Caffeine Intake and its Association with Urinary Incontinence in United States Men: Results from National Health and Nutrition Examination Surveys 2005–2006 and 2007–2008

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Abbreviations and Acronyms

BMI = body mass index

ISI = Incontinence Severity Index

UI = urinary incontinence

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Purpose: Epidemiological studies in women have revealed an association between caffeine intake and urinary incontinence, although evidence among men is limited. Therefore, we evaluated the association between caffeine intake and urinary incontinence in United States men.

Materials and Methods: Data were used from male NHANES (National Health and Nutrition Examination Surveys) 2005–2006 and 2007–2008 participants. Urinary incontinence was defined using a standard questionnaire with Incontinence Severity Index scores 3 or greater categorized as moderate to severe. Structured dietary recall was used to determine caffeine consumption (mg per day), water intake (gm per day) and total dietary moisture (gm per day). Stepwise multivariable logistic regression models were used to assess the association between caffeine intake at or above the 75th and 90th percentiles and moderate to severe urinary incontinence, controlling for potential confounders, urinary incontinence risk factors and prostate conditions in men age 40 years or older.

Results: Of the 5,297 men 3,960 (75%) were 20 years old or older with complete data. Among these men the prevalence of any urinary incontinence was 12.9% and moderate to severe urinary incontinence was 4.4%. Mean caffeine intake was 169 mg per day. Caffeine intake at the upper 75th percentile (234 mg or more daily) and 90th percentile (392 mg or more per day) was significantly associated with having moderate to severe urinary incontinence (1.72, 95% 1.18–2.49 and 2.08, 95% 1.15–3.77, respectively). In addition, after adjusting for prostate conditions, the effect size for the association between caffeine intake and moderate to severe urinary incontinence remained.

Conclusions: Caffeine consumption equivalent to approximately 2 cups of coffee daily (250 mg) is significantly associated with moderate to severe urinary incontinence in United States men. Our findings support the further study of caffeine modification in men with urinary incontinence.

Key Words: caffeine, urinary incontinence, food habits, men

Urinary incontinence is a prevalent condition in men, and is associated with profound physical, psychosocial and quality of life burdens.[1] Among community dwelling United States men, prevalence estimates have ranged between 5% and 21%.[1–4] Lifestyle changes are recommended for initial UI treatment, and may include fluid modification such as maintaining adequate

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hydration and reducing intake of caffeinated beverages.[2]

Caffeine, the most widely used stimulant in the world, is consumed by more than 85% of adults in the United States.[5] Recent large epidemiological studies of women have revealed that caffeine is associated with prevalent UI and incident urgency UI.[6,7] Smaller intervention studies in women have suggested a physiological link between high caffeine intake and diuresis.[8–10] Other trials have suggested that caffeine reduction in women leads to less frequent UI.[11,12]

Despite these findings in women, the evaluation of caffeine and UI in men has been relatively unexplored. A large cohort study of men in the United Kingdom failed to find an association between different types of caffeinated beverages and symptoms suggestive of overactive bladder, but an association with all types of UI was not specifically assessed.[13]

Given the prevalence of UI and the frequency of caffeine consumption, additional studies are needed to evaluate the relationship between caffeine intake and UI in men. In this analysis we explored the association between caffeine intake and UI in a representative sample of United States men and controlled for prostate factors.

MATERIALS AND METHODS

We used publically available data from the 2005–2006 and 2007–2008 NHANES for this analysis (www.cdc.gov/nchs/nhanes.htm). NHANES data are cross-sectional biannual surveys on the health and nutrition status of a nationally representative, noninstitutionalized United States population. The NHANES uses a complex, stratified, multistage, probability cluster design for sampling, including interviews and physical examinations. The National Center for Health Statistics Ethics Review Board approved the protocol. All participants provided written informed consent with guaranteed confidentiality.

NHANES participants were interviewed in their homes, and underwent standardized physical examination including measured height and weight, with further questioning at a mobile examination center. Questions regarding UI were assessed by computer assisted personal interviews methodology. A positive response to the question, "During the past 12 months, have you leaked or lost control of even a small amount of urine with activity like coughing, lifting or exercise?" defined stress UI. Urgency UI was defined based on a positive response 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 couldn't get to the toilet fast enough?" In men who responded negatively to the stress and urgency UI questions, a positive response to the question, "During the past 12 months, have you leaked or lost control of even a small amount of urine during nonphysical activities?" defined other incontinence. Positive responses to the stress and urgency UI questions defined mixed UI. Any UI was defined by a positive response to at least 1 of the UI questions.

To define moderate to severe UI we used data from the validated 2-item ISI,[6,14] which measures incontinence frequency and incontinence volume. The product of the responses to these items was calculated to obtain a severity score ranging from 1 to 12. An ISI score of 3 or more was categorized as moderate to severe UI, which corresponds to at least weekly leakage or monthly leakage of volumes of more than just drops.[14]

A multiple-pass dietary recall method, developed and validated by the U.S. Department of Agriculture for NHANES, was used to collect dietary data.[15] Participants participated in 2, 24-hour dietary recall periods. The first 24-hour dietary recall was done during the initial computer assisted personal interviews, while the second recall occurred 3 to 10 days later by telephone. From the 2, 24-hour dietary recalls we calculated average caffeine consumption (mg per day), water intake (consisting of tap, bottled, plain or carbonated, sweet or unsweetened water, in gm daily) and total moisture (consisting of all moisture present in foods and beverages in gm daily, excluding alcohol).[15] Caffeine intake from the dietary data included fluid sources (coffee, tea and soda) and food sources (chocolate).[15] Caffeine intake was categorized into quartiles based on the distribution of intake among men as lower (0 to 40 mg daily), lower middle (41 to 114 mg daily), upper middle (115 to 234 mg per day) and upper (greater than 234 mg per day) quartiles. We analyzed the upper quartile and the upper tenth percentile (392 mg or more daily) to examine for an association with UI.

Water intake was divided into quartiles, with the upper quartile (1,304 mg or more per day) defined as high water intake. Total dietary moisture from foods and beverages was also categorized into quartiles with the upper quartile (3,319 gm or more per day) defining high intake. Alcohol intake was obtained through the alcohol use questionnaire, and was dichotomized as "never drank alcohol" and "prior or current alcohol consumption."

Chronic disease data were based on self-report, and included arthritis, stroke, emphysema, chronic bronchitis, asthma, coronary heart disease, angina, myocardial infarction, hypertension and diabetes mellitus. An affirmative response to the question, "Have you ever been told by a doctor or health professional that you had an enlarged prostate gland?" defined benign prostate enlargement. Responding yes to the question, "Have you ever been told by a doctor or health professional that you had prostate cancer?" counted as having prostate cancer.

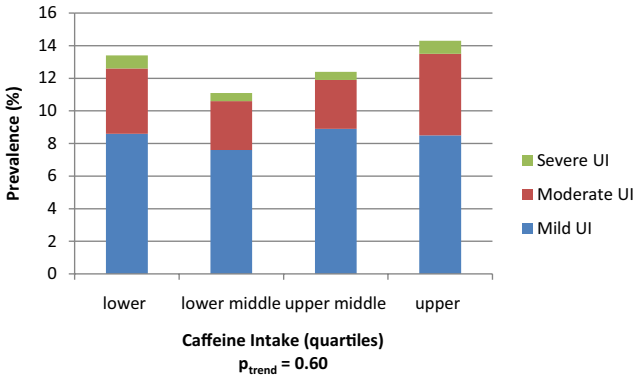
Self-rated general health status was defined by the question, "Would you say that in general your health is excellent, very good, good, fair or poor?" Responses to this question were aggregated into 2 categories of excellent, very good or good health vs fair or poor health. Depression was assessed using the validated Patient Health Questionnaire-9 (PHQ-9).[16–18] The PHQ-9 yields scores from 0 to 27, and scores of 10 or greater were used to define major depression.[16] Vigorous physical activity was defined by separate questions from the 2005–2006 and 2007–2008 NHANES cycles, and is described in detail elsewhere.[6]

All statistical analyses were calculated using STATA® 12.1, which incorporates the design effect, appropriate

sample weights, and the stratification and clustering of the complex NHANES sample design.[19] Pearson's chi-square test was used to assess the association between UI status and demographic and medical characteristics with prevalence estimates and 95% CIs. Estimates with relative standard errors greater than 30% were identified as statistically unreliable. Multivariable logistic regression models for caffeine intake at or above 75th and 90th percentiles were constructed using significant variables from the unadjusted analysis, in a stepwise fashion, with sociodemographic variables in step 2 (age, race/ethnicity, education and poverty status), comorbidity and BMI (step 3), self-rated health and depression (step 4), alcohol intake (step 5), total water and moisture intake (steps 6 and 7), and benign prostate enlargement and prostate cancer (steps 7 and 8, respectively). Prevalence odds ratios and 95% CIs were reported with statistical significance set at $p < 0.05$.

RESULTS

Of the 5,297 men in the pooled samples 3,960 (75%) had complete data for the UI and dietary intake variables. The overall prevalence of any UI was 12.9% (95% CI 11.0–15.0) and of moderate to severe UI was 4.4% (95% CI 3.6–5.3). The overall prevalence by UI type was 2.5% (1.8–3.5) for stress UI, 10.3% (9.1–11.6) for urgency UI and 2.7% (1.7–2.9) for mixed UI. Men with data missing on UI or dietary intake were more likely to be younger than 39 years and identify with ethnic groups other than nonHispanic white. Those with missing data more frequently reported less than a high school education, an income below the poverty threshold and fewer chronic diseases. Variables significantly associated with any UI in men included older age, higher BMI, fair/poor self-rated health, depression, a history of prostate cancer or enlargement, increased number of chronic diseases and alcohol intake (see supplementary table at http://jurology.com/). Men with moderate to severe UI differed in that BMI was not a significant factor. In the unadjusted analysis the association between race/ethnicity and any UI showed a trend toward significance ($p = 0.06$). However, there was no significant association in those with moderate to severe UI.



Quartiles of caffeine intake, and prevalence of mild, moderate and severe UI among men in NHANES (unadjusted).

Association of caffeine intake with moderate to severe UI

	Caffeine Intake 75th Percentile	Caffeine Intake 90th Percentile
Unadjusted analysis:		
No. pts	3,960	
POR (95% CI)	1.53 (1.13, 2.10)	1.91 (1.16, 3.15)
p Value	0.008	0.01
Multivariable model 1:*		
No. pts	3,831	
POR (95% CI)	1.72 (1.18, 2.49)	2.08 (1.15, 3.77)
p Value	0.006	0.02
Multivariable model 2:†		
No. pts	2,546	
POR (95% CI)	1.69 (1.09, 2.61)	2.03 (1.09, 3.78)
p Value	0.02	0.03

* Controls for age, race/ethnicity, education, BMI, vigorous activity, poverty-to-income ratio, chronic disease, health status, depression, alcohol intake, water intake and total moisture intake.

† Controls for all variables listed for model 1 in addition to prostate cancer and prostate enlargement in men 40 years old or older.

Mean caffeine intake was 169 mg per day (range 0 to 2,415). Men with caffeine intake at the upper 75th percentile or higher were more likely to report moderate to severe UI ($p = 0.008$), as were those in the upper 90th percentile or higher ($p = 0.006$). However, the dose-response relationship between caffeine intake and moderate to severe UI was not significant (see figure). Comparing men with UI who reported caffeine intake in the upper 75th percentile (163) to those below, there was a trend toward an association with stress UI and urgency UI.

Water intake at the 75th or greater percentile (1,304 mg or more per day) was not significantly related to any UI. Total moisture intake at the 75th or greater percentile (3,319 gm or more daily) was associated with any UI ($p = 0.03$). After adjustment for potential confounding variables, there was no significant association between water intake or total moisture intake and any UI or moderate to severe UI (data not shown).

In multivariable analysis controlling for all significant variables from the unadjusted analysis, as well as for education, race/ethnicity and the poverty-to-income ratio, caffeine intake at the 75th and 90th percentiles (234 mg or more and 392 mg or more per day) was significantly associated with moderate to severe UI (see table) but not any UI (data not shown). Further adjustment for prostate related conditions (analyzed separately and together in different models) among men 40 years old or older did not significantly change the effect size for the association between caffeine intake and moderate to se-

vere UI. A test of interaction to assess if the association between caffeine intake and moderate to severe UI varied based on total moisture or total water consumption were not significant.

DISCUSSION

After controlling for age, UI risk factors and potential confounders, the prevalence of moderate to severe UI, which corresponds to at least weekly leakage or monthly leakage of volumes more than just drops, was associated with a caffeine intake of 234 mg or more per day in a representative sample of United States men age 20 years or older. Two cups of coffee typically have at least 250 mg caffeine and a previous study showed that United States men age 35 to 54 years have a mean intake of 336 mg per day.[5] Given that caffeine intake may be increasing in the United States population,[20] an evaluation of limiting caffeine among men with UI is warranted.

Few studies have explored the association between caffeine and UI in men. A recent cross-sectional study of middle-aged to older Japanese adults did not find a significant correlation between caffeine intake and UI in men and women. The mean caffeine intake of this population was 120 mg per day, which was notably less than the caffeine consumption of the men in our analysis.[21] A longitudinal study exploring the association between dietary and lifestyle factors and incident overactive bladder in men 40 years old or older (19,355) found no significant association between daily caffeine intake and the onset of urgency or urgency UI.[13] However, this study did not use a composite caffeine variable or evaluate UI as a separate outcome, which may have decreased the ability to detect an association.

Some studies suggest pathophysiological mechanisms which could explain a causal relationship between caffeine and UI.[22–24] Caffeine has been shown to affect genitourinary structures leading to increased detrusor pressure with bladder filling and diuresis, particularly when daily caffeine consumption exceeds 250 to 300 mg.[8,23] Intervention studies in women reveal that caffeine reduction is associated with decreased frequency and volume of UI. Bryant et al found that caffeine reduction to 100 mg or less per day in conjunction with bladder retraining methods significantly improved urinary frequency and urgency in a sample of low (101 to 200 mg daily) to high (greater than 301 mg daily) consumers of caffeine.[25] Another small sample of community dwelling elderly women revealed an association between caffeine reduction and UI frequency which approached significance ($p = 0.07$), while increased fluid intake and UI showed no association.[11]

In our analysis water and fluid intake showed no association with UI after controlling for other confounders. This association is consistent with intervention studies in women showing no increased risk of UI while increasing fluid intake within a recommended range.[11,12] While patients may attempt to reduce UI frequency by reducing overall fluid intake, these results are consistent with a recommendation that water and total fluid intake are not associated with UI in men. Given the association between the prevalence of UI and high caffeine intake, decreasing consumption of caffeine containing beverages is a more appropriate target for intervention.

Finally, our findings increase knowledge regarding the impact of caffeine intake on lower urinary tract symptoms, specifically comparing the effects of caffeine on UI in male and female populations using validated urinary symptom questionnaires.[6] In a sample of predominately white women without UI (65,176) from the Nurses' Health Study, Jura et al found an increased risk of incident UI among the highest caffeine consumers (greater than 450 mg per day) compared to those with the lowest intake level (less than 150 mg per day) (RR 1.19, 95% CI 1.06–1.34).[7] Our findings from NHANES, which oversampled specific racial/ethnic minorities to be representative of the United States population, demonstrated an association between lower levels of caffeine intake (234 mg or more and 392 mg or more per day) and moderate to severe UI in men. Among women in NHANES we found an association between caffeine intake (204 mg or more per day) and any UI (POR 1.47, 95% CI 1.07–2.01).[6] In a prospective cohort evaluation of women from the Nurses' Health Study (21,564), the authors found no association between the risk of moderate UI progression and long-term caffeine intake even as intake levels increased.[22]

Among the limitations of our study is the cross-sectional design of NHANES. Therefore, causation cannot be determined. Sources of dietary caffeine from the NHANES data set could not be determined, which would be of interest in determining the differential effects on UI based on the type of caffeinated intake. Due to the small percentage of men reporting caffeine intake in the 90th percentile (1.89%), a reliable analysis related to the type of UI could not be completed. The smaller sample size of men in specific racial/ethnic groups and of men age 80 years or older limit our ability to discuss subgroup trends in this combined sample. Although widely used and validated,[14,26] the ISI requires additional research to validate the instrument in male populations.[27] Overall, 25% of the sample was excluded from analysis for missing UI and dietary data. The NHANES self-reported data on prostate conditions have shown some validity in accurately reporting prostate cancer.[28] However, validation of self-reported prostate enlarge-

ment is needed. Lastly, NHANES excludes institutionalized persons, thereby limiting generalizability.

CONCLUSIONS

Our findings demonstrate that consumption of caffeine equivalent to just 2 cups of coffee a day is associated with moderate to severe UI in men. Lifestyle interventions are recommended as first line treatment of UI in adults as they are relatively free of side effects and are amenable to targeted interventions.[2,25] While caffeine reduction is part of these recommendations in women,[2] research suggesting a link between caffeine and UI in men has been limited. Our epidemiological findings support the evaluation of caffeine reduction in men with UI.

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