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Association between physical activity patterns and symptoms of obstructive sleep apnea: a cross-sectional analysis of NHANES data

Fei Xue[1*†] and Yating Zhou[1†]

Abstract

Background With the acceleration of modern life, the "Weekend Warrior" (WW) exercise pattern has become increasingly popular. This study based on data from the National Health and Nutrition Examination Survey (NHANES) from 2007–2008, 2015–2016, and 2017–2020, examines the association between physical activity (PA) patterns and symptoms of obstructive sleep apnea (OSA) in adults aged 18 and above.

Methods The analysis included 19,223 adults who provided self-reported data on their PA patterns. Participants were categorized into four PA groups: inactive, insufficiently active, weekend warrior (WW), and regularly active (RA). Multivariable logistic regression was used to calculate odds ratios (ORs) and 95% confidence intervals (CIs) to determine the association between PA patterns and OSA symptoms. Stratified analyses were performed to assess variations across demographic and BMI subgroups.

Results After adjusting for relevant covariates, the WW (OR = 0.85, 95% CI: [0.72, 0.99]) and RA (OR = 0.83, 95% CI: [0.77, 0.90]) groups demonstrated significantly lower odds of OSA symptoms compared to the inactive group. The protective effect of the WW pattern was observed in specific subgroups, including non-Hispanic whites, low-income individuals, and males. In contrast, the RA pattern exhibited a more consistent protective effect across most demographic and BMI subgroups. No significant difference in OSA symptom likelihood was found between the RA and WW groups after adjusting for covariates (OR = 1.02, 95% CI: [0.87, 1.20]).

Conclusion Both the WW and RA patterns are associated with a significantly lower prevalence of OSA symptoms compared to inactivity. While the WW pattern appears beneficial for certain subgroups, the RA pattern shows broader applicability. These findings highlight the potential of even non-daily PA, such as weekend activity, in reducing the likelihood of OSA symptoms, especially in specific populations.

Keywords NHANES, Physical activity patterns, Obstructive sleep apnea, Sleep, Weekend warrior

Introduction

Obstructive sleep apnea (OSA) is a significant global public health concern, characterized by recurrent airway obstruction, intermittent hypoxia, and frequent awakenings during sleep. Common symptoms include daytime sleepiness, fatigue, loud snoring, and gasping for air, which collectively contribute to a reduced quality of life

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and increased health risks [1]. OSA affects approximately 936 million people worldwide, with the highest prevalence observed in China, followed by the United States, Brazil, and India [2]. The prevalence of mild OSA in adults ranges from 9 to 38%, with severe cases affecting 6% to 17% of adults and up to 36% of older populations [3]. OSA is often comorbid with obesity, hypertension, dyslipidemia, and diabetes [4], significantly increasing mortality and healthcare costs.

While OSA is clinically diagnosed through polysomnography [5], large-scale epidemiological studies often rely on self-reported symptoms to assess the prevalence of sleep-disordered breathing and its associated factors [6–8]. These symptoms, referred to as OSA symptoms, encompass excessive daytime sleepiness, loud snoring, and gasping during sleep. Although less precise than clinical diagnoses, self-reported OSA symptoms provide a practical and cost-effective way to explore population-level trends and identify modifiable risk factors.

The impact of physical activity (PA) and other lifestyle factors on sleep health is increasingly recognized. PA enhances cardiovascular health, muscle strength, and overall endurance, all crucial for managing the physical demands and fatigue associated with sleep disorders [9, 10]. It has also been shown to positively influence immune function and recovery, further supporting its role in sleep health [11, 12]. Adequate PA not only helps improve sleep quality but also mitigates the risk of complications arising from poor sleep [13–15].

Despite the World Health Organization's recommendation that adults engage in at least 150 to 300 min of moderate-intensity or 75–150 min of vigorous-intensity PA weekly [16], the fast pace of modern life makes it challenging for many to adhere to these guidelines consistently. As a result, some individuals opt to concentrate their exercise into fewer, longer sessions over the weekend, adopting the "Weekend Warrior" (WW) pattern. Although this pattern involves fewer weekly exercise sessions, each session is prolonged, leading to significant energy expenditure [17].

Emerging evidence suggests that both WW and regular PA (RA) patterns are effective for weight control, improving metabolic health, and lowering the likelihood of cardiovascular diseases [18, 19]. In the context of OSA symptoms, moderate to vigorous PA has been shown to alleviate symptom severity [20, 21], whereas low levels of PA are associated with worsened symptoms [22]. However, research exploring the relationship between specific PA patterns, such as WW, and OSA symptoms remains scarce. A recent study [23] suggested that both evenly distributed and weekend-concentrated PA could improve sleep efficiency, but systematic analysis of how irregular PA patterns influence OSA symptoms is lacking.This study aims to address this gap by systematically comparing the associations between WW and RA exercise patterns with self-reported OSA symptoms. By exploring how different frequencies and durations of PA influence OSA symptoms, this study seeks to provide actionable insights for developing public health strategies and personalized exercise recommendations. The findings are particularly relevant for individuals facing time constraints in a fast-paced modern lifestyle, offering guidance on how alternative PA patterns may mitigate the risk of OSA symptoms.

Materials and methods

Data source

The NHANES datasets used in this cross-sectional study are publicly available and do not require further ethical review board permission. Comprehensive information is available on the NHANES website.

This study utilized NHANES data from the 2007–2008 to 2015–2020 cycles to assess the health and nutritional status of American adults. Detailed information on NHANES data collection methods can be found on their website (http://www.cdc.gov/nchs/nhanes.htm). We excluded 493 individuals with insufficient PA data, 14,369 individuals without OSA-related data, and 1,595 participants under 18 years old, resulting in a final sample size of 19,223 participants. Figure 1 shows the participant selection flowchart.

OSA symptoms assessment

In this study, OSA symptoms were assessed based on self-reported responses to specific questions related to sleep disorders in the NHANES survey. Unlike clinical diagnoses of OSA, which rely on polysomnography, this study focuses on behavioral and perceptual indicators of OSA symptoms reported by participants. Participants were classified as having OSA symptoms if they provided a positive response to at least one of the following three questions:

(1) Excessive Daytime Sleepiness: Despite having about 7 h of sleep or more on workdays, participants reported feeling excessively sleepy during the day for 16 to 30 times over the past month.
(2) Breathing Pauses: Participants reported experiencing gasping, snorting, or breathing pauses on three or more nights per week.
(3) Snoring: Participants reported snoring on three or more nights per week.

These questions were designed to capture key behavioral indicators commonly associated with OSA symptoms, based on widely accepted standards in prior

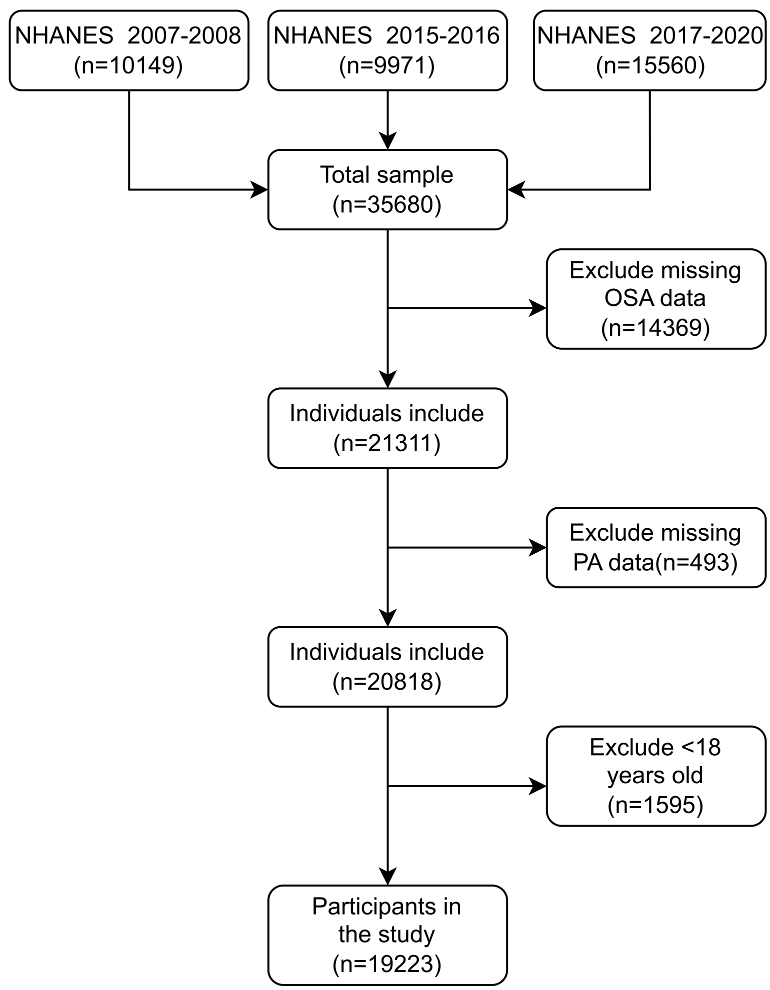

Fig. 1 Flow chart of study population enrollment

epidemiological studies [8]. Each symptom was coded as a binary variable (yes/no) for statistical analysis, enabling the study to explore associations between PA patterns and the likelihood of OSA symptoms.

PA assessment

In this study, PA was assessed using the Global Physical Activity Questionnaire, which has been developed and validated by the World Health Organization, asking participants about the frequency and duration of vigorous and moderate activities per week [24]. Vigorous activity time is doubled and added to moderate activity time to calculate total PA time [25]. PA patterns are categorized into four groups [26, 27]: (1) Inactive; (2) Insufficiently Active: less than 150 min per week; (3) WW: 1–2 sessions per week totaling 150 min; (4) RA: more than 3 sessions per week totaling at least 150 min.

Assessment of covariates

This study included covariates such as age, gender, racial background, educational level, and the ratio of family income to poverty level [28]. Body Mass Index (BMI) was categorized into three groups: underweight/normal weight (≤24.99), overweight (25.0–29.99), and obese (≥30.0) [29]. Smoking status was determined by asking participants if they had smoked at least 100 cigarettes in their lifetime; a positive response classified them as smokers [30]. Alcohol consumption was assessed by asking if participants had consumed at least 12 alcoholic beverages in any one year; a positive response classified them as drinkers [14]. Diagnoses of hypertension, diabetes, and dyslipidemia were based on medical diagnoses. Blood biomarkers included low-density lipoprotein (LDL), high-density lipoprotein (HDL), triglycerides (TG), and total cholesterol (TC).

Statistical analysis

During data analysis, we accounted for NHANES database weights. Continuous variables, based on their distribution, were expressed as mean ± standard deviation for normally distributed variables and medians with interquartile ranges for skewed distributions, while categorical variables were expressed as counts and percentages. Survey-weighted logistic regression was used to analyze the relationship between PA patterns and OSA symptoms, calculating odds ratios (ORs) and 95% confidence intervals (CIs). The crude model did not adjust for any variables. Model 1 adjusted for age, gender, education level, race, income level, and marital status. Model 2 further adjusted for high-density lipoprotein, low-density lipoprotein, triglycerides, cholesterol, BMI, alcoholism, smoking status, hypertension, hyperlipidemia, and diabetes. Sensitivity analyses were performed through stratified demographic analyses and subgroup interaction tests to assess the impact of related confounding factors. All analyses were conducted using R statistical software version 4.3.2, ensuring reproducibility and accuracy of the results. Data sources and all relevant materials are publicly available on the NHANES website.

Results

Characteristics of study participants

This study analyzed 19,223 adults, including 49.18% males and 37.37% non-Hispanic Blacks (Supplementary Table 1). The prevalence of OSA symptoms, defined based on self-reported data, was 54.92%, which aligns with prior epidemiological findings [8], however, it is important to note that self-reported symptoms may not fully capture the prevalence of clinically diagnosed OSA. OSA symptoms patients typically had higher BMI, and elevated low-density lipoprotein, triglycerides, and total cholesterol levels, but lower high-density lipoprotein. A higher prevalence of OSA symptoms was observed among middle-aged males, individuals with lower educational attainment, obesity, smokers, and those diagnosed with hypertension, hyperlipidemia, and diabetes.

PA patterns (Table 1) indicated lower OSA symptoms prevalence rates in the RA and WW groups at 52.65% and 48.42%, respectively. The RA group also showed lower levels of low-density lipoprotein and total cholesterol. The inactive group had higher rates of smoking, hypertension, and hyperlipidemia, and was more likely to include Mexican Americans, overweight individuals, and those with low income. The WW group had the highest percentages of males and heavy drinkers.

Association between PA patterns and OSA symptoms

To assess the relationship between PA patterns and the likelihood of developing OSA symptoms, we applied multivariable logistic regression models (Fig. 2). In Model 2, which adjusted for demographic factors, behavioral characteristics, and health conditions, a reduced likelihood of OSA symptoms was observed in the Insufficiently Active (OR = 0.94, 95% CI [0.86, 1.03], $P = 0.196$), WW (OR = 0.85, 95% CI [0.72, 0.99], $P = 0.045$), and RA groups (OR = 0.83, 95% CI [0.77, 0.90], $P < 0.0001$) compared to the Inactive group.The odds of OSA symptoms were significantly higher in the Inactive group compared to the RA group (OR = 1.20, 95% CI [1.12, 1.30], $P < 0.0001$) and the Insufficiently Active group (OR = 1.14, 95% CI [1.03, 1.25], $P < 0.0001$). Notably, there was no significant difference in the likelihood of OSA symptoms between the WW and RA groups (OR = 1.02, 95% CI [0.87, 1.20], $P = 0.8$), indicating a similar protective effect of these PA patterns against OSA symptoms. To further elucidate the relationship between PA patterns and OSA symptoms, we included supplementary distribution and density plots (Supplementary Fig. 1). Supplementary Fig. 1A illustrates the distribution of OSA symptoms and non-OSA symptoms individuals across different PA patterns, highlighting the higher prevalence of OSA symptoms in the inactive group, while the WW and RA groups exhibited lower prevalence rates. Supplementary Fig. 1B presents the distribution of OSA symptoms status across PA patterns, demonstrating similar trends between the RA and WW groups. Finally, Supplementary Fig. 1C shows that after adjusting for all covariates, the likelihood of OSA symptoms does not differ significantly between the RA and WW groups, reinforcing the protective nature of these activity patterns.

Stratified analyses according to demographic characteristics

To investigate whether the association between PA patterns and OSA symptoms varies across different demographic subgroups, we performed stratified analyses based on age, sex, education level, race, marital status, income level, and BMI, as shown in Table 2. In the WW group, significant reductions in the likelihood of OSA symptoms were observed among non-Hispanic whites (OR = 0.50, 95% CI [0.31, 0.80]), individuals with low income (OR = 0.62, 95% CI [0.45, 0.87]), and males (OR = 0.81, 95% CI [0.67, 0.98]). No significant associations were found in other subgroups. In contrast, the RA group exhibited a consistent trend of significantly reduced likelihood of OSA across most demographic subgroups. Specifically, significant protective effects were found in the 20–39 years (OR = 0.77, 95% CI [0.68, 0.88])

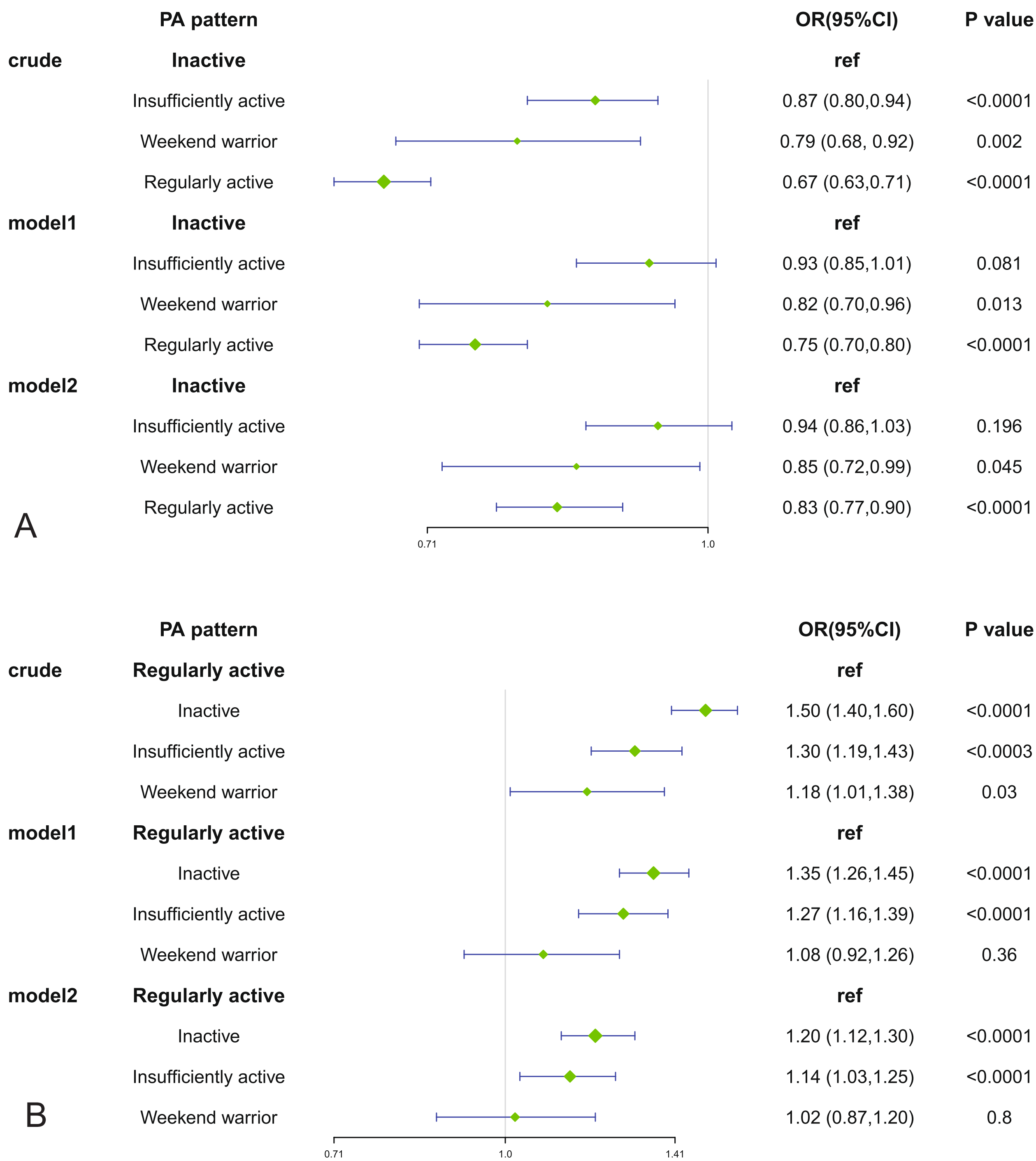

Fig. 2 The relationship between OSA symptoms and PA patterns

and 40–59 years (OR = 0.79, 95% CI [0.69, 0.90]) age groups, males (OR = 0.77, 95% CI [0.69, 0.85]), females (OR = 0.89, 95% CI [0.80, 0.99]), unmarried individuals (OR = 0.82, 95% CI [0.73, 0.93]), and married or cohabiting individuals (OR = 0.82, 95% CI [0.75, 0.90]). In the overweight (OR = 0.80, 95% CI [0.70, 0.91]) and obese (OR = 0.79, 95% CI [0.70, 0.89]) subgroups, the RA group also showed significantly reduced likelihood of OSA symptoms. For income, the middle-income group showed results close to significance (OR = 0.90, 95% CI [0.80, 1.01]), while the high-income group had a significant protective effect (OR = 0.79, 95% CI [0.70, 0.90]).

Table 1 Baseline characteristics by PA patterns

Variables	Inactive ($n=10,266$)	Insufficiently active ($n=2913$)	WW ($n=718$)	RA ($n=5326$)	*P*
Age (years)	53.22 ± 17.41	50.06 ± 16.88	43.01 ± 16.50	44.76 ± 17.10	< .001
BMI (kg/m^2)	30.06 ± 7.84	29.82 ± 7.51	28.92 ± 7.12	28.42 ± 7.03	< .001
Triglycerides (mmol/L)	1.05 (0.35,2.40)	1.12 (0.36,2.57)	1.16 (0.36,2.79)	1.21 (0.42,3.25)	< .001
Cholesterol (mmol/L)	188.00 (161.00,218.00)	188.00 (162.00,219.00)	189.00 (164.00,214.00)	184.00 (159.00,214.00)	< .001
High-Density Lipoprotein (mmol/L)	1.29 (1.06,1.58)	1.32 (1.09,1.63)	1.24 (1.03,1.53)	1.37 (1.10,1.68)	< .001
Low-Density Lipoprotein (mmol/L)	2.87 (1.89,3.83)	2.85 (1.81,3.75)	2.87 (1.87,3.80)	2.59 (1.37,3.60)	< .001
Gender (%)					< .001
Male	4740 (46.17)	1304 (44.76)	526 (73.26)	2884 (54.15)	
Female	5526 (53.83)	1609 (55.24)	192 (26.74)	2442 (45.85)	
Education level (%)					< .001
Less than high school graduate	3219 (31.36)	484 (16.62)	126 (17.55)	623 (11.70)	
High school graduate or GED	2716 (26.46)	629 (21.59)	184 (25.63)	983 (18.46)	
Some college or above	4331 (42.19)	1800 (61.79)	408 (56.82)	3720 (69.85)	
Race (%)					< .001
Mexican American	1667 (16.24)	357 (12.26)	113 (15.74)	687 (12.90)	
Non-Hispanic white	1277 (12.44)	274 (9.41)	85 (11.84)	548 (10.29)	
Non-Hispanic black	3664 (35.69)	1193 (40.95)	279 (38.86)	2047 (38.43)	
Other Hispanic	2439 (23.76)	652 (22.38)	160 (22.28)	1225 (23.00)	
Other race	1219 (11.87)	437 (15.00)	81 (11.28)	819 (15.38)	
BMI status (%)					< .001
Underweight/Normal	2685 (26.15)	772 (26.50)	215 (29.94)	1799 (33.78)	
Overweight	3234 (31.50)	948 (32.54)	260 (36.21)	1792 (33.65)	
Obese	4347 (42.34)	1193 (40.95)	243 (33.84)	1735 (32.58)	
Marital Status (%)					0.008
Living alone	4048 (39.43)	1054 (36.18)	268 (37.33)	2104 (39.50)	
Married/Living with a partner	6218 (60.57)	1859 (63.82)	450 (62.67)	3222 (60.50)	
Income level (%)					< .001
Low income	3735 (36.38)	716 (24.58)	170 (23.68)	1130 (21.22)	
Middle income	4229 (41.19)	1137 (39.03)	299 (41.64)	1916 (35.97)	
High income	2302 (22.42)	1060 (36.39)	249 (34.68)	2280 (42.81)	
Alcoholism (%)					< .001
Yes	7721 (75.21)	2300 (78.96)	613 (85.38)	4469 (83.91)	
No	2545 (24.79)	613 (21.04)	105 (14.62)	857 (16.09)	
Smoking statue (%)					< .001
Yes	4773 (46.49)	1157 (39.72)	343 (47.77)	1971 (37.01)	
No	5493 (53.51)	1756 (60.28)	375 (52.23)	3355 (62.99)	
Hypertension (%)					< .001
Yes	4284 (41.73)	1111 (38.14)	171 (23.82)	1446 (27.15)	
No	5982 (58.27)	1802 (61.86)	547 (76.18)	3880 (72.85)	
Hyperlipidemia (%)					< .001
Yes	3999 (38.95)	1111 (38.14)	189 (26.32)	1641 (30.81)	
No	6267 (61.05)	1802 (61.86)	529 (73.68)	3685 (69.19)	
Diabetes (%)					< .001
Yes	1904 (18.55)	410 (14.07)	54 (7.52)	462 (8.67)	
No	8362 (81.45)	2503 (85.93)	664 (92.48)	4864 (91.33)	
OSA symptoms (%)					< .001
No	4268 (41.57)	1311 (45.01)	340 (47.35)	2747 (51.58)	
Yes	5998 (58.43)	1602 (54.99)	378 (52.65)	2579 (48.42)	

Table 2 Stratified analyses assess the associations between PA patterns and OSA symptoms across demographic characteristics

Characteristics	Inactive	Insufficiently active OR (95%CI)	WW OR (95%CI)	RA OR (95%CI)	P for interaction
Age					0.283
20–39 years	ref	0.97 (0.83, 1.14)	0.85 (0.67, 1.08)	0.77 (0.68, 0.88)	
40–59 years	ref	0.80 (0.69, 0.94)	0.78 (0.59, 1.05)	0.79 (0.69, 0.90)	
60–80 years	ref	1.06 (0.91, 1.22)	0.81 (0.57, 1.15)	0.92 (0.80, 1.05)	
Gender					0.246
Male	ref	0.90 (0.79, 1.03)	0.81 (0.67, 0.98)	0.77 (0.69, 0.85)	
Female	ref	1.00 (0.88, 1.12)	0.79 (0.58, 1.07)	0.89 (0.80, 0.99)	
Education level					0.379
Less than high school graduate	ref	1.13 (0.92, 1.39)	0.82 (0.56, 1.20)	0.89 (0.74, 1.07)	
High school graduate or GED	ref	0.97 (0.81, 1.16)	0.73 (0.54, 1.00)	0.78 (0.67, 0.91)	
Some college or above	ref	0.89 (0.79, 1.00)	0.92 (0.74, 1.14)	0.83 (0.75, 0.91)	
Race					0.609
Mexican American	ref	0.85 (0.66, 1.08)	0.95 (0.63, 1.43)	0.73 (0.60, 0.89)	
Non-Hispanic white	ref	0.87 (0.66, 1.16)	0.50 (0.31, 0.80)	0.83 (0.66, 0.92)	
Non-Hispanic black	ref	0.98 (0.85, 1.13)	0.84 (0.65, 1.09)	0.82 (0.72, 0.92)	
Other Hispanic	ref	0.92 (0.76, 1.10)	0.87 (0.62, 1.23)	0.82 (0.70, 0.96)	
Other race	ref	1.00 (0.79, 1.28)	1.20 (0.73, 1.97)	0.90 (0.73, 1.11)	
Marital Status					0.417
Living alone	ref	1.03 (0.90, 1.19)	0.84 (0.65, 1.09)	0.82 (0.73, 0.93)	
Married/Living with a partner	ref	0.89 (0.80, 1.00)	0.85 (0.69, 1.04)	0.82 (0.75, 0.90)	
Income level					0.177
Low income	ref	0.98 (0.83, 1.17)	0.62 (0.45, 0.87)	0.76 (0.66, 0.88)	
Middle income	ref	0.99 (0.86, 1.14)	0.95 (0.74, 1.23)	0.90 (0.80, 1.01)	
High income	ref	0.87 (0.74, 1.01)	0.90 (0.68, 1.19)	0.79 (0.70, 0.90)	
BMI					0.577
Underweight/Normal	ref	0.97 (0.82, 1.15)	0.85 (0.63, 1.15)	0.90 (0.78, 1.03)	
Overweight	ref	0.98 (0.84, 1.14)	0.77 (0.59, 1.00)	0.80 (0.70, 0.91)	
Obese	ref	0.89 (0.77, 1.02)	0.96 (0.72, 1.28)	0.79 (0.70, 0.89)	

All models were adjusted for demographics data, behavioral factors and health condition

None of the interaction terms were statistically significant, suggesting that the association between PA patterns and OSA symptoms was consistent across the examined demographic subgroups.

Discussion

Our findings indicate that individuals engaging in WW and RA patterns exhibit a lower prevalence of OSA symptoms compared to inactive individuals. This suggests that even non-daily PA, such as concentrated weekend exercise, can offer protective benefits, particularly for those with limited time during the workweek.

Our results are consistent with previous research demonstrating the positive impact of PA on overall health [31]. However, existing studies differ in how PA is defined and measured, including activities such as walking, gardening, running, and gym workouts [32–34]. By focusing on the WW pattern—a concentrated and underexplored form of PA—we provide novel insights into an alternative activity model. Approximately 1–3% of U.S. adults reportedly follow the WW pattern, which has been linked to lower fat mass, BMI, and waist circumference, as well as reduced risks of cardiovascular disease, depression, and cancer mortality [35–37].

This study is among the first to systematically evaluate the association between specific PA patterns and OSA symptoms using a large, nationally representative sample. While prior studies have shown that PA reduces the risk of OSA symptoms [38, 39], few have distinguished between daily and non-daily PA patterns. For example, one study [23] investigated the effects of weekend exercise on sleep disorders, reporting improved sleep efficiency, which aligns with our findings. By leveraging NHANES data, which offers comprehensive information on PA and sleep-related health, our study provides robust evidence linking WW and RA patterns to reduced OSA symptoms.

Several biological mechanisms may explain the protective effects of PA against OSA symptoms. PA reduces body weight and fat deposition, particularly around the neck and upper airway, which improves airway openness and reduces collapsibility [40]. Additionally, PA strengthens respiratory muscles, enhances insulin sensitivity, and lowers cortisol levels, mitigating obesity-related OSA risks [41]. Its anti-inflammatory properties and ability to regulate neurotransmitters further contribute to improved sleep quality and reduced OSA severity [42, 43].

In addition to its physiological effects, the WW pattern may offer psychological and social benefits. Concentrated weekend exercise alleviates stress and fosters social interactions, which can improve motivation and adherence to PA routines [44, 45]. These factors may further enhance the protective effects of PA on OSA symptoms.

Our subgroup analysis revealed that the protective effects of the WW pattern were most significant among non-Hispanic whites, low-income individuals, and males. These findings may reflect lifestyle and socioeconomic factors, as low-income individuals are more likely to engage in high-intensity weekend activities due to limited resources during the week. Similarly, males may favor vigorous or socially oriented PA, which could yield greater health benefits. However, no significant associations were observed in other subgroups, suggesting that the protective effects of the WW pattern may be limited to specific populations.

In contrast, the RA pattern demonstrated consistent protective effects across subgroups defined by age, sex, race, education level, and BMI. This indicates that regular PA has broader applicability for reducing the likelihood of OSA symptoms. Furthermore, no significant associations between PA patterns and OSA symptoms were found in normal or underweight individuals, suggesting that genetic or non-PA-related factors may play a more prominent role in these populations. Our interaction analysis showed no significant differences between subgroups, indicating that the association between PA patterns and OSA symptoms is generally stable across different populations.

Despite these valuable findings, our study has several limitations. First, NHANES data rely on self-reported measures of PA and OSA symptoms, which may introduce recall and reporting biases. Future studies should incorporate objective assessments, such as accelerometry and polysomnography, to enhance data accuracy. Second, the cross-sectional design limits causal inference, preventing us from determining whether PA directly reduces OSA symptoms or if individuals with fewer symptoms are more likely to engage in PA. Longitudinal studies are needed to establish temporal relationships and causal pathways. Third, the dataset lacks variables such as detailed PA characteristics (e.g., type, intensity, and session duration) and sleep metrics, restricting our ability to explore nuanced interactions between PA and OSA symptoms. Other potential confounders, such as genetic predisposition or occupational stress [46] were also not accounted for, which could influence the observed associations.Future research should address these gaps with longitudinal designs and advanced monitoring technologies to provide a more comprehensive understanding of PA's role in OSA symptom management.

Future research should adopt longitudinal designs and incorporate advanced monitoring technologies to better understand the temporal and mechanistic relationships between PA and OSA symptoms. Exploring how external factors, such as stress and environmental influences, shape these interactions could provide further insights. Policy changes, such as improving access to recreational spaces and promoting community-based PA programs, may encourage broader adoption of regular PA patterns. These measures could reduce the burden of OSA symptoms and other lifestyle-related conditions, even for individuals who engage in non-daily exercise like the WW pattern.

In conclusion, this study highlights the potential of the WW pattern as a practical alternative for individuals with limited time for regular exercise, though its benefits may vary by demographic factors. The RA pattern demonstrated more consistent protective effects across populations, emphasizing its broader applicability. Tailored PA recommendations and supportive policies are essential to maximize the public health impact of both PA patterns in reducing OSA symptoms.

Conclusion

Both the WW and RA patterns are associated with a significantly lower prevalence of OSA symptoms compared to inactivity. However, the protective effect of the WW pattern may be limited to specific subgroups, while the RA pattern shows broader benefits across various populations. This finding suggests that even non-daily PA, such as weekend activity, may be an effective strategy for lowering the likelihood of OSA symptoms, particularly in certain demographic groups.

Abbreviations

PA	Physical activity
OSA	Obstructive sleep apnea
NHANES	National health and nutrition examination survey
WW	Weekend warrior
RA	Regularly active
ORs	Odds ratios

CIs	Confidence intervals
BMI	Body mass index

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12890-024-03431-w.

Supplementary Material 1: Supplementary Table 1. Baseline Characteristics Stratified by OSA symptoms Status.

Supplementary Material 2: Supplementary Fig. 1. Distribution and Density of Physical Activity Patterns in Relation to OSA symptoms Status. All models were adjusted for demographics data, behavioral factors and health condition.

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Authors' contributions
XF was responsible for the research design, methodological guidance, and contributed to the writing and reviewing of the manuscript. ZYT conducted the data analysis, created tables and figures, and was involved in writing and reviewing the analysis results. All authors have read and approved the final manuscript submitted.

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Data availability
The data supporting the findings of this study were obtained from the National Health and Nutrition Examination Survey (NHANES), a publicly available dataset. The NHANES data can be accessed via the Centers for Disease Control and Prevention (CDC) website at the following URL: https://www.cdc.gov/nchs/nhanes/index.htm.

Declarations

Ethics approval and consent to participate
This study utilized data from the National Health and Nutrition Examination Survey (NHANES), which was approved by the National Center for Health Statistics (NCHS) Ethics Review Board. Informed consent was obtained from all participants by the NCHS during the data collection phase. The current study involved secondary analysis of publicly available, de-identified data, and no additional ethical approval was required.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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