



# Urinary incontinence and chronic conditions in the US population age 50 years and older

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## Abstract

**Introduction and hypothesis** Urinary incontinence is common among older adults with chronic conditions. The purpose of this study is to examine the association of urinary incontinence with chronic conditions in the US population.

**Methods** We used data from the 2001–2014 National Health and Nutrition Examination Survey; 7226 women and 7239 men age  $\geq 50$  years answered questions regarding urinary symptoms. The analysis accounted for the complex survey design, and prevalence reflects estimates within the non-institutionalized US population.

**Results** The mean age was 64.2 years [standard error (SE) 0.2] among women and 62.9 (SE 0.1) years among men. Bothersome stress, urgency and mixed incontinence were reported by 6.7% (SE 0.4), 4.8% (SE 0.4) and 19.3% (SE 0.59) of women, respectively, and 0.6% (SE 0.1), 3.5% (SE 0.2) and 1.9% (SE 0.2) of men, respectively. Among chronic conditions, heart failure was associated with higher prevalence of mixed incontinence in women and urgency incontinence in men. Among women, heart failure was associated with significantly increased odds of bothersome mixed incontinence (OR 2.35; 95% CI 1.62, 3.42) and lower odds of stress (OR 0.50; 95% CI 0.3, 0.9) or urgency incontinence (OR 0.43; 95% CI 0.19, 0.98) after adjustment for covariates. Among men, heart failure was associated with higher odds of stress (OR 1.99; 95% CI 0.39, 10.22), urgency (1.65; 95% CI 0.91, 2.99) and mixed incontinence (OR 1.54; 95% CI 0.91, 2.62) but associations were not statistically significant.

**Conclusions** Heart failure is associated with higher odds of bothersome incontinence, especially among women.

**Keywords** Urinary incontinence · Heart failure · Cardiovascular disease · Population health

## Introduction

Urinary incontinence is a common and burdensome condition that affects 25–45% of older women and 11–34% of older

men [1–4]. Because the US population is aging, the economic burden of urgency incontinence alone is projected to exceed 86 billion dollars within the next few years with most costs incurred by patients [5]. Primary care and other providers may not be aware of a patient's incontinence symptoms because of either lack of reporting by the patient or lack of screening by the provider [6]. If urinary symptoms such as incontinence are never discussed, then patients will never receive counseling or interventions. In addition, incontinence can potentially interfere with self-management of chronic conditions that require diuretics such as heart failure, hypertension and chronic kidney disease (CKD). Incontinence is also associated with need for assistance in daily needs and unmet care needs [7]. Thus, identifying issues of incontinence in patients may help discern need for better social support to improve self-management.

Previous studies have found associations of urinary incontinence with several chronic conditions, including type 2 diabetes [2, 8] and obesity [2, 9]. However, information on the association of incontinence with chronic conditions such as

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hypertension, heart failure or CKD remains limited. These chronic conditions are often treated with diuretics and/or beta-blockers, both of which may exacerbate lower urinary tract symptoms [10, 11]. In addition, the prevalence of these conditions is increasing because of the aging of the US population.

We used data from a nationally representative sample of the US population to examine the prevalence of incontinence among adults age  $\geq 50$  years by presence of chronic conditions. We also examined the association of incontinence with use of diuretics and beta-blockers, drugs commonly used to treat cardiovascular and kidney diseases. We hypothesized that incontinence prevalence is higher among older adults with chronic conditions.

## Methods

### Study population

We used data from the 2001–2014 National Health and Nutrition Examination Survey, a probability sample of the civilian non-institutionalized US population age  $\geq 2$ -months. Details of the survey design can be found in the NHANES operation manual [12]. In total, 72,216 individuals were surveyed between 2001 and 2014. Because incontinence and cardiovascular disease (CVD) and other chronic conditions are uncommon among younger adults, we limited our analyses to the 18,874 NHANES participants who were  $\geq 50$  years of age. Because the sample size for “other” race/ethnicity was small, our analyses included participants who reported their race as non-Hispanic white, non-Hispanic black or Mexican-American ( $n = 16,348$ ). Our sample population excluded NHANES participants who did not answer questions regarding urinary incontinence ( $n = 1525$ ) or had a sample weight  $< zero$  ( $n = 358$ ). In the final analysis set, 7226 respondents were women and 7239 were men.

### Chronic conditions

Medical history was collected during the interview by trained personnel using standardized questionnaires. Hypertension was defined as blood pressure  $\geq 140/90$  mmHg and/or use of antihypertensive medications. Fasting blood samples were collected from all participants and measured for serum creatinine. CKD was defined as presence of an estimated glomerular filtration rate  $< 60$  ml/min/1.73 m<sup>2</sup> based on measured serum creatinine value using the CKD-Epi equation [13]. Heart failure was defined as the respondent answering “Yes” to the question, “Have you ever been told by a physician that you had heart failure?” CVD was defined as the participant

self-reporting a previous physician diagnosis of angina, coronary artery disease or myocardial infarction. Diabetes mellitus was defined as the respondent self-reporting a previous physician diagnosis of diabetes mellitus (except during pregnancy) or if the respondent had a history of taking insulin or other glucose-lowering medications. A history of prostate cancer was based on the self-report of a physician diagnosis of prostate cancer.

### Incontinence

During the interview, study participants answered standardized questions which were administered in English or Spanish by trained personnel. Presence of stress incontinence was defined as responding “Yes” to 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?” and absence of urgency incontinence. Presence of urgency incontinence was defined as responding “Yes” to 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 could not get to the toilet fast enough?” and absence of stress incontinence. Mixed incontinence was defined as a “Yes” response to questions on stress and urgency incontinence. Incontinence was determined to be bothersome if the participant rated any involuntary leakage of urine, regardless of its frequency, as being “somewhat,” “very much” or “greatly” bothersome.

### Covariates

Age was defined as the age at the time of the interview. Race/ethnicity data were based on self-report. Body mass index in kg/m<sup>2</sup> was calculated from the weight and height measured during physical examination at the mobile survey center. Parity data were collected during the standardized interview. Participants were asked to bring all prescription medications taken in the past 2 weeks to their NHANES medical evaluation. Medication names were then recorded by trained personnel and coded into medication classes according to their generic equivalents. See Table S1 in Supplemental Materials for a list of medications included in the analyses.

### Statistical analysis

Statistical analyses were performed with SAS®-callable SUDAAN® software version 9.0. Sample weights were incorporated to calculate prevalence estimates that would reflect the entire non-institutionalized US population. NHANES 2001–2014 data are weighted to account for the probability of selection and to adjust for nonresponse to the interview and physical examination. Sex-specific multivariable logistic

regression analyses were used to calculate odds of urinary incontinence by morbidity and medication use. Model 1 adjusted for age, race and body mass index as well as parity in women. Model 2 included model 1 and further adjusted for the use of diuretics and/or beta-blockers as well as estrogen in women and alpha-blockers for treatment of benign prostatic hyperplasia in men. Model 3 included model 2 and further adjusted for the concurrent presence of hypertension, CKD, heart failure, CVD, diabetes mellitus and/or prostate cancer (men).

## Results

Table 1 shows the characteristics of the study population. Race/ethnicity was reported as non-Hispanic white in 85.3% of women and 85.7% of men, non-Hispanic black in 9.3% of

**Table 1** Characteristics of the study population

	Women (sampled persons = 7226)	Men (sampled persons = 7239)
Age, years	+ 64.2 (0.2)	+ 62.9 (0.1)
% 50–59.9 years	48.0 (0.7)	42.8 (0.76)
% 60–69.9 years	28.2 (0.7)	28.4 (0.7)
% 70–79.9 years	20.9 (0.5)	24.5 (0.6)
% 80 + years	2.9 (0.2)	4.4 (0.3)
Body mass index kg/m <sup>2</sup>	+ 29.3 (0.1)	+ 29.0 (0.1)
% < 25 kg/m <sup>2</sup>	21.6 (0.6)	29.7 (0.7)
% 25–29.9 kg/m <sup>2</sup>	42.4 (0.8)	31.2 (0.8)
% 30–39.9 kg/m <sup>2</sup>	32.0 (0.7)	31.0 (0.7)
% 40+ kg/m <sup>2</sup>	4.1 (0.4)	8.2 (0.4)
Race		
% Non-Hispanic White	84.7 (0.8)	85.3 (1.0)
% Non-Hispanic Black	10.9 (0.8)	9.7 (0.7)
% Mexican-American	4.4 (0.5)	5.0 (0.6)
Chronic conditions		
% Hypertension	59.0 (0.9)	55.1 (1.0)
% Chronic kidney disease	19.1 (0.6)	14.3 (0.5)
% Heart failure	4.9 (0.3)	5.6 (0.4)
% Cardiovascular disease	13.1 (0.6)	19.1 (0.6)
% Diabetes	15.0 (0.6)	16.4 (0.5)
% Prostate cancer	–	4.7 (0.3)
Parity		
% 0	1.4 (0.2)	–
% 1	16.0 (0.6)	–
% 2	34.0 (0.7)	–
% ≥ 3	48.6 (0.9)	–

+Values expressed as means (standard error). Values are expressed as prevalence (standard error) unless otherwise indicated. Percentages are based on weighted data

women and 10.1% of men, and Mexican-American in 4.9% of women and 5.1% of men. Mean age was 64.2 years [standard error (SE) 0.2] in women and 62.9 years (SE 0.1) in men while mean body mass index was 29.3 kg/m<sup>2</sup> (SE 0.1) in women and 29.0 kg/m<sup>2</sup> (SE 0.1) in men. The percentage of men and women age ≥ 80 years was 2.9% (SE 0.2) and 4.4% (SE 0.3), respectively. CKD, congestive heart failure and CVD were present in 19.1% (SE 0.6), 4.9% (SE 0.3) and 13.1% (SE 0.6) of women, respectively, and 14.3% (SE 0.5), 5.6% (0.4) and 19.1% (0.6) of men, respectively. Diuretic use was reported by 23.4% (SE 0.7) of the women and 17.0% (SE 0.6) of men. Beta-blocker use was documented by 18.9% (SE 0.7) of both men and women. Overall, 6.6% (SE 0.4) of women reported estrogen use while 9.6% (SE 0.4) of men reported use of alpha-blockers for benign prostatic hyperplasia. Prevalence of stress, urgency and mixed incontinence, regardless of both, was reported by 26.8% (SE 0.7), 14.4% (SE 0.6) and 23.9% (SE 0.6) of women, respectively, and 2.9% (SE 0.3), 15.2% (SE 0.5) and 4.6% (SE 0.3) of men, respectively. Prevalence estimates of bothersome incontinence for all types were lower in men than women (see Table 2). Supplemental Table 2 shows the prevalence of bothersome incontinence by incontinence type among women and men across age and BMI groups. For both men and women, bothersome incontinence generally increased with advancing age and with higher BMI except for bothersome female stress incontinence prevalence, which was not age dependent.

Population estimates of incontinence among the general non-institutionalized US population age ≥ 50 years are shown in Table 2. In total, an estimated 9.6 million women and 2.2 million men age ≥ 50 years are affected by bothersome stress and/or urgency incontinence. Figures 1 and 2 show the difference in prevalence of bothersome incontinence among women and men, respectively, by presence of chronic conditions. Among both women and men, prevalence of mixed incontinence was generally higher with presence of a chronic condition such as diabetes, hypertension, heart failure and CVD. Significant differences in all types of bothersome incontinence were noted with presence of heart failure for both women and men. Small but significant differences in bothersome mixed incontinence prevalence were noted with use of diuretics or beta-blockers (Fig. 3) among women. However, after adjustment for age, BMI and chronic conditions, no significant association was noted with diuretics or beta-blockers and bothersome incontinence of any type among women or men (data not shown).

The adjusted odds of bothersome incontinence for women and men by presence of a chronic condition are shown in Tables 3 and 4. Among women, no significant association was noted with hypertension, CKD, or CVD and bothersome stress, urgency or mixed incontinence. However, after adjustment for all covariates, heart failure was associated with significantly lower odds of both stress (OR 0.50; 95% CI 0.28,

**Table 2** Prevalence of any, frequent and bothersome incontinence by incontinence type among women and men age  $\geq$  50 years

	% (SE)	Sampled persons	Population estimate in millions	% (SE)	Sampled persons	Population estimate in millions
	Women			Men		
Any incontinence						
Stress	26.8 (0.7)	1667	1.1 (0.5)	2.9 (0.3)	227	1.1 (0.1)
Urgency	14.4 (0.6)	1172	5.9 (0.3)	15.2 (0.5)	1347	5.5 (0.3)
Mixed	23.9 (0.6)	1751	9.8 (0.4)	4.6 (0.3)	437	1.7 (0.1)
Bothersome incontinence						
Stress	6.7 (0.4)	393	2.7 (0.2)	0.6 (0.1)	45	0.2 (0.04)
Urgency	4.8 (0.4)	369	1.9 (0.2)	1.9 (0.2)	309	1.3 (1.0)
Mixed	12.1 (0.5)	872	5.0 (0.2)	1.9 (0.2)	194	0.7 (0.1)

Values are expressed as prevalence (standard error) unless otherwise indicated. Percentages are based on weighted data; thus, the actual percentage of adults in an incontinence group may not equal the projected population prevalence using the sample weights

0.91) and urgency (0.43; 95% CI 0.19, 0.98) incontinence, while both heart failure (OR 2.35; 95% CI 1.62, 3.42) and diabetes mellitus (OR 1.40; 95% CI 1.10, 1.77) were significantly associated with higher odds of mixed incontinence (Table 3). Among men, heart failure was associated with higher odds of stress (OR 1.99; 95% CI 0.39, 10.22) urgency (OR 1.65; 95% CI 0.91, 2.99) and mixed incontinence (OR 1.54; 95% CI 0.91, 2.62) but the 95% CI included 1.00. (Table 4). Prostate cancer history was associated with significantly higher odds of both stress incontinence (OR 22.54; 95% CI 7.85, 64.72) and mixed incontinence 3.04 (1.62, 5.68).

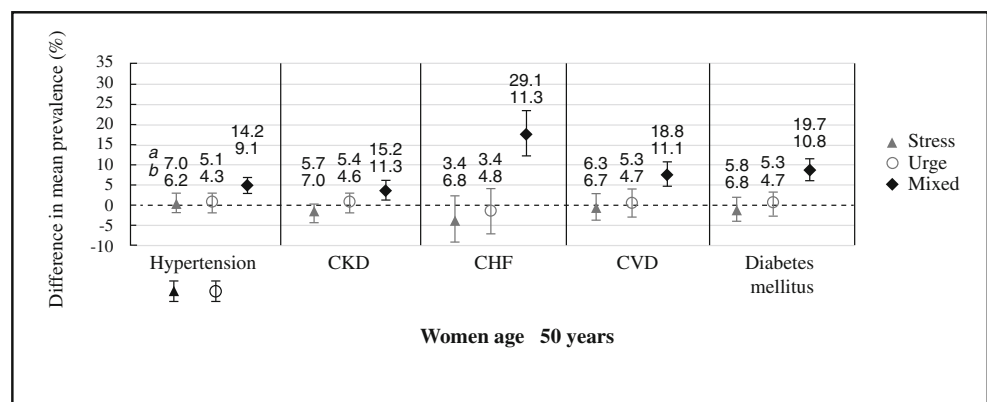
## Discussion

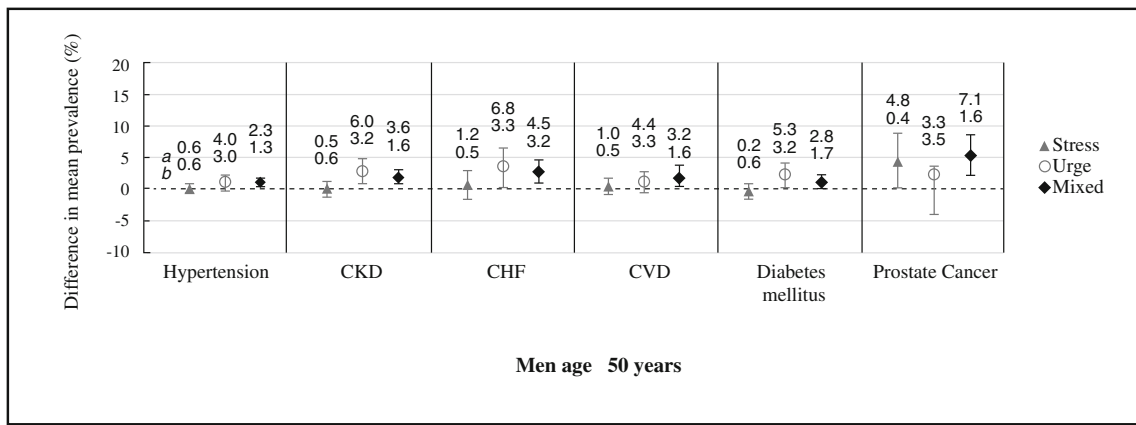
Our analysis of a representative sample of the non-institutionalized US population age  $\geq$  50 years estimates that almost 10 million women and  $>$  2 million men suffer from bothersome urgency or stress incontinence. Within the next 30

years, North America is expected to be the second oldest region on the globe with over 20% of the population age 65 years and older [16]. The aging of the population is compounded by an ongoing and unabated obesity epidemic [17], and obesity can increase intra-abdominal pressure, which may lead to chronic strain and weakening of the pelvic floor. Because incontinence risk increases with advancing age [2], and with obesity [2, 8, 14, 15], the population burden of incontinence will likely increase over the next several decades.

Advancing age and obesity are also strong risk factors for the development of multiple chronic conditions including diabetes mellitus, hypertension, CKD, CVD and heart failure [18]. This study shows generally higher prevalence of bothersome mixed incontinence among women and bothersome urgency and mixed incontinence among men, with presence of these chronic conditions. Higher odds of bothersome mixed incontinence were noted with presence of heart failure, especially among women even after adjustment for age, body mass index and medication use. Very few studies have examined

**Fig. 1** Differences in prevalence of bothersome incontinence by presence of chronic conditions among women age  $\geq$  50 years. Prevalence of bothersome incontinence is shown in those with<sup>a</sup> and without<sup>b</sup> the chronic condition, respectively, and error bars represent 95% confidence interval in mean difference





**Fig. 2** Differences in prevalence of bothersome incontinence by presence of chronic conditions among men age => 50 years. Prevalence of bothersome incontinence is shown in those with<sup>a</sup> and without<sup>b</sup> the

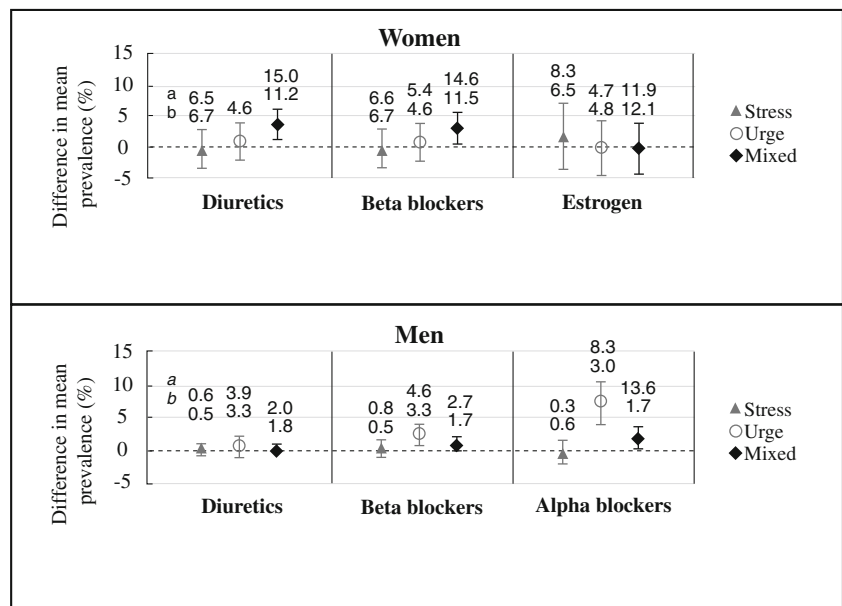
chronic condition, respectively, and error bars represent 95% confidence interval in mean difference

incontinence or other lower urinary tract symptoms in persons with heart failure [10, 19]. Some postulate that the heightened ventricular wall tension in heart failure leads to release of natriuretic peptides, which stimulate natriuresis and urge to urinate, similar to diuretics [10]. In addition, persons with heart failure may also be less active, leading to poor pelvic muscle function. Because incontinence depends to a degree on pelvic floor function [20], any chronic illness can lead to deconditioning of pelvic floor muscle tone. Medications such as diuretics and beta-blockers are another potential reason why patients with heart failure may be at higher risk of incontinence [10]. Diuretics may exacerbate incontinence by causing large volumes of urine to enter the bladder over a shorter time [11], which leads to more times that the bladder reaches maximal capacity. When the bladder volume reaches maximal capacity, urgency incontinence can be triggered in susceptible

patients. Beta-adrenergic blocking drugs may cause or worsen urgency and mixed incontinence by increasing bladder contractility, leading to an increased sense of urinary urgency and urgency incontinence [10]. In our analyses, however, we found no significant association between use of diuretics or beta-blockers and prevalence of bothersome incontinence, which may be due to behavioral adaptations [21, 22].

We also found significant associations of incontinence with diabetes mellitus and bothersome mixed incontinence among women. The link between diabetes mellitus and incontinence is likely multi-factorial and includes increased urine volumes with glucosuria and, in more advanced diabetes, neuropathy, which may impair detrusor muscle contractility, leading to large postvoid residual volume, urinary retention and eventually overflow incontinence [23]. One recent study, however, found no association between presence of neuropathy and

**Fig. 3** Mean difference in prevalence of bothersome incontinence by presence of medication use. Prevalence of bothersome incontinence is shown in those with<sup>a</sup> and without<sup>b</sup> medication use, respectively, and error bars represent 95% confidence interval in mean difference



**Table 3** Multivariable adjusted odds of incontinence with bother by presence of chronic condition and by incontinence type among women

Multivariable odds ratios (95% CI)			
Condition	Stress incontinence with bother		
	Model 1	Model 2	Model 3
Hypertension	1.35 (1.01–1.81)	1.26 (0.92–1.75)	1.24 (0.81–1.90)
Chronic kidney disease	1.10 (0.74–1.63)	1.21 (0.80–1.85)	1.24 (0.81–1.90)
Heart failure	0.55 (0.31–0.97)	0.49 (0.27–0.92)	0.50 (0.28–0.91)
Cardiovascular disease	1.70 (1.33–2.16)	1.13 (0.72–1.79)	1.20 (0.76–1.91)
Diabetes mellitus	0.83 (0.58–1.18)	0.82 (0.56–1.19)	0.84 (0.56–1.24)
Condition	Urgency incontinence with bother		
	Model 1	Model 2	Model 3
Hypertension	0.94 (0.70–1.26)	0.72 (0.35–1.52)	0.93 (0.66–1.31)
Chronic kidney disease	0.85 (0.64–1.18)	0.60 (0.21–1.72)	0.83 (0.58–1.20)
Heart failure	0.51 (0.27–0.95)	0.50 (0.26–0.97)	0.43 (0.19–0.98)
Cardiovascular disease	0.90 (0.64–1026)	0.90 (0.63–1.230)	1.01 (0.67–1.51)
Diabetes mellitus	1.02 (0.76–1.35)	0.60 (0.26–1.38)	1.05 (0.74–1.48)
Condition	Mixed incontinence with bother		
	Model 1	Model 2	Model 3
Hypertension	1.34 (1.05–1.72)	1.31 (1.02–1.60)	1.30 (0.99–1.72)
Chronic kidney disease	1.24 (0.96–1.62)	1.21 (0.92–1.59)	1.07 (0.81–1.40)
Heart failure	2.72 (1.93–3.85)	2.67 (1.87–3.80)	2.35 (1.62–3.42)
Cardiovascular disease	1.65 (1.28–2.13)	1.62 (1.26–2.10)	1.32 (0.99–1.75)
Diabetes mellitus	1.67 (1.37–2.03)	1.61 (1.28–2.01)	1.40 (1.10–1.77)

**Table 4** Multivariable adjusted odds of incontinence with bother by presence of chronic condition and by incontinence type among men

Multivariable odds ratios (95% CI)			
Condition	Stress incontinence		
	Model 1	Model 2	Model 3
Hypertension	1.09 (0.54–2.23)	0.84 (0.42–1.69)	0.82 (0.81–1.65)
Chronic kidney disease	0.65 (0.25–1.66)	0.61 (0.24–1.58)	1.06 (0.70–1.59)
Heart failure	2.45 (0.77–7.80)	2.34 (0.53–10.27)	1.99 (0.39–10.22)
Cardiovascular disease	2.12 (0.75–5.96)	1.40 (0.85–2.29)	1.75 (0.759–5.22)
Diabetes mellitus	0.32 (0.07–1.51)	0.90 (0.56–1.46)	0.33 (0.07–1.6)
Prostate cancer	21.26 (6.65–67.97)	21.32 (6.68, 68.08)	22.54 (7.85, 64.72)
Condition	Urgency incontinence		
	Model 1	Model 2	Model 3
Hypertension	0.96 (0.70–1.33)	1.04 (0.74–1.46)	1.02 (0.873–1.44)
Chronic kidney disease	1.40 (0.95–2.07)	1.41 (0.96–2.07)	1.28 (0.97–1.69)
Heart failure	1.1 (0.98–2.64)	1.63 (0.94–2.82)	1.65 (0.91–2.99)
Cardiovascular disease	1.01 (0.71–1.344)	0.98 (0.65–1.51)	0.89 (0.57–1.38)
Diabetes mellitus	1.41 (0.99–2.02)	1.36 (0.94–1.95)	1.33 (0.92–1.92)
Prostate cancer	0.69 (0.41–1.18)	0.72 (0.42–1.23)	0.68 (0.39–1.16)
Condition	Mixed incontinence with bother		
	Model 1	Model 2	Model 3
Hypertension	1.29 (0.81–2.07)	1.40 (0.88–2.22)	1.34 (0.84–2.14)
Chronic kidney disease	1.15 (0.74–1.78)	1.21 (0.79–1.87)	1.16 (0.77–1.76)
Heart failure	1.46 (0.89–2.40)	1.65 (1.00–2.73)	1.54 (0.91–2.62)
Cardiovascular disease	1.23 (0.77–2.00)	1.25 (0.75–2.09)	1.12 (0.66–1.91)
Diabetes mellitus	1.09 (0.66–1.79)	1.09 (0.68–1.76)	1.05 (0.64–1.72)
Prostate cancer	3.02 (1.64–5.50)	3.01 (1.63–5.58)	3.04 (1.62–5.68)

incontinence in patients with diabetes [8], and therefore the mechanism of this association remains unclear. History of treated prostate cancer was significantly associated with incontinence among men as shown in previous studies [24, 25].

Our study has several strengths. We analyzed a representative sample of the US population, and the analyses accounted for the complex survey design and non-response. Our analyses provide estimates of the number of US adults age 50 years and older who may suffer from incontinence. The weaknesses of the study include potential recall bias because prevalence estimates relied on self-reported incontinence, which is known to yield results that are somewhat different from those based on urodynamic evaluation [26]. The recall bias could lead to over- or underestimation of urinary symptoms, depending on the individual. However, self-report has the advantage of including the participant's subjective assessment of "bother" associated with incontinence. Women and men may have differed in their reporting of leakage symptoms based on accepted cultural norms, potentially complicating comparison of incontinence between the sexes. Presence of chronic conditions was also based on self-report. Because of these limitations, the findings of this study need to be confirmed in other population studies.

In conclusion, our analysis further supports that urinary incontinence is a bothersome symptom that affects many US women and men age  $\geq 50$  years. Older adults with chronic conditions, especially heart failure, may be more likely to have bothersome incontinence. The findings from this study require confirmation in other study populations but providers should be aware of the high prevalence of bothersome incontinence among older patients. Querying presence of urinary incontinence may help guide treatment of chronic conditions in some patients.

### Compliance with ethical standards

**Conflict of interest** All authors report no conflicts of interest.

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