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Research article

Association between Sitting Time and Urinary Incontinence in the US population: Data from the National Health and Nutrition Examination Survey (NHANES) 2007 to 2018

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ABSTRACT

Background: Urinary incontinence (UI) is a common health problem that affects the quality of life and health of millions of people in the United States (US). We aimed to investigate the association between sitting time and UI symptoms in the US population.
Methods: A cross-sectional survey of participants aged 20 and above from the National Health and Nutrition Examination Survey 2007–2018 was performed. A self-report questionnaire that reported complete data on UI, sitting time and covariates was included. Weighted multivariable logistic and regression models were used to assess the association between sitting time and UI symptoms.
Results: A total of 22,916 participants were enrolled. Prolonged sitting time was associated with urgency UI (UUI, odds ratio [OR] = 1.2, 95% confidence interval [CI] = 1.1 to 1.3, $p = 0.001$). Compared with patients with sitting a time shorter than 7 hours (h), moderate recreational activity modified the association between sitting time and mixed UI in males in the fully adjusted model (OR = 2.5, 95% CI = 1.4 to 4.5, $p = 0.002$). A sitting time over 7 h was related to mixed UI (MUI, OR = 1.6, 95% CI = 1.1 to 2.2, $p = 0.01$) in males, and stress UI (SUI, OR = 0.9, 95% CI = 0.8 to 0.98, $p = 0.03$) in females. However, no significant difference was found among the UI, SUI, and MUI groups in fully adjusted model.
Conclusions: A prolonged sitting time (≥7 h) was associated with UUI symptoms in all populations, SUI symptoms in females and MUI symptoms in males compared with sitting time lower than 7 h. Compared with those sit shorter than 7 h, moderate recreational activity may be a modifier between prolonged sitting and MUI symptoms in male participants, which warrants further studies for confirmation.

1. Introduction

Urinary incontinence (UI) is a common but underreported disease that affects the quality of life and health of approximately 20

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million females and 6 million males in the United States (US) [1]. UI is associated with an increased incidence of depression and social isolation [2]. Despite the great progress of therapies targeting UI, only a quarter of females receive a diagnosis and clinical care [3]. In general, UI is characterized as involuntary leakage of urine with or without bladder control dysfunction which includes stress urinary incontinence (SUI), urgency urinary incontinence (UUI), and mixed urinary incontinence (MUI) [4]. Many risk factors have been reported to contribute to UI. For females, high parity, vaginal delivery history, and menopause were identified as independent risk factors for UI [5,6]. For males, postsurgery of the prostate (prostatectomy, transurethral resection of the prostate) might contribute to the leakage of urine [7]. Importantly, damage to neural control of the bladder and pelvic floor, obesity, age, and others might cause UI in both males and females as well [8].

In recent years, there has been increasing focus on sedentary behavior, such as leisure time, screen time, and sitting time. Excessive sitting time has been reported to be associated with several diseases. For instance, a study in Korea demonstrated that prolonged sitting time increased the risk of low back pain [9]. A long duration of sitting was also associated with cardiovascular disease, diabetes mellitus (DM), and depression [10,11]. In addition, a longer sitting time could also elevate the risk of cancer-specific and all-cause mortality [12]. Given the increasing attention and evidence, the World Health Organization's 2020 Global Guidelines on *Physical Activity and Sedentary Behavior* [13] recommends replacing sedentary behavior with moderate physical activity for staying healthy [14].

Although a recent study revealed that sedentary behavior duration was related to UUI in older women in the US, no study has investigated the association between sitting duration and UI [15]. The association between individual components of sedentary behaviors and UI warrants clarification. However, scarce evidence is available on sitting time and UI in males. Therefore, we performed a cross-sectional study to comprehensively investigate the relationship between sitting time and UI in both sexes using the National Health and Nutrition Examination Survey (NHANES) 2007–2018.

2. Materials and methods

2.1. Study population

NHANES (http://www.cdc.gov/nchs/nhanes.htm) is a large survey designed, cross-sectional, and nationally representative survey for recording the health and nutrition conditions of the US population with two years for each cycle. The interviews were performed in homes by well-trained agents. We performed a post hoc analysis using data from 6 cycles (2007–2018), including 59,842 adults in total. The exclusion criteria were as follows: (1) individuals younger than 20 years of age (n = 25,372); (2) individuals who did not respond to the survey on UI symptoms and sitting time (n = 4863); (3) individuals with unknown covariates (n = 6991). Of note, all the protocols in the NHANES were approved by the National Center for Health Statistics ethical review board. The ethical approval is not required for the current study. All participants signed the informed consent forms in the NHANES.

2.2. Definition of sitting time

Sitting time is an important component of sedentary activities and was collected by a self-report questionnaire. The NHANES defined sitting time by the question "How much time spent sitting or reclining on a typical day". The sitting time was divided into "< 7 hours (h)" and "≥ 7 h" according to previous studies [9].

2.3. Definition of urinary incontinence symptoms

The "Kidney Condition-Urology" questionnaire defined SUI by the question "During the past 12 months, have you leaked or lost control of even a small amount of urine with an activity like coughing, lifting or exercise?". UUI was determined by the question "During the past 12 months, have you leaked or lost control of even a small amount of urine with an urge or pressure to urinate and you couldn't get to the toilet fast enough like coughing, lifting, or exercise?". MUI was determined based on "yes" answers to both the SUI and UUI questions.

2.4. Assessment of covariates

Multiple covariates were obtained from interviews and examinations [16], including age, race (Mexican American, non-Hispanic Black, non-Hispanic White, other Hispanic, and other races), education level (less than 12th grade, high school graduate, and college graduate), family income-to-poverty ratio (<1.3, 1.3–3.5 and >3.5), marital status, body mass index (BMI, weight/height^2, kg/m^2), smoking history, alcohol consumption history (<1 drink per week, 1–3 drinks per week, and >4 or more drinks per week), moderate recreational activity, vigorous recreational activity, DM, hypertension, and coronary heart disease. Moderate recreational activity was determined by the question "In a typical week do you do any moderate-intensity sports, fitness, or recreational activities that cause a small increase in breathing or heart rate such as brisk walking, bicycling, swimming, or golf for at least 10 min continuously?". Vigorous recreational activity was determined by the question "In a typical week do you do any vigorous-intensity sports, fitness, or recreational activities that cause large increases in breathing or heart rate like running or basketball for at least 10 min continuously?".

2.5. Statistical analysis

The sampling weights, strata, and primary sample units were recommended by the Centers for Disease Control and Prevention (CDC) to better represent the US population. Continuous data are presented as the mean ± standard deviations (SDs), and categorical variables are presented as numbers with percentages. Missing data were excluded for complete case analyses. The differences between groups were compared using the chi-square test for categorical variables and linear regression for continuous variables.

First, the association between sitting time and total UI symptoms was analyzed. Given the different etiologies and incidences of UI in males and females, sex-stratified subgroup analyses were performed. According to the overall and sex-stratified analyses, further stratified analyses were performed based on the positive results to identify the potential modifiers of the associations. Furthermore, weighted multivariate logistic regression analyses were adopted to assess the association between sitting time and UI in models 1 and 2. The crude model was not adjusted. Model 1 was adjusted for baseline demographic information, including age, race, education level, family income-to-poverty ratio, and marital status. In addition to the confounding factors in Model 1, Model 2 was further adjusted for BMI, smoking history, alcohol consumption history, moderate recreational activity, vigorous recreational activity, DM, hypertension, and coronary heart disease. To clarify the modification effects of covariates, stratified logistic regression analysis was conducted in the UI subgroup. To confirm the association between sitting time and UI, a nonlinear analysis was performed. To investigate whether physical or recreational activity modified the association between sitting time and UI for both sexes, we performed subgroup analyses. Spline smoothing with a generalized additive model (GAM) was performed to identify the nonlinear relationships.

Statistical analyses were conducted by *R* software version 4.1 (http://www.R-project.org; R Foundation for Statistical Computing, Vienna, Austria) and EmpowerStats (http://www.empowerstats.com, X&Y Solutions, Inc.). A *p* value of <0.05 (two-sided) indicated statistical significance.

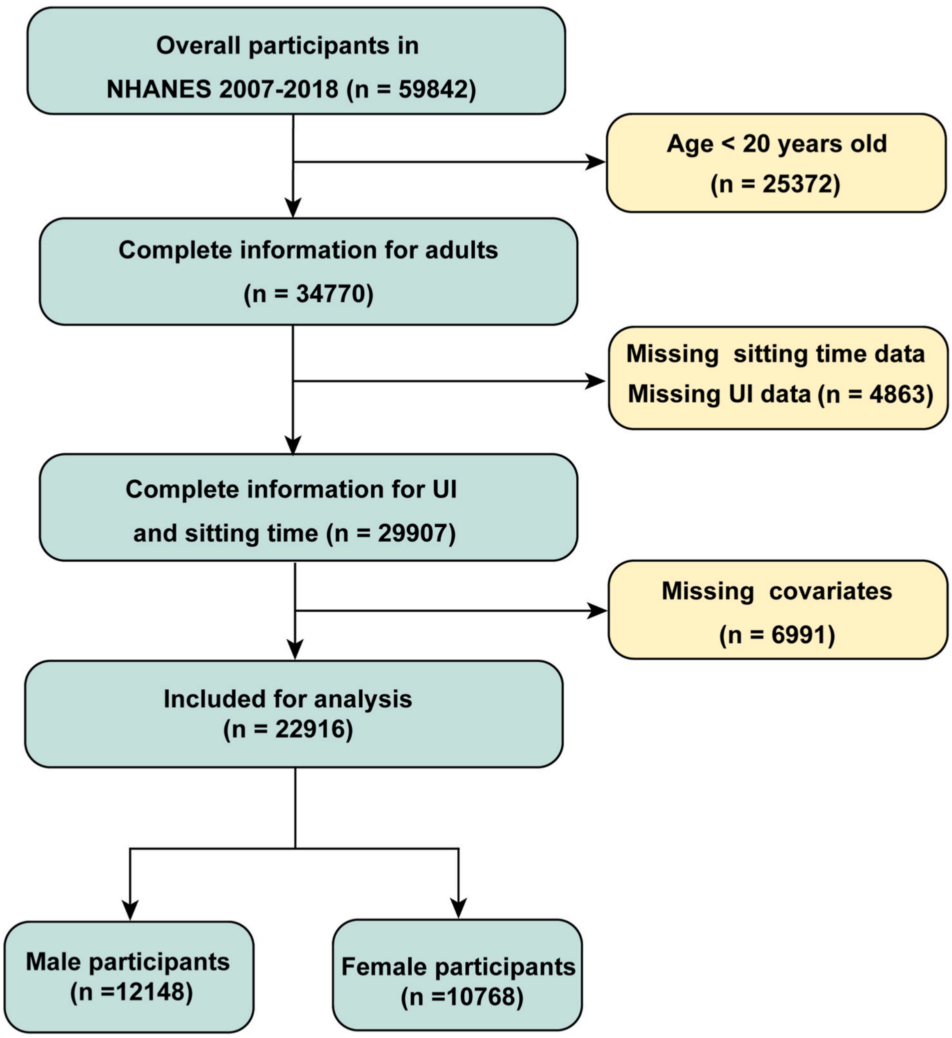

Fig. 1. Screening of the study population. NHANES, National Health and Nutrition Examination Survey; UI, Urinary incontinence.

3. Results

A total of 22,916 adult participants (10,768 females and 12,148 males) were enrolled for further analysis (Fig. 1). Among the 22,916 participants, 2202 males (weighted proportion 18.1%) and 5860 females (weighted proportion 54.4%) suffered from UI symptoms (Table 1). The sitting hours were 5.9 ± 3.4 h among males and 6.0 ± 3.4 h among females. In females, the most prevalent subtype of UI was SUI, while UUI was the most prevalent subtype in males. Among participants with a daily sitting time <7 h, the

Table 1
Characteristics of participants categoried by sex from NHANES 2007–2018, weighted.

	Sex		
Characteristics	**Male**	**Female**	***p* value**
Number (n)	12,148	10,768	
Age	49.8 ± 17.5	48.9 ± 17.2	<0.0001
Sitting hours (h)	5.9 ± 3.4	6.0 ± 3.4	0.416
Race (n/%)			<0.0001
Mexican American	1798 (14.8%)	1385 (12.9%)	
Non-Hispanic Black	2480 (20.4%)	2313 (21.5%)	
Non-Hispanic White	5412 (44.6%)	4979 (46.2%)	
Other Hispanic	1127 (9.3%)	1091 (10.1%)	
Other race	1331 (10.96%)	1000 (9.3%)	
Education level (n/%)			<0.0001
Lower than 12th grade	2921 (24.1%)	2003 (18.6%)	
High school grade	2938 (24.2%)	2340 (21.7%)	
College grade	6289 (51.8%)	6425 (59.7%)	
Family income-to-poverty ratio (n/%)			0.002
<1.3	3576 (29.4%)	3317 (30.8%)	
≥1.3, <3.5	4611 (37.96%)	4057 (37.7%)	
≥ 3.5	3961 (32.6%)	3394 (31.5%)	
Marital state			<0.0001
Married	6800 (55.98%)	4870 (45.2%)	
Divorced	1189 (9.8%)	1556 (14.5%)	
Widowed	472 (3.9%)	1088 (10.1%)	
Separated	353 (2.9%)	432 (4.0%)	
Living with partner	1122 (9.2%)	852 (7.9%)	
Never married	2212 (18.2%)	1970 (18.3%)	
BMI (kg/m^2, n/%)			<0.0001
≤ 20	399 (3.3%)	633 (5.9%)	
>20, ≤25	2901 (23.9%)	2647 (24.6%)	
>25, ≤30	4545 (37.4%)	2966 (27.5%)	
>30	4303 (35.4%)	4522 (41.99%)	
Smoking history (n/%)			<0.0001
Non-smoker	5220 (42.97%)	6206 (57.6%)	
Smoker	6928 (57.0%)	4562 (42.4%)	
Alcohol drinking history (drinks/week, n/%)			<0.0001
< 1	6925 (57.0%)	7787 (72.3%)	
1–3	3549 (29.2%)	2267 (21.1%)	
≥ 4	1674 (13.8%)	714 (6.6%)	
Vigorous activity (n/%)			<0.0001
No	8873 (73.0%)	8680 (80.6%)	
Yes	3275 (26.96%)	2088 (19.4%)	
Moderate activity (n/%)			0.187
No	7092 (58.4%)	6227 (57.8%)	
Yes	5056 (41.6%)	4541 (42.2%)	
Diabetes mellitus (n/%)			0.0005
No	9721 (80.0%)	8962 (83.2%)	
Yes	2427 (19.98%)	1806 (16.8%)	
Hypertension (n/%)			0.004
No	6778 (55.8%)	6271 (58.2%)	
Yes	5370 (44.2%)	4497 (41.8%)	
Coronary heart disease (n/%)			<0.0001
No	11,439 (94.2%)	10,507 (97.6%)	
Yes	709 (5.8%)	261 (2.4%)	
UI			<0.0001
No	9946 (81.9%)	4908 (45.6%)	
SUI	246 (2.0%)	2594 (24.1%)	
UUI	1612 (13.3%)	1339 (12.4%)	
MUI	344 (2.8%)	1927 (17.9%)	

Mean ± SD for continuous variables, *p*-value was by survey-weighted linear regression. % for categorical variables, *p*-value was by survey-weighted Chi-square test. $p < 0.05$ presents significant difference. h, hour; BMI, Body mass index; UI, Urinary incontinence; SUI, Stress urinary incontinence; UUI, Urgency urinary incontinence; MUI, Mixed urinary incontinence; NHANES, National Health and Nutrition Examination Survey; h, hour.

incidences were 1898 (12.5%) for SUI, 1869 (12.3%) for UUI, and 1486 (2.8%) for MUI. Moreover, among participants with a daily sitting hours ≥7 h, the incidences were 942 (12.2%) for SUI, 1082 (14.0%) for UUI, and 785 (10.2%) for MUI.

Weighted logistic regression analyses were performed to identify the relationship between sitting time and UI symptoms (Table 2). After adjusting for demographic characteristics, sitting time ≥7 h per day was related to a higher incidence of UUI symptoms among males (odds ratio [OR] = 1.2, 95% confidence interval [CI] = 1.1 to 1.3, $p = 0.001$). Based on Model 1, Model 2 showed a similar outcome (OR = 1.1, 95% CI = 1.0 to 1.2, $p = 0.03$). However, no significant difference was found among UI, SUI, and MUI groups in the full adjusted model.

The results demonstrated that prolonged sitting ≥7 h was related to MUI in males in the minimally adjusted model (OR = 1.7, 95% CI = 1.2 to 2.4, $p = 0.002$) and fully adjusted model (OR = 1.6, 95% CI = 1.1 to 2.2, $p = 0.01$). In addition, prolonged sitting time over 7 h was related to SUI in females in the fully adjusted model (OR = 0.9, 95% CI = 0.8 to 0.98, $p = 0.03$). However, the relationships between total UI symptoms and sitting time for both sexes were not significant. Interestingly, no difference was found between SUI and sitting time among male participants, whereas it was significant among females after full adjustment.

Supplementary Fig. 1 shows a linear relationship between sitting time and UUI in a fully adjusted model of the whole population of the US. Compared with a sitting time within 7 h, people suffering from MUI symptoms tended to be non-Hispanic races with more physical activity. Then, we further investigated whether the moderate recreational activity could modify the association between sitting time and MUI in males. Compared with patients with sitting time shorter than 7 h, moderate recreational activity modified the association between sitting time and mixed UI in males in the minimally adjusted model (OR = 2.7, 95% CI = 1.5 to 4.8, $p = 0.001$) and fully adjusted model (OR = 2.5, 95% CI = 1.4 to 4.5, $p = 0.002$) (Table 3). The nonlinear analysis revealed a linear association between MUI and sitting time among males with moderate recreational activity (Supplementary Fig. 2). Interestingly, the risk of MUI among males in a prolonged sitting time and no moderate recreational activity increased sharply after approximately 12 h.

4. Discussion

In the current cross-sectional study using the NHANES database, we investigated the association between sitting time and UI symptoms in the adult population of the US. We identified that prolonged sitting time ≥7 h was associated with UUI symptoms in all populations, and MUI symptoms in the male population. The association in men might be modified by race and moderate recreational activity. Although multiple subgroup and stratified analyses were performed to investigate the detailed associations between UI and sitting time in overall, male and female populations, only a few results were significant.

Table 2
Logistic regression analyses of the association between UI and sitting time by sex-stratified linear regression model, weighted.

		All	Sex	
UI	Sitting time (h)	(OR, 95% CI), *p*	Male (OR, 95% CI), *p*	Female (OR, 95% CI), *p*
UI				
< 7		Reference	Reference	Reference
≥ **7**				
Crude model		1.0 (0.97,1.1), 0.3	1.0 (0.997,1.0), 0.099	1.0 (0.99,1.0), 0.9
Model 1		1.1 (0.97,1.1), 0.2	1.1 (0.98,1.3), 0.1	1.0 (0.9,1.2), 0.4
Model 2		1.0 (0.9,1.1), 0.8	1.1 (0.93,1.2), 0.3	0.957 (0.9,1.1), 0.4
SUI				
< 7		Reference	Reference	Reference
≥ **7**				
Crude model		1.0 (0.9,1.1), 0.9	1.0 (1.0,1.1), 0.009**	0.99 (0.98,1.0), 0.2
Model 1		0.99 (0.91,1.1), 0.9	1.3 (1.0,1.7), 0.04*	0.96 (0.9,1.1), 0.5
Model 2		0.96 (0.9,1.1), 0.4	1.2 (0.97,1.6), 0.09	0.9 (0.8,0.98), 0.03*
UUI				
< 7		Reference	Reference	Reference
≥ **7**				
Crude model		1.1 (1.0,1.2), 0.02*	1.0 (0.99,1.0), 0.2	1.0 (1.0,1.0), 0.06
Model 1		1.2 (1.1,1.3), 0.001**	1.2 (0.99,1.4), 0.1	1.2 (1.1,1.4), 0.003**
Model 2		1.1 (1.0,1.2), 0.03*	1.1 (0.95,1.3), 0.2	1.1 (0.99,1.3), 0.08
MUI				
< 7		Reference	Reference	Reference
≥ **7**				
Crude model		1.1 (0.98,1.244), 0.1	1.1 (1.0, 1.1), 0.006**	1.0 (0.99,1.0), 0.5
Model 1		1.2 (1.0,1.3), 0.03*	1.7 (1.2, 2.4), 0.002**	1.1 (0.96,1.3), 0.2
Model 2		1.1 (0.95,1.2), 0.2	1.6 (1.1, 2.2), 0.01*	1.0 (0.9,1.2), 0.9

Crude model: adjusted for none. Model 1: adjusted for age, race, education level, family income-to-poverty ratio, and marital state. Model 2: adjusted for age, race, education level, family income-to-poverty ratio, marital state, BMI, smoking history, alcohol drinking history, moderate recreational activity, vigorous recreational activity, DM, hypertension, coronary heart disease. $p < 0.05$ presents significant difference. OR, Odds ratio; CI, Confidence interval; h, hour; BMI, Body mass index; DM, Diabetes mellitus; UI, Urinary incontinence; SUI, Stress urinary incontinence; UUI, urgency urinary incontinence; MUI, Mixed urinary incontinence. *$p < 0.05$, **$p < 0.01$.

Table 3
Logistic regression analyses by moderate recreational activity-stratified linear regression model between MUI and sitting time in male participants, weighted.

	Sitting time (h)	
Moderate recreational activity	<7 (OR, 95% CI), *p*	≥7 (OR, 95% CI), *p*
No		
Crude model	Reference	1.5 (1.1, 2.2), 0.02*
Model 1	Reference	1.3 (0.9, 1.8), 0.2
Model 2	Reference	1.2 (0.8, 1.7), 0.4
Yes		
Crude model	Reference	1.96 (1.1, 3.4), 0.02*
Model 1	Reference	2.7 (1.5, 4.8), 0.001**
Model 2	Reference	2.5 (1.4, 4.5), 0.002**

Crude model: adjusted for none. Model 1: adjusted for age, race, education level, family income-to-poverty ratio, and marital state. Model 2: adjusted for age, race, education level, family income-to-poverty ratio, marital state, BMI, smoking history, alcohol drinking history, vigorous recreational activity, DM, hypertension, coronary heart disease. $p < 0.05$ presents significant difference. OR, Odds ratio; h, hour; BMI, Body mass index; DM, Diabetes mellitus; h, hour. *$p < 0.05$, **$p < 0.01$.

Sedentary behavior is defined as rest or sedentary activities without physical activities consuming energy [17,18]. Several studies have identified an inverse association between sedentary behavior and multiple diseases, including obesity, DM, cardiovascular diseases, and others [19,20]. As a main component of sedentary behavior, sitting time has been identified as an important public health issue. Previous studies including 20 nations demonstrated that US adults are sedentary for 7.3 h–7.9 h per day [21].

Consistent to a previous study, UUI is positively associated with elevated average time of sedentary behavior [15]. However, Javier and colleagues only focused on the population of older women. We have expanded the population to both females and males of all ages, and significant relationship between sitting time and UI was found in both sexes. In addition, we have also performed sitting time-stratified analyses to investigate the association in depth. Of note, we have identified relationships between prolonged sitting time and MUI in men which may arouse great attention from clinicians.

The etiologies of UUI have not been clarified to date, and studies have reported a link to metabolic syndrome [22]. Given that sedentary behavior is a risk factor for metabolic syndrome and UUI is prevalent in the obese population, sitting time might be associated with UUI [23,24]. In this study, BMI did not modify the association between sitting time and UI. This finding was similar to that in a cross-sectional study that reported that UI was correlated with excess fat mass and poor physical fitness [25]. One study demonstrated that all subtypes of UI were prevalent among females with obesity and comorbidities [26]. In addition to UUI, obesity can also result in increased intra-abdominal pressure that leads to SUI due to the weakening of the pelvic floor [27].

Furthermore, studies have scarcely reported the effect of sitting time on UI in males. In our study, we identified an association between sitting time and MUI in males. Sitting more than 7 h was associated with MUI among US men. In addition, an analysis stratified by recreational activity level demonstrated that prolonged sitting time with moderate recreational activity was associated with MUI. Indeed, the role of physical activity in diseases has not been fully elucidated. Physical activity is beneficial for many diseases, such as DM, obesity, and cardiovascular diseases [28,29]. The health benefits of "moving more and sitting less" are irrefutable in contemporary society. Studies have demonstrated that moderate recreational activity is associated with a lower likelihood of UI in the female population [30]. However, moderate recreational activity did not modify the association between UI and prolonged sitting time among males in our study. Moreover, nonlinear analysis revealed a rapid increase in the risk of MUI among males without moderate recreational activity. Hence, adequate moderate recreational activity with less sitting time might confer more benefits.

Several biological mechanisms might explain our results. Prolonged sitting time could affect metabolic and sex hormones, inflammation, and immunity processes [15]. Furthermore, increasing attention has been given to sitting-associated abnormal glucose metabolism, which could be attenuated by reducing sitting time [31,32]. Importantly, studies have demonstrated that sitting might diminish the function of moderate physical activity, which could explain our results regarding MUI in males [33]. Additional causal studies are needed to evaluate whether physical activity reverses the impairment caused by prolonged sitting in the UI population.

The strength of our study is that it is the first to specifically investigate the association between sitting duration and UI. We identified that prolonged sitting time was related to UUI. Furthermore, sitting for more than 7 h was also associated with MUI in males. The recommendations of adequate physical activity could attenuate the effects of long-term sedentary activity, encouraging patients to engage more in physical activities. However, limitations in this study could not be avoided. First, the cross-sectional design of the NHANES limited further investigation of the effect on people suffering from UI. Second, sitting time and urine leakage history were obtained by self-report, which might have been influenced by bias. Notably, although the questionnaire for the diagnosis of UI is not completely in line with international recommendations, clinical diagnosis of UI based on symptoms are strongly recommended by EAU association [34,35]. Nonetheless, only obtaining UI symptoms through interview without exclusion of potential factors through history assessment and physical examinations that may cause similar symptoms, such as pelvic floor surgery, trauma, and infection, causes overestimation of UI population. Hence, the confounding bias cannot be avoided in the current study which is also a limitation. Third, the physical activity was not further stratified by accurate time duration or subtype. More details on the effect of physical activity on UI were not eligible. Fourth, sitting time is only one important factor in sedentary behavior, other sedentary behaviors are also potential factors that affect UI that needs further research. Additionally, some participants who had comorbidities and physical impairments were likely to spend more time sitting. UI may have been the reason for the impairments that increased sitting time, which could not be obtained from the NHANES. Finally, the data from the NHANES only included only the baseline information without behavioral changes during follow-up.

5. Conclusions

This cross-sectional study showed that prolonged sitting time (≥7 h) was associated with UUI symptoms in all populations, SUI symptoms in females and MUI symptoms in males compare with sitting time lower than 7 h. Compared with a sitting time shorter than 7 h, the moderate recreational activity may modulate the relationship between prolonged sitting time and MUI symptoms in men, which needs further validation.

Funding statement

Not applicable.

Availability of data and materials

All raw data are publicly available in the NHANES database (https://wwwn.cdc.gov/nchs/nhanes/Default.aspx).

Ethics approval and consent to participate

The studies involving human participants were reviewed and approved by http://www.cdc.gov/nchs/nhanes.htm. Written informed consent to participate in this study was provided by the participant's legal guardian/next of kin.

Additional information

No additional information is available for this paper.

CRediT authorship contribution statement

Xingpeng Di: Writing – original draft, Project administration, Investigation, Formal analysis. **Chi Yuan:** Validation, Software, Investigation, Formal analysis. **Liyuan Xiang:** Writing – review & editing, Visualization, Validation, Software, Methodology. **Guanbo Wang:** Validation, Formal analysis. **Banghua Liao:** Writing – review & editing, Supervision, Project administration, Funding acquisition, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.heliyon.2024.e27764.

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