	3733 (25.86)	3112 (23.63)	621 (48.32)	
Stroke (%)				< 0.001
No	13,106 (98.37)	12,012 (98.66)	1094 (95.47)	
Yes	283 (1.63)	209 (1.34)	74 (4.53)	
Depressive symptom (%)				< 0.001
No	12,024 (90.83)	11,197 (92.44)	827 (74.58)	
Yes	1365 (9.17)	1024 (7.56)	341 (25.42)	
Cardiovascular disease				< 0.001
No	12,626 (95.48)	11,665 (96.43)	961 (85.88)	
Yes	763 (4.52)	556 (3.57)	207 (14.12)	

Table 1 (continued)

Variable	Total	Non-sleep disorders	Sleep disorder	*P* value
Tumors				< 0.001
No	12,664 (93.59)	11,614 (94.15)	1050 (87.99)	
Yes	725 (6.41)	607 (5.85)	118 (12.01)	
Healthy Eating Index 2015 (%)				0.17
[0, 40.03]	3347 (24.34)	3031 (24.30)	316 (24.73)	
(40.03, 49.25]	3348 (24.72)	3021 (24.40)	327 (28.03)	
(49.25, 59.09]	3348 (24.60)	3085 (24.76)	263 (22.98)	
(59.09, 96.00]	3346 (26.34)	3084 (26.54)	262 (24.26)	
Daily energy intake (%)				0.17
[0, 1511]	3353 (23.41)	3035 (23.14)	318 (26.08)	
(1511, 2032]	3348 (25.53)	3043 (25.39)	305 (26.93)	
(2032, 2733]	3341 (26.17)	3087 (26.48)	254 (23.00)	
(2733, 13687]	3347 (24.89)	3056 (24.98)	291 (23.99)	
Leisure-time physical activity (%)				< 0.001
No	6440 (42.73)	5754 (41.25)	686 (57.58)	
Yes	6949 (57.27)	6467 (58.75)	482 (42.42)	
Transportation-time physical activity (%)				0.07
No	9561 (73.10)	8671 (72.71)	890 (76.99)	
Yes	3828 (26.90)	3550 (27.29)	278 (23.01)	
Work-time physical activity (%)				0.08
No	7505 (53.59)	6810 (53.21)	695 (57.34)	
Yes	5884 (46.41)	5411 (46.79)	473 (42.66)	

Table 2 Association between different domains of physical activity and sleep disorders

	Crude model		Model 1		Model 2		Model 3	
	OR (95% CI)	*P*	OR (95% CI)	*P*	OR (95% CI)	*P*	OR (95% CI)	*P*
Leisure-time physical activity								
No	ref		ref		ref		ref	
Yes	0.52 (0.43, 0.62)	< 0.001	0.53 (0.43, 0.64)	< 0.001	0.54 (0.44, 0.66)	< 0.001	0.68 (0.56, 0.84)	< 0.001
Transportation-time physical activity								
No	ref		ref		ref		ref	
Yes	0.80 (0.62, 1.02)	0.8	0.84 (0.66, 1.08)	0.84	0.83 (0.64, 1.07)	0.83	0.98 (0.76, 1.26)	0.98
Work-time physical activity								
No	ref		ref		ref		ref	
Yes	0.85 (0.70, 1.02)	0.85	0.83 (0.69, 1.00)	0.83	0.83 (0.69, 1.00)	0.83	0.91 (0.76, 1.10)	0.91

Table 3 Potential dose–response relationship between leisure-time physical activity and sleep disorders

	Model 1		Model 2		Model 3	
	OR (95% CI)	*P*	OR (95% CI)	*P*	OR (95% CI)	*P*
Leisure-time physical activity (min/week)						
0	ref		ref		ref	
1–149	0.65 (0.50, 0.85)	0.002	0.67 (0.51, 0.87)	0.004	0.75 (0.57, 0.99)	0.04
150–299	0.46 (0.35, 0.62)	< 0.001	0.47 (0.36, 0.63)	< 0.001	0.59 (0.45, 0.79)	< 0.001
> 300	0.48 (0.35, 0.65)	< 0.001	0.49 (0.36, 0.68)	< 0.001	0.68 (0.49, 0.95)	0.03

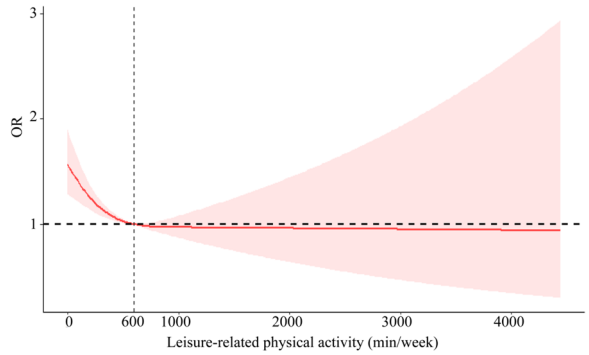

Fig. 2 Fully adjusted relationship between leisure-time physical activity and sleep disorders in NHANES 2007–2014

correlated with morning awakening issues [41]. Compared to individuals with low WTPA, high WTPA is associated with poorer sleep quality and duration health outcomes [42]. The results of this study differ from previous ones. In this study, we found that LTPA was associated with reduced prevalence of sleep disorders regardless of age, gender, race, marriage, educational experience, economic level, other behavioral habits, and comorbidities, whereas WTPA and TTPA were not significantly associated.

In addition, the duration of LTPA can influence the risk and severity of diseases [43–45]. Research indicates that 150 min of moderate walking or 75 min of vigorous exercise per week over 12 weeks similarly reduces the severity of depression in middle-aged and older adults [43]. During preconception or pregnancy, engaging in LTPA for more than 25 times per month or more than 4 h per week can lower the risk of pre-eclampsia in women [45]. Furthermore, a high-quality study has shown that LTPA is negatively associated with the risk of cardiovascular disease, stroke, and atrial fibrillation [46]. In this study, the relationship between LTPA and

Table 4 Subgroups analysis of the relationship between leisure-time physical activity and sleep disorders

Character	Leisure-related physical activity(min/week)								
	0	1–149	*P*	150–299	*P*	> 300	*P*	*P* for trend	*P* for interaction
		OR (95% CI)		OR (95% CI)		OR (95% CI)			
Sex									0.75
Female	ref	0.66 (0.50, 0.86)	0.003	0.55 (0.38, 0.79)	0.002	0.43 (0.29, 0.64)	< 0.001	< 0.001	
Male	ref	0.66 (0.40, 1.09)	0.11	0.39 (0.25, 0.62)	< 0.001	0.46 (0.31, 0.68)	< 0.001	0.01	
Age group									0.49
45–64	ref	0.77 (0.57, 1.04)	0.09	0.45 (0.29, 0.70)	< 0.001	0.48 (0.34, 0.68)	< 0.001	0.003	
20–44	ref	0.57 (0.40, 0.81)	0.003	0.52 (0.34, 0.81)	0.004	0.53 (0.35, 0.79)	0.003	0.02	
Marital status									0.2
Married/living with partner	ref	0.70 (0.50, 1.00)	0.05	0.43 (0.30, 0.62)	< 0.001	0.47 (0.33, 0.67)	< 0.001	< 0.001	
Never married	ref	0.32 (0.15, 0.68)	0.004	0.37 (0.17, 0.80)	0.01	0.46 (0.27, 0.81)	0.01	0.4	
Widowed/divorced/separated	ref	0.85 (0.53, 1.35)	0.48	0.83 (0.49, 1.41)	0.48	0.50 (0.31, 0.81)	0.01	0.03	
Race									0.34
Other	ref	0.69 (0.37, 1.31)	0.25	0.58 (0.33, 1.05)	0.07	0.73 (0.47, 1.14)	0.16	0.04	
Mexican	ref	0.85 (0.40, 1.77)	0.65	0.33 (0.10, 1.08)	0.07	0.45 (0.23, 0.86)	0.02	0.07	
Black	ref	0.82 (0.54, 1.23)	0.33	0.68 (0.45, 1.01)	0.06	0.57 (0.36, 0.90)	0.02	0.08	
White	ref	0.60 (0.42, 0.83)	0.003	0.42 (0.30, 0.59)	< 0.001	0.39 (0.27, 0.58)	< 0.001	< 0.001	
Poverty income ratio									0.12
< 1.3	ref	0.47 (0.28, 0.77)	0.003	0.61 (0.42, 0.89)	0.01	0.44 (0.26, 0.76)	0.004	0.002	
1.3–3.5	ref	0.72 (0.51, 1.02)	0.06	0.66 (0.39, 1.10)	0.11	0.58 (0.37, 0.92)	0.02	0.08	
> 3.5	ref	0.75 (0.52, 1.08)	0.12	0.33 (0.19, 0.59)	< 0.001	0.41 (0.28, 0.60)	< 0.001	0.9	
BMI (kg/m^2) (%)									0.85
< 25	ref	0.64 (0.45, 0.91)	0.01	0.59 (0.39, 0.88)	0.01	0.51 (0.36, 0.72)	< 0.001	< 0.001	
25–30	ref	0.82 (0.51, 1.33)	0.42	0.40 (0.21, 0.79)	0.01	0.56 (0.36, 0.88)	0.01	0.001	
> 30	ref	0.64 (0.34, 1.21)	0.17	0.57 (0.27, 1.20)	0.14	0.58 (0.34, 0.98)	0.04	0.21	
Education level									0.43
High school diploma	ref	0.55 (0.32, 0.95)	0.03	0.61 (0.36, 1.03)	0.06	0.56 (0.33, 0.94)	0.03	0.01	
Lower than high school	ref	0.65 (0.34, 1.26)	0.2	0.47 (0.20, 1.11)	0.08	0.64 (0.35, 1.17)	0.15	0.02	
More than high school	ref	0.65 (0.47, 0.90)	0.01	0.40 (0.28, 0.55)	< 0.001	0.39 (0.29, 0.53)	< 0.001	0.18	

the prevalence of sleep disorders generally presents an L-shaped correlation (Fig. 2). We found that at less than about 600 min of weekly LTPA, the risk of sleep disorders decreased significantly with increasing weekly LTPA time, which appeared to be a linearly decreasing relationship, and at greater than 600 min, the risk of sleep disorders decreased less with increasing weekly LTPA time, which appeared to be a plateau-like change. According to these findings, LTPA time of about 600 min per week is the most significant in reducing the prevalence of sleep disorders, and it is recommended that young and middle-aged people participate in LTPA for about 600 min per week is the most beneficial for sleep and physical and mental health.

The present study, which included a large, nationally representative sample and conducted subgroup analyses, was the first to assess whether the effects of different domains of PA on sleep disorders were of equal benefit, finding that only LTPA was associated with sleep disorders among the various types of PA. Inevitably, there are some limitations to this study. First, although NHANES has improved the reliability of questionnaires through regular training of investigators and other measures, recall bias and self-report bias still exist. PA is evaluated once a week, and stable PA trajectories cannot be obtained. Second, although we adjusted for possible confounders, such as basic information and underlying diseases, we could not avoid the presence of residual confounders. Second, although we have adjusted for possible confounding factors, such as basic information and underlying diseases, residual confounding factors cannot be avoided. Third, the study was cross-sectional, so it cannot prove a causal relationship between the two. Fourth, because this study did not include participants under the age of 20 and over the age of 65, the results of this study may not apply to younger patients and older adults. Fifth, the limited number of participants reporting specific subtypes of sleep disorders precluded analyses of the relationship between physical activity and distinct sleep disorder categories. Future studies should prioritize expanding this subsample to investigate subtype-specific associations rigorously. Finally, PA and sleep patterns were assessed via self-reported questionnaires, which inherently carry recall bias. This methodological limitation may impact the statistical power and validity of the findings.

Conclusion

In different areas of PA, LTPA was associated with reduced prevalence of sleep disorders in young and middle-aged adults, while WTPA and TTPA had no significant correlation. It is helpful to develop appropriate PA intervention strategies to improve the sleep quality of young and middle-aged people. Based on this, clinicians can offer behavioral therapy to people with sleep disorders.

Abbreviations

PA	Physical activity
WTPA	Work-related PA
LTPA	Leisure-related PA
TTPA	Transportation-related PA
NHANES	National Health and Nutrition Examination Survey
GPAQ	Global Physical Activity Questionnaire
BMI	Body mass index
HEI	Healthy eating index
CVD	Cardiovascular disease
PIR	Poverty income ratio
FPL	Federal poverty level
USDA	U.S. Department of Agriculture
OR	Odds ratio
CI	Confidence intervals

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Author contributions

YF and QH (Qian Huang) designed the study. YF extracted data from the NHANES set. QH (Qian Huang) analyzed the data. WL drew figures and tables. WL and QH (Qian He) wrote the manuscript. ZD supervised the research process. All authors reviewed the manuscript and approved the submitted version.

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Availability of data and materials

The data set for this study can be found on the NHANES website NHANES—National Health and Nutrition Examination Survey Homepage (cdc.gov).

Declarations

Ethics approval and consent to participate

The data used in this study are from the NHANES database with no direct participants. All participants in this database have signed informed consent forms provided by the NHANES Ethics Review Board.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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