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Fluid intake and risk of stress, urgency, and mixed urinary incontinence

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Abstract

Objective—We investigated the relation between total fluid intake and incident urinary incontinence in the Nurses' Health Study cohorts.

Study Design—We measured daily fluid intake using food frequency questionnaires among 65,167 women, aged 37–79 years, without urinary incontinence at study baseline (2000–2001). Women reported incontinence incidence on questionnaires during 4 years of follow-up. Multivariable-adjusted hazard ratios and 95% confidence intervals were calculated using Cox proportional hazards models.

Results—We found no association between total fluid intake and risk of incident incontinence (hazard ratio 1.04, 95% confidence interval 0.98–1.10 comparing top versus bottom quintile of fluid intake). In analyses of incontinence type, total fluid intake was not associated with risks of incident stress, urgency, or mixed incontinence.

Conclusion—No significant risk of incident urinary incontinence was found with higher fluid intake in women. These findings suggest that women should not restrict their fluid intake to prevent incontinence development.

Keywords

epidemiology; fluid intake; urinary incontinence

INTRODUCTION

Approximately 17–40% of community dwelling women with urinary incontinence (UI) report restricting their fluid intake in an effort to manage their urinary symptoms.^{1–3} This practice is supported by several cross-sectional studies^{1, 4, 5} that have shown a weak or modest positive correlation between fluid intake and severity of certain UI types, as well as

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clinical trials^{6, 7} that have shown some improvement in prevalent UI symptoms with fluid reduction.

However, data on whether fluid intake is related to development of UI are severely limited.⁸ The only large prospective study, by Dallosso et al.⁹, to examine the relation between total fluid intake and incident UI found no association between total fluid intake and the risks of stress incontinence or overactive bladder, although they did not examine urgency UI. Clearly, further studies on the relation between total fluid intake and UI are needed to help draw conclusions.

Therefore, we prospectively investigated the association between total fluid intake and incident UI, including stress, urgency, and mixed UI, over four years of follow-up in 65,167 women enrolled in the Nurses' Health Study (NHS) and the Nurses' Health Study II (NHS II).

MATERIALS AND METHODS

Study population

In 1976, the NHS was initiated when 121,700 female nurses aged 30 to 55 years returned a mailed questionnaire about their health and lifestyle. The NHS II was initiated in 1989 when 116,430 female nurses aged 25 to 42 years completed and returned a similar questionnaire. Participants provided informed consent by returning their questionnaires. In both cohorts, biennial questionnaires are used to collect updated information. Participants were asked about urinary incontinence on the 2000, 2002, and 2004 NHS questionnaires and the 2001, 2003, and 2005 NHS II questionnaires. The Institutional Review Board of Brigham and Women's Hospital approved these studies.

For these analyses, we defined baseline as 2000 in the NHS and 2001 in the NHS II. In each cohort, 93% (NHS: 78,197/83,997; NHS II: 79,684/85,507) of the women who provided information on UI at baseline also provided UI information on at least one of the follow-up questionnaires and were eligible for these analyses. Importantly, median fluid intake was identical in women who did and those who did not provide follow-up UI information (2.0 L/day), thus there is unlikely any meaningful bias due to the small loss to follow-up.

Among the 83,997 NHS participants and 85,507 NHS II participants with data on UI at baseline, we excluded 40,807 NHS participants and 43,926 NHS II participants with prevalent UI, defined as UI at least once per month or UI less than once per month of quantities at least enough to wet the underwear. In addition, at the beginning of each 2-year follow-up period, we excluded women missing data on UI incidence, fluid intake, or important potential confounding factors (i.e., body mass index [BMI], parity, or caffeine intake). We also excluded women with major neurologic conditions (i.e., stroke, multiple sclerosis, Parkinson's disease, or amyotrophic lateral sclerosis) or functional limitations (defined as difficulty climbing a flight of stairs, walking 1 block, bathing, or dressing). Thus, 65,167 women (NHS: 34,143 NHS; NHS II: 31,024) were included in these analyses.

Measurement of incident urinary incontinence

In both cohorts, participants were asked, "During the last 12 months, how often have you leaked or lost control of your urine?" Questions very similar to this have been previously proven valid for assessing UI.^{10, 11} Response options were never, less than once per month, 2–3 times per month, about once per week, and almost every day. Women who reported UI were then asked, "When you lose your urine, how much usually leaks?" Response options were a few drops, enough to wet your underwear, enough to wet your outer clothing, and

enough to wet the floor. A reliability study among 200 participants demonstrated high reproducibility of responses to these questions.¹²

Incident cases were defined as those reporting UI at least once per month on any of the follow-up questionnaires. Among incident cases, frequent incontinence was defined as incontinence occurring at least once per week.

At the first follow-up, we assessed incontinence type using a supplementary questionnaire mailed only to women with frequent incontinence because we believed that it would be easier for them to identify the precipitating circumstances of their incontinence. The items included to assign the type of UI were previously validated.^{13, 14} In the NHS, due to the large number of women with incident frequent UI, the supplementary questionnaire was mailed to a random sample of 80% of the cases (n=2,183) and completed by 84%. In the NHS II, the supplementary questionnaire was mailed to 98% of incident cases (n=1,224; 19 women were identified after the supplementary questionnaire mailing was complete and, thus, did not receive a mailing) and completed by 79%. For the second follow-up period, data on incontinence type were collected directly from the main questionnaire, and thus information on incontinence type was available from 99% of women with frequent incontinence.

Stress UI was defined as leaking primarily with coughing or sneezing, lifting things, laughing, or exercise. Urgency UI was defined as primarily leaking accompanied by an urge to urinate or a sudden feeling of bladder fullness. UI type was classified as mixed when women reported that stress and urgency UI symptoms were equally common.

Measurement of beverage intake

In both cohorts, food and beverage data were collected repeatedly with validated semi-quantitative food frequency questionnaires. FFQs were administered in 1980, 1984, 1986, and every four years thereafter in the NHS and every four years starting in 1991 in the NHS II. On the FFQ, participants were asked how often on average during the previous year they drank one standard serving of 22 different, commonly-consumed beverages. There were nine response options ranging from “none or less than 1/month” to “6+/day”. To calculate the average daily intake of each beverage, the serving size was multiplied by the reported frequency of use. Total fluid intake was calculated as liters per day by summing intakes of all beverages.

The reproducibility and validity of the NHS and NHS II FFQs have been reported previously.¹⁵ In a validation study among NHS participants, there were generally high correlations between beverage intakes assessed with the FFQ and with four 1-week diet records completed over a 1-year period; correlations were 0.78–0.93 for coffee, 0.68–0.88 for milk, 0.40–0.84 for soda, 0.34–0.56 for punch (noncarbonated fruit flavored drinks, Hawaiian punch, or lemonade), 0.75–0.89 for juice, and 0.52 for water (ranges due to different correlations for specific varieties of coffee, milk, soda, etc).^{16, 17} In an additional validation study, a reasonable correlation ($r=0.59$) between fluid intake on the FFQ and 24-hour urinary volume was reported.¹⁸

Statistical analysis

For the primary analyses, we defined daily fluid intake using the participant’s report from the most recent questionnaire prior to development of incontinence. Since the distribution of fluid intake was very similar in the two cohorts, we categorized fluid intake into quintiles based on the distribution of intake in the combined cohorts.

Cox proportional hazards models stratified by age in months and two-year risk period were used to calculate multivariable-adjusted hazard ratios (HRs) and their 95% confidence intervals (CIs) for each case definition (i.e., any, frequent, stress, urgency, and mixed UI). Covariates in the models were potential UI risk factors identified from the literature, including parity (0, 1–2, 3 or more births), BMI (kg/m², continuous), cigarette smoking (never, past, current: 1–14, 15–24, 25–34, 35 or more cigarettes per day), race (white, black, Asian, other or missing), diabetes, caffeine intake (mg/day, continuous), and physical activity (metabolic equivalent [MET]-hours per week, continuous).^{19–21} Further adjustment for diuretic use did not change the results and thus we did not include this variable in the multivariable models.

We conducted analyses in each cohort separately as well as after pooling the data from the two cohorts. Before combining data, we tested whether the association between fluid intake and incident UI varied between the older women in the NHS and the younger women in the NHS II by using an interaction term in the Cox proportional hazards models. For each outcome, the interaction term was not significant (all p-values for interaction ≥ 0.16), indicating that the association between fluid intake and UI was not different between cohorts. Thus we present only results from the pooled analyses. Nonetheless, analyses were adjusted for study cohort in addition to the variables described above.

We conducted several secondary analyses to explore possible bias in fluid intake measurement and to examine the association between fluid intake and incident UI in more detail. First, we repeated the analyses using the average of the two previous reports of daily fluid intake (i.e., from questionnaires up to 6 years prior to study baseline) rather than only the baseline report to decrease measurement error in a single report and minimize the impact of any changes in fluid intake that might have occurred in response to early incontinence symptoms. In addition, we examined the associations between specific beverage types and UI risk. For these analyses, we examined risks associated with a 240 ml (8 ounce) increase in intake of: 1) milk (including skim and whole milk); 2) juice (including apple, orange, grapefruit, tomato, and other fruit juices); 3) tea and coffee (both caffeinated and decaffeinated); 4) soda; 5) punch and lemonade; 6) alcoholic beverages; and 7) water. To isolate the association between each beverage type and risk of incident UI, the multivariable model included all 7 beverage types simultaneously as well as the covariates listed above.

For all analyses, two-tailed p-values < 0.05 were considered statistically significant. All data were analyzed using SAS 9.1 (SAS Institute Inc, Cary, NC).

RESULTS

In 2000, the NHS participants were 54 to 79 years old and in 2001, NHS II participants were 37 to 54 years old. In both cohorts, women who had higher daily fluid intake had higher mean physical activity levels and higher mean caffeine intake (table 1). Cigarette smoking tended to be more common with higher daily fluid intake, particularly in the NHS II. All these potential confounding factors were included in multivariable models.

Among women in the NHS and NHS II, the median daily fluid intakes across quintiles were 1.1 L, 1.6 L, 2.0 L, 2.4 L and 2.9 L, and the UI incidence rates in each quintile were 6.8, 6.8, 7.0, 7.1, and 7.2 cases per 100 person-years, respectively. After adjusting for potential confounding factors, there were no significant differences in UI risk across quintiles of fluid intake (table 2). For example, comparing women in the highest versus the lowest quintile of fluid intake, the fully adjusted HR was 1.04 (95% CI 0.98–1.09) for incident UI overall and 0.98 (95% CI 0.88–1.08) for incident frequent UI.

When we examined the risk of specific UI types (table 3), for frequent urgency UI, there was a borderline significant increased risk in the highest compared with the lowest quintile of fluid intake after adjusting for age and cohort (HR 1.22, 95% CI 0.98–1.53, $p=0.08$). However, this HR was attenuated to 1.13 (95% CI 0.89–1.43) with additional adjustment for caffeine intake, and the fully adjusted HR was 1.12 (95% CI 0.88–1.42) and not statistically significant. Fluid intake was also not associated with the risks of frequent stress or mixed UI.

In secondary analyses, we defined fluid intake using the average of the two most recent reports of fluid intake because we wanted to minimize measurement error associated with a single report, and we were concerned that the most recent report might have been influenced by early urinary symptoms; results were consistent with those reported above. For example, the HR for UI was 1.07 (95% CI 1.01–1.13) comparing the top to the bottom quintile of fluid intake. HRs for incident frequent stress (0.94, 95% CI 0.80–1.10), urgency (0.94, 95% CI 0.74–1.20), and mixed UI (1.22, 95% CI 0.96–1.53), comparing the top to the bottom quintile of fluid intake, were also similar to those in the primary analyses. In addition, we examined the associations between specific beverages and incident UI (data not shown in table). Overall, there were no consistent statistically significant associations between a 240 mL increase in intake of any of the beverages (milk, juice, water, etc.) and risk of incident UI.

COMMENT

In this analysis of two large prospective cohorts of women, we did not observe any associations between total fluid intake and risk of UI overall, or stress, urgency, or mixed UI.

Some limitations of our study should be considered. First, all information on urinary incontinence and fluid intake was self reported. However, previous studies have established the reliability and validity of self-reported UI data.^{10, 12} In addition, previous findings indicate that self-reported UI type is highly specific,²² which is most important for achieving valid results in prospective studies.²³ Furthermore, our beverage data were derived from well-validated FFQs^{15, 17} and, in secondary analyses, we averaged the two most recent reports of fluid intake to help minimize measurement error in a single report and address concerns that some women may have changed their fluid intake in response to early urinary symptoms.²⁴ Nonetheless, averaging the two most recent reports may not have completely eliminated potential bias from changes in fluid intake due to possible early symptoms.

Second, although we adjusted for a number of potential confounding factors in our statistical analyses, residual confounding cannot be ruled out as a potential explanation for the observed results. In particular, we did not collect data on urinary symptoms other than UI. If women with higher versus lower levels of fluid intake were less likely to have bladder storage or sensory symptoms that may increase risk of developing UI (e.g., urgency), our effect estimates would be underestimated. However, the clear null associations we observed suggest that variables unaccounted for in our analyses would need to be very strongly related to both fluid intake and UI risk in order for a clinically significant association between fluid intake and incident UI to be plausible.

Third, our data did not allow us to identify the exact quantity of fluid intake at a single time (e.g., six servings at once versus spread throughout the day), and thus we cannot determine whether large quantities of fluid consumed at once may result in different risks of UI than smaller quantities at a time.

Finally, findings from these cohorts of largely white women may not be generalizable to broader populations of women. In particular, because >95% of our study participants are white, our findings may not be generalizable to non-white women, in whom incidence and type of incontinence tend to be different than in white women.

Although data are sparse regarding the relation between fluid intake and incident UI, our null findings are consistent with those from a prospective study by Dallosso et al. in which no significant association was found between total fluid intake and the risk of incident overactive bladder or stress UI among 6,424 community dwelling women aged 40 years, followed for one year.⁹ However, in contrast to our results, carbonated drinks were strongly related to both overactive bladder (OR 1.70, 95% CI 1.28–2.25) and stress UI (OR 2.10, 95% CI 1.57–2.81) when consumed on a daily basis compared to less than weekly. Our different findings for carbonated beverages may partly be explained by the adjustment for caffeine intake in our study, which is a common component of many carbonated beverages. We have shown in a prior study of the NHS and NHS II that higher total caffeine intake is associated with a modest increased risk of urgency UI.²⁵

In conclusion, we found no association between total fluid intake and risk of UI. Therefore, although more research is needed to confirm our findings, our results suggest that women without UI should not be concerned about restricting their fluid intake for fear of increasing their risk of incident UI.

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Table 1
Baseline characteristics in each cohort according to total fluid intake (quintiles 1, 3, and 5)

Variable	Total fluid intake					
	NHS			NHS II		
	Q1 (n=6629)	Q3 (n=6567)	Q5 (n=6307)	Q1 (n=5783)	Q3 (n=5913)	Q5 (n=6151)
Mean age (years)	65.4	65.7	64.7	45.9	46.0	46.2
Mean BMI (kg/m ²)	25.8	25.8	26.0	25.3	25.5	25.8
Mean physical activity (MET-hrs/wk)	16.2	19.0	23.0	19.2	21.8	27.1
Mean caffeine intake (mg/day)	136.8	199.3	309.2	123.3	200.2	333.1
Race (%)						
White	96.7	97.2	98.1	95.0	96.8	98.1
Black	2.2	1.5	1.1	2.2	1.1	0.6
Asian	0.9	1.0	0.4	1.9	1.4	0.8
Other/missing	0.2	0.3	0.4	0.9	0.7	0.6
Parity (%)						
0	5.7	6.5	6.5	20.0	21.6	23.8
1–2	37.2	35.2	36.0	53.3	51.8	50.1
3+	57.1	58.4	57.5	26.6	26.6	26.1
Cigarette smoking (%)						
Never	47.9	45.7	41.3	73.7	68.9	59.8
Past	43.7	45.6	48.3	20.1	24.0	30.2
Current, cigarettes per day						
1–14	4.7	4.6	5.3	3.8	4.2	6.2
15–24	2.9	3.2	3.9	1.8	2.3	3.0
≥ 25	0.8	0.9	1.2	0.6	0.6	0.9

BMI, body mass index; MET, metabolic equivalent.

Table 2

Hazard ratios (95% confidence intervals) for incident urinary incontinence, by incontinence frequency, according to quintile of total fluid intake^a

Case definition	Total fluid intake				
	Q1	Q2	Q3	Q4	Q5
Median (L/day)	1.1	1.6	2.0	2.4	2.9
Person-years	45,508	45,732	45,979	44,804	43,084
Any UI					
Cases	3,078	3,131	3,210	3,176	3,082
Age and cohort adjusted HR	1.00 (reference)	1.03 (0.98 – 1.08)	1.03 (0.98 – 1.09)	1.06 (1.01 – 1.11)	1.04 (0.99 – 1.10)
Fully adjusted HR ^b	1.00 (reference)	1.03 (0.98 – 1.08)	1.03 (0.98 – 1.08)	1.06 (1.00 – 1.11)	1.04 (0.98 – 1.09)
Frequent UI					
Cases	891	876	876	903	876
Age and cohort adjusted HR	1.00 (reference)	0.98 (0.89 – 1.08)	0.98 (0.89 – 1.08)	1.04 (0.94 – 1.14)	1.03 (0.94 – 1.14)
Fully adjusted HR ^b	1.00 (reference)	0.98 (0.89 – 1.07)	0.96 (0.87 – 1.06)	1.02 (0.92 – 1.12)	0.98 (0.88 – 1.08)

CI, confidence interval; HR, hazard ratio; UI, urinary incontinence.

^a Any UI is defined as incontinence at least once per month; Frequent UI is defined as incontinence at least once per week.

^b HR adjusted for age, cohort, body mass index (kg/m², continuous), parity (0, 1–2, 3+ live births), cigarette smoking (never, past, current: 1–14, 15–24, 25+ cigarettes/day), race (white, black, Asian, other/missing), physical activity (metabolic equivalent-hrs/wk, continuous), caffeine intake (mg/day, continuous).

Table 3

Hazard ratios (95% confidence intervals) for incident frequent urinary incontinence, by incontinence type, according to quintile of total fluid intake^a

Case definition	Total fluid intake				
	Q1	Q2	Q3	Q4	Q5
Stress UI					
Cases	364	365	329	372	326
Age and cohort adjusted HR	1.00 (reference)	1.00 (0.87 – 1.16)	0.90 (0.77 – 1.05)	1.05 (0.90 – 1.21)	0.92 (0.79 – 1.07)
Fully adjusted HR ^b	1.00 (reference)	1.00 (0.86 – 1.16)	0.89 (0.77 – 1.04)	1.05 (0.90 – 1.22)	0.90 (0.76 – 1.06)
Urgency UI					
Cases	150	165	168	135	167
Age and cohort adjusted HR	1.00 (reference)	1.14 (0.91 – 1.43)	1.11 (0.89 – 1.40)	0.93 (0.73 – 1.17)	1.22 (0.98 – 1.53)
Fully adjusted HR ^b	1.00 (reference)	1.13 (0.90 – 1.42)	1.08 (0.86 – 1.35)	0.89 (0.70 – 1.14)	1.12 (0.88 – 1.42)
Mixed UI					
Cases	162	153	164	173	173
Age and cohort adjusted HR	1.00 (reference)	0.99 (0.79 – 1.23)	1.06 (0.85 – 1.32)	1.14 (0.92 – 1.42)	1.17 (0.94 – 1.46)
Fully adjusted HR ^b	1.00 (reference)	0.98 (0.78 – 1.23)	1.03 (0.82 – 1.29)	1.12 (0.90 – 1.40)	1.11 (0.88 – 1.40)

CI, confidence interval; HR, hazard ratio; UI, urinary incontinence.

^a Frequent UI is defined as incontinence at least once per week.

^b HR adjusted for age, cohort, body mass index (kg/m², continuous), parity (0, 1–2, 3+ live births), cigarette smoking (never, past, current: 1–14, 15–24, 25+ cigarettes/day), race (white, black, Asian, other/missing), physical activity (metabolic equivalent-hrs/wk, continuous), caffeine intake (mg/day, continuous).