

## Bladder Health in U.S. Shift Workers: A Cross-Sectional Study (NHANES)

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**Purpose:** Working during non-traditional hours is becoming more prevalent in modern societies and presents a significant hurdle to an individual's circadian rhythm. We examined the bladder health of shift workers in the United States by analyzing information obtained from the National Health and Nutrition Examination Survey.

**Materials and methods:** National Health and Nutrition Examination Survey (NHANES) datasets from 2005 to 2010 were utilized. Regression analyses were used to assess the association between shift work and bladder health (stress incontinence, urge incontinence, and nocturia) by adjusting for age, race, education, smoking, and other factors.

**Results:** The percentage of non-Hispanic Black individuals was notably higher among shift workers (25.8% vs. 17.8%). Among shift workers, there was a lower percentage of individuals with a college degree or higher compared to day workers. Shift work was found to be associated with nocturia in men in the unadjusted model (OR=1.2, 95%CI=1.0-1.5,  $p = 0.038$ ). However, the adjusted results indicate that the connection is not statistically significant (Adjusted Model II: OR=1.2, 95%CI=1.0-1.5,  $p = 0.105$ ). Similarly, no statistically significant association was observed between shift work and nocturia in women. There was also no significant relationship between shift work and Stress Urinary Incontinence (SUI) in men or women. The results from the fully adjusted model (Adjusted Model II) indicate a significant association between shift work and the prevalence of Urgency Urinary Incontinence (UUI) in women (OR=1.2, 95%CI=1.0-1.5,  $p = 0.041$ ).

**Conclusion:** Results of this cross-sectional study indicated that shift work was associated with a higher risk of UUI in women. Further research is needed to explore this relationship.

**Keywords:** shift work; stress incontinence; urge incontinence; nocturia; nhanes; association; cross-sectional analysis

### INTRODUCTION

In contemporary societies, it is becoming more prevalent for individuals to work outside of conventional daylight hours.<sup>(1)</sup> The rising demand for round-the-clock services, especially in healthcare and transportation sectors, results in employees commonly adhering to shift work patterns.<sup>(2)</sup> Working in shifts and rotating shift patterns disrupts an individual's natural body rhythms, causing changes in their circadian rhythm.<sup>(3)</sup> In addition to the anticipated functional challenges related to sleep, such as excessive daytime drowsiness and sleeplessness, shift work has been linked to various health issues, including peptic ulcer disease, coronary heart disease, metabolic syndrome, cancers, and the exacerbation of preexisting medical conditions.<sup>(4-8)</sup> Previous studies have found a strong relationship between circadian rhythm and bladder function.<sup>(9-11)</sup> Kim discovered that patients who worked alternating shifts experienced an increase in nocturia, particularly during night shifts.<sup>(9)</sup> A single-cohort study found that night shift workers have more pronounced urinary system-related symptoms compared to traditional day workers, leading to a reduced quality of life.<sup>(10)</sup> This current research aimed to fill a gap in existing studies by examining bladder health in a group of shift workers based in the United States. By analyzing data from the National Health and Nutrition Examination

Survey (NHANES), we compared bladder health between individuals who reported working shifts and those who worked during the day.

### MATERIALS AND METHODS

This research is a cross-sectional analysis utilizing data accessible from the National Health and Nutrition Examination Survey (NHANES). NHANES, a major survey carried out by the Centers for Disease Control and Prevention (CDC) in the United States, is a comprehensive multistage, stratified survey. Its purpose is to gather health and nutrition information systematically to oversee the well-being of U.S. residents. A unique feature of the survey is its combination of in-home interviews and physical examinations. In-home interviews cover demographics, socioeconomic status, dietary habits, and health-related data. Physical examinations include medical, dental, and physiological assessments, along with laboratory tests conducted by certified medical professionals. For further details, visit <https://www.cdc.gov/nchs/nhanes/index.htm>. In this research, we merged three NHANES cycles (2005-2006, 2007-2008, and 2009-2010). Initially, 39,749 individuals were included. Subsequently, individuals without complete information regarding bladder health, those with missing data on shift work status, and those with incomplete covariate data were excluded. Ultimately,

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**Table 1.** Study sample characteristics: a comparison by shift work status.

	Day Workers	Shift Workers	P-value
N	6009	1377	
Body mass index (kg/m <sup>2</sup> )	28.8 ± 6.4	29.0 ± 6.8	0.328
Age	43.5 ± 13.6	38.8 ± 14.1	< 0.001
PIR	3.0 ± 1.6	2.5 ± 1.6	< 0.001
Drinking history			0.505
Yes	4598 (76.5%)	1042 (75.7%)	
No	1411 (23.5%)	335 (24.3%)	
Hypertension			< 0.001
Yes	1478 (24.6%)	277 (20.1%)	
No	4531 (75.4%)	1100 (79.9%)	
High cholesterol level			< 0.001
Yes	3323 (55.3%)	674 (48.9%)	
No	2685 (44.7%)	703 (51.1%)	
Sex			0.655
Male	3198 (53.2%)	742 (53.9%)	
Female	2811 (46.8%)	635 (46.1%)	
Race			< 0.001
Mexican American	1252 (20.8%)	274 (19.9%)	
Other Hispanic	567 (9.4%)	137 (9.9%)	
Non-Hispanic White	2846 (47.4%)	542 (39.4%)	
Non-Hispanic Black	1070 (17.8%)	355 (25.8%)	
Other Race	274 (4.6%)	69 (5.0%)	
Educational level			< 0.001
Less than high school	1344 (22.4%)	330 (24.0%)	
High school or equivalent	1337 (22.2%)	367 (26.7%)	
College or above	3328 (55.4%)	680 (49.4%)	
Diabetes			0.481
Yes	599 (10.0%)	146 (10.6%)	
No	5410 (90.0%)	1231 (89.4%)	
Smoking history			0.09
Yes	2555 (42.5%)	620 (45.0%)	
No	3454 (57.5%)	757 (55.0%)	
SUI			0.007
No	4788 (79.6%)	1142 (82.8%)	
Yes	1227 (20.4%)	237 (17.2%)	
UUI			0.647
No	5025 (83.5%)	1159 (84.0%)	
Yes	990 (16.5%)	220 (16.0%)	
Nocturia			0.260
No	5025 (83.5%)	1159 (84.0%)	
Yes	1282 (21.3%)	313 (22.7%)	

7,386 participants met the inclusion criteria (**Figure 1**).

### Occupational Health

Data from the Occupation Questionnaire Section were utilized to evaluate shift work status. The question, "Which of the following best describes the hours you usually work at your main job or business?" was used to assess shift work status. Potential answers included (1) a regular daytime schedule, (2) a regular evening shift, (3) a regular night shift, (4) a rotating shift, and (5) another schedule. We removed the last answer (5) because this particular schedule was not described in greater detail. In our study, the evening/night shift and rotating shift were consolidated into a single "shift

work" category.<sup>(12)</sup>

### Bladder Health

The evaluation of urinary incontinence involved the use of a standardized survey. According to the standards, any occurrence of urine leakage during actions like coughing, lifting heavy objects, or physical activity in the past 12 months was categorized as stress urinary incontinence (SUI). Urge urinary incontinence (UUI) was described as unintentional urine leakage due to the sudden need or pressure to urinate without being able to make it to a restroom in time. The presence of nocturia among participants was evaluated through the question, "Over the last 30 days, how often did you

**Table 2.** Association of shift work and prevalence of SUI.

Shift Work Status	Unadjusted Model OR (95% CI) P	Adjusted Model I OR (95% CI) P	Adjusted Model II OR (95% CI) P
Female			
Day Workers	1 (Reference)	1 (Reference)	1 (Reference)
Shift Workers	0.8 (0.7, 0.9) 0.007	0.9 (0.7, 1.1) 0.239	0.9 (0.7, 1.1) 0.218
Male			
Day Workers	1 (Reference)	1 (Reference)	1 (Reference)
Shift Workers	0.8 (0.5, 1.4) 0.475	1.0 (0.6, 1.6) 0.869	0.9 (0.6, 1.6) 0.816

ORs are displayed with their 95% confidence intervals and p-value.

Adjusted Model I: Adjusted for age, educational level, race, PIR.

Adjusted Model II: Adjusted for age, educational level, race, PIR, BMI, drinking history, hypertension, high cholesterol level, diabetes, smoking history.

**Table 3.** Association of shift work and prevalence of UUI.

Shift Work Status	Unadjusted Model OR (95% CI) P	Adjusted Model I OR (95% CI) P	Adjusted Model II OR (95% CI) P
Female			
Day Workers	1 (Reference)	1 (Reference)	1 (Reference)
Shift Workers	1.2 (0.9, 1.4) 0.156	1.3 (1.0, 1.5) 0.037	1.2 (1.0, 1.5) 0.041
Male			
Day Workers	1 (Reference)	1 (Reference)	1 (Reference)
Shift Workers	0.7 (0.5, 0.9) 0.019	0.8 (0.6, 1.0) 0.062	0.7 (0.6, 1.0) 0.059

ORs are displayed with their 95% confidence intervals and p-value.

Adjusted Model I: Adjusted for age, educational level, race, PIR.

Adjusted Model II: Adjusted for age, educational level, race, PIR, BMI, drinking history, hypertension, high cholesterol level, diabetes, smoking history.

typically wake up at night to urinate from the time you went to bed until waking up in the morning?" The responses varied from 0 to 5+ voids/night. In our study, participants with  $\geq 2$  voids/night were categorized as experiencing nocturia.

### Covariates

Covariates were chosen primarily based on prior research examining the association between bladder health and various exposure factors.<sup>(13,14)</sup> NHANES gathered information on participants' age, gender, education level, family poverty-to-income ratio (PIR), and ethnicity. Body mass index (BMI) was divided into three categories:  $< 25$ , 25-30, and  $\geq 30$  kg/m<sup>2</sup>. Hypertension was identified if participants responded "yes" to being told by a health professional they had hypertension or were told to take prescribed medicine for it. Diabetes was ascertained by either glycosylated hemoglobin levels  $\geq 6.5\%$  or an affirmative response to being told by a health professional they had diabetes. Participants who were advised by physicians about elevated cholesterol levels, prescribed medication for hypercholesterolemia, or had a total cholesterol level of  $\geq 240$  mg/dL were categorized as having high cholesterol. Participants were segregated into those who consumed alcohol regularly (at least 12 drinks per year) and those who did not. Individuals who disclosed smoking at least 100 cigarettes in their lifetime were categorized as smokers.

### Statistical Analysis

The analyses were conducted using R and EmpowerStats. Categorical variables were presented as frequency distributions, while continuous variables were reported as mean with standard deviation. Due to differences in male and female urinary system anatomy, we conducted regression analyses separately for each gender. Multivariable logistic models were constructed to analyze the association between shift work status and bladder health. The unadjusted model did not adjust for confounding variables, while Adjusted Model I adjusted for age, educational level, race, and PIR. Adjusted

Model II further adjusted for BMI, drinking history, hypertension, high cholesterol level, diabetes, and smoking history. A *p*-value of less than 0.05 was considered statistically significant.

## RESULTS

### Characteristics of the Population Included in the Analysis

(Table 1) presents the demographic and anthropometric characteristics of the study participants categorized by their shift work status. Our findings indicated no significant differences between the two groups in terms of gender. However, the association between shift work status and race was evident. The percentage of non-Hispanic Black individuals was notably higher among shift workers (25.8% vs. 17.8%). Moreover, our results revealed a significant connection between working in shifts and an individual's educational attainment, as well as annual household income. Among shift workers, there was a lower percentage of individuals with a college degree or higher compared to day workers. Our findings indicate no association between shift work status and body weight ( $p=0.328$ ). The percentage of overweight and obese individuals among shift workers did not show a substantial variance compared to those working during the day.

### Association of Shift Work and Prevalence of SUI

Logistic regression analysis was performed to establish the association between shift work and the occurrence of SUI. The results indicated no significant relationship between shift work and SUI in men or women in any of the models, as shown in (Table 2).

### Association of Shift Work and Prevalence of UUI

Logistic regression models were used to explore the potential association between shift work and the risk of UUI. In the unadjusted model, the risk of UUI was significantly lower for men who did shift work (OR = 0.7, 95%CI = 0.5-0.9,  $p = 0.019$ ) compared to men who did day work. However, after controlling for potential confounders, the association was no longer significant

**Table 4.** Association of shift work and nocturia.

Shift Work Status	Unadjusted Model OR (95% CI) P	Adjusted Model I OR (95% CI) P	Adjusted Model II OR (95% CI) P
Female			
Day Workers	1 (Reference)	1 (Reference)	1 (Reference)
Shift Workers	1.0 (0.8, 1.2) 0.688	1.0 (0.8, 1.3) 0.717	1.0 (0.8, 1.3) 0.828
Male			
Day Workers	1 (Reference)	1 (Reference)	1 (Reference)
Shift Workers	1.2 (1.0, 1.5) 0.038	1.2 (1.0, 1.5) 0.097	1.2 (1.0, 1.5) 0.105

ORs are displayed with their 95% confidence intervals and p-value.

Adjusted Model I: Adjusted for age, educational level, race, PIR.

Adjusted Model II: Adjusted for age, educational level, race, PIR, BMI, drinking history, hypertension, high cholesterol level, diabetes, smoking history.

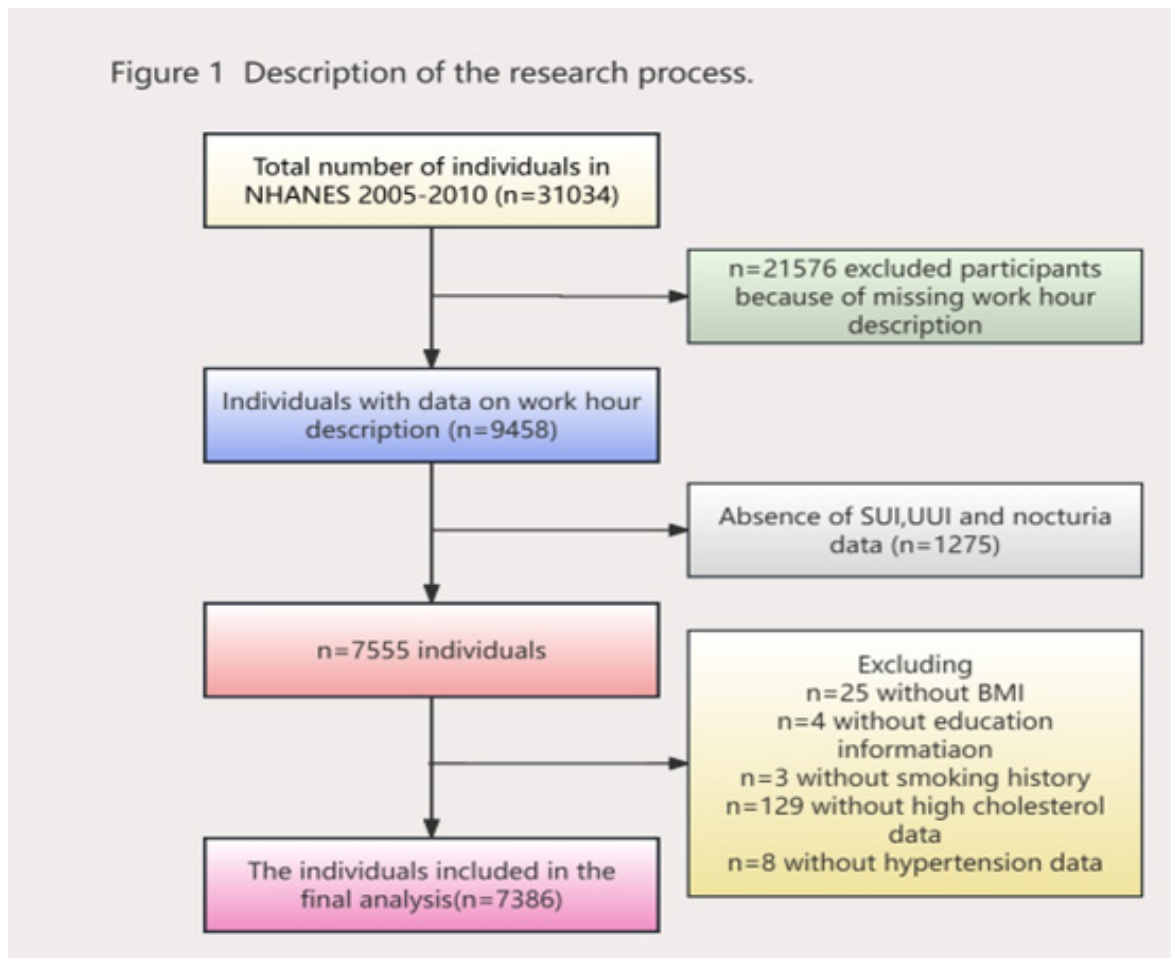


Figure 1. Flowchart of participant selection from the National Health and Nutrition Examination Survey (NHANES) 2005-2010.

(Adjusted Model II: OR = 0.7, 95%CI = 0.6-1.0,  $p = 0.059$ ). Although in the unadjusted model shift work did not seem to be associated with UUI in women (OR=1.2, 95%CI = 0.9-1.4,  $p = 0.156$ ), the results from the fully adjusted model (Adjusted Model II) indicate a significant association between shift work and the prevalence of UUI in women (OR = 1.2, 95%CI = 1.0-1.5,  $p = 0.041$ ). The findings are summarized in (Table 3).

#### Association of Shift Work and Nocturia

Shift work was found to have a significant association with nocturia in men in the unadjusted model (OR = 1.2, 95%CI = 1.0-1.5,  $p = 0.038$ ). However, the adjusted results indicate that the connection is not statistically significant (Adjusted Model II: OR = 1.2, 95%CI = 1.0-1.5,  $p = 0.105$ ). Similarly, no statistically significant association was observed between shift work and nocturia in women. A detailed account of the results can be found in (Table 4).

## DISCUSSION

In this study, we analyzed the 2005-2010 NHANES database to investigate the associations between shift work and bladder health (SUI, UUI, and nocturia). After taking into account potential confounding factors, we found that shift work was associated with UUI among women. However, such an association was not observed in men. We also found that shift work was not

associated with either nocturia or SUI. It is important to avoid over-reliance on significance tests and instead consider the clinical significance of results by examining appropriate association measures, such as odds ratio estimates with 95% confidence intervals.<sup>(15)</sup>

Many previous studies have reported health problems linked to shift work. Literature indicates that night shift work results in inadequate sunlight exposure and disruption of the endogenous circadian system.<sup>(16,17)</sup> Furthermore, numerous epidemiological and laboratory studies suggest that night shift work is associated with an elevated risk for various chronic illnesses, including different types of cancer, coronary heart disease, metabolic diseases, and sleep disorders.<sup>(18-20)</sup> Unfortunately, there is limited research available regarding the connection between shift work and urinary diseases. The Nurses' Health Study found no strong evidence for an association between night shift work and bladder cancer risk.<sup>(21)</sup>

Our study indicates that shift work does not correlate with stress incontinence in either men or women. In the unadjusted model, male shift workers were found to have a higher risk of experiencing nocturia. However, based on the findings of the logistic regression analysis, there was no independent association between the two variables. An investigation by Kim highlighted that patients working alternating shifts experience increased nocturia, particularly during their night shifts.<sup>(9)</sup>

Our study had a larger sample size and utilized logistic regression analysis, whereas his study may have been more accurate in assessing nocturia as ours was based on self-reports.

Our results suggest that shift work was independently associated with UUI in women. The storage and voiding functions of the urinary bladder have a characteristic diurnal variation.<sup>(22)</sup> While circadian controls may be susceptible to dysregulation from changes in the day-night schedule, shift work represents a change in the circadian rhythm too rapid for the body to adapt fully through the entrainment process.<sup>(23,24)</sup> Studies on the loss of circadian function in intensive care unit patients have demonstrated how acute mediators like cortisol quickly lose their characteristic circadian variation.<sup>(25)</sup> Correspondingly, urine production might be more prone to alterations due to circadian disruption. Another plausible explanation could involve a psychological stress-related mechanism that disrupts brain-bladder signaling.<sup>(26)</sup> Shift workers often experience higher levels of psychosocial work stress.<sup>(27)</sup>

Our study has several limitations. Firstly, we utilized a cross-sectional design; while it had sufficient representation of the U.S. population, we cannot establish a causal relationship. Secondly, we did not know the duration of night shift work, the current daily work hours, or the type of work being performed. As a result, the cumulative impact or intensity of the work could not be determined. Thirdly, there are potential covariates that have not been included, such as the consumption of coffee and energy drinks. Finally, urinary incontinence was measured through a questionnaire, the results of which could be influenced by subjective factors.

## CONCLUSIONS

Results of this cross-sectional study indicated that shift work was associated with a higher risk of UUI in women. Further research is needed to explore this relationship.

## SUMMARY

This study of U.S. workers found that women who work shifts have a higher risk of urge urinary incontinence (UUI). No significant link was found between shift work and stress incontinence or frequent nighttime urination for either gender after adjustments.

## FUNDING

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## CONFLICT OF INTEREST

The authors declare that the research was conducted without any commercial or financial relationships that could be seen as a potential conflict of interest.

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