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Body mass index and adult female urinary incontinence

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Summary. The aim of the present investigation was to study the possible role of obesity in the etiology of adult female urinary incontinence (UI). A random population sample of 3,114 women aged 30–59 years were mailed a questionnaire concerning UI and, among other things, body weight and height. The overall rate of response was 85%, and the present analysis comprises 2,589 women who supplied information about their body weight and height. The period prevalence of all UI, stress UI, urge UI, and mixed stress and urge UI was 17%, 15%, 9%, and 7%, respectively. The mean body mass index (BMI) was 22.7 kg/m^2. Irrespective of other risk indicators, BMI was positively associated with UI prevalence (OR, 1.07/BMI unit; $P < 0.0001$). BMI interacted with childbirth in predicting stress UI prevalence, with cystitis in predicting urge UI, and with both in predicting mixed UI. Stress UI proved to be the UI type most closely associated with BMI.

In Western industrialized countries, female urinary incontinence (UI) is prevalent both in elderly [9, 19] and in young and middle-aged female populations [5, 12]. UI appears to be associated with a variety of health phenomena [3]. In spite of obesity's also being a prevalent condition [7, 8], empirical evidence about its possible role in UI etiology is scant, but an association has been suggested from epidemiologic population studies [2, 19] and clinical studies [4, 11]. Taking into account other UI-prevalence risk factors [6, 13, 14], the present analysis aims at expanding our insight into the role of obesity and its interaction with other factors.

Subjects and methods

The present cross-sectional design and the data have been presented previously [5]. During January and February 1988, the members of an age-stratified random sample of 3,114 women aged 30–59 years and living in the municipality of Aarhus (total female population of the same age, 47,702) were mailed a questionnaire. Nonrespondents were addressed two additional times. Finally, 2,631 (84,5%) women responded, with a slight but significant reduction by age (OR, 0.93/5-year group; $P < 0.025$; multiple logistic regression estimate). Among the respondents, 2,589 women provided sufficient information for the present analyses.

Among other things, the women were asked whether they had experienced episodes of UI during 1987 and if so, whether the UI episodes were generally provoked by physical stress, e.g., lifting, coughing, sneezing, or laughing (stress UI), and/or were accompanied by a feeling of urge to void (urge UI). In addition, they were queried as to (a) their body height (centimeters) and weight (kilograms), (b) their age, (c) whether they had had their last menstruation, (d) whether they had had children, (e) whether they had undergone abdominal and gynecologic surgery, (f) their experience with cystitis, and (g) their occupation. Body mass index (BMI) is the body weight in kilograms divided by the square of the body height in meters. The present analysis deals with the 2,589 women (98.4% of the respondents) who did not fail to report their height or their weight.

For statistical analysis we applied the Pearson χ^2 test and multiple linear and logistic regression [1, 10]. Regression was performed by use of a combination of forward selection and backward elimination. A significance level of $P < 0.05$ was used. Body weight and BMI proved to be approximately normally distributed. The statistical analysis was performed by one of the authors (A.F.).

Results

The mean self-reported body height was 165.9 cm (median, 166.0 cm; range, 128–186 cm) and the mean body weight was 62.5 kg (median 60.0 kg; range, 40.0–62.0 kg). On average, the body weight differed by 0.6 kg/cm height difference ($P < 0.0001$). The mean BMI was 22.7 kg/m^2 (median 22.0 kg/m^2; 10th percentile, 19.1 kg/m^2;

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Table 1. UI prevalent in 1987 by clinical type of UI and BMI in 2,589 women aged 30–59 years in Aarhus, Denmark, 1988

BMI (kg/m²)	All UI		All stress UI		All urge UI		Mixed UI	
	%	OR[a]	%	OR[a]	%	OR[a]	%	OR[a]
13.7–19.9	12.5	0.70*[2]	10.2	0.67*[3]	6.1	0.72*[1]	4.6	0.66*[1]
20 –29.9	17.5	1.00	15.2	1.00	8.7	1.00	7.2	1.0
30 –39.9	32.7	2.23*[5]	29.9	2.31*[5]	17.8	2.21*[4]	15.9	2.37*[4]
40 –65.8	25.0	1.51	25.0	1.77	12.5	1.44	12.5	1.77
Total	17.1	1.07*[6]	14.8	1.07*[6]	8.6	1.07*[6]	7.1	1.08*[6]

*[1] $P < 0.10$; *[2] $P < 0.025$; *[3] $P < 0.01$; *[4] $P < 0.005$; *[5] $P < 0.0005$; *[6] $P < 0.00001$

[a] Odds ratio denoting the age-corrected relative risk of prevalent UI associated with BMI difference. For BMIs of 13.7–19.9, 30–39.9, and 40–65.8 kg/m², ORs refer to a BMI of 20–29.9 kg/m². ORs at the bottom denote the change per BMI unit.

Table 2. Multivariate odds ratios of BMI by 1987 prevalences of UI in 2,589 women aged 30–59 years in Aarhus, Denmark, 1988

UI type	OR
All UI	1.07 (1.04–1.10)*
All stress UI	1.07 (1.04–1.10)*
All urge UI	1.08 (1.05–1.11)*
Mixed stress and urge UI	1.08 (1.05–1.11)*

OR (with 95% confidence limits given in parentheses) denotes the change in UI prevalence risk per BMI unit, corrected for age, parity, surgical operations, cystitis, menopause, and occupation
* $P < 0.0001$

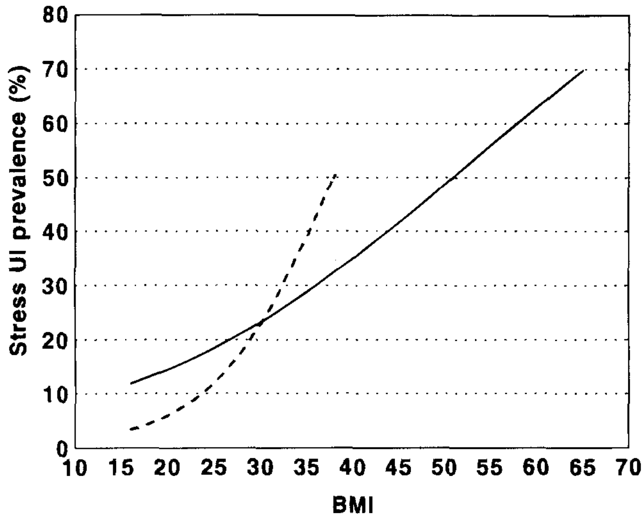

Fig. 1. Estimated stress UI prevalence by parity and BMI (kg/m²) in 2,589 women aged 30–59 years in Aarhus, Denmark, 1988. Estimations were made by logistic regression. Model: OR_{MBI} 1.17; P <0.0001, OR_{parous} 3.93, $P < 0.0001$, $OR_{interaction}$ 0.91, $P < 0.025$; combined, $P < 0.00001$. Model fit, $P > 0.50$. Reported to be parous: 2,037 women (78.7%); —— parous, - - - - nulliparous

90th percentile, 27.2 kg/m²; range, 13.7–65.8 kg/m²). In all, 4.4% of the women had a BMI of 30 kg/m² or higher. Body weight increased by 0.13 kg and BMI, by 0.08 unit/year of age. After correction for age, body weight increased by 0.45 kg ($P < 0.025$) and BMI, by 0.19 units ($P < 0.005$) per reported childbirth. White-collar workers had a lower BMI (difference, 0.73 units; $P < 0.0001$) and unskilled blue-collar workers had a higher BMI (difference, 0.83 units; $P < 0.0001$) than did the other members of the study group. BMI proved to be unassociated with a history of surgery, menopause, or experience with cystitis at an adult age.

In all, 17% of the women reported UI; 14.8% had stress-provoked UI, 8.6% reported the symptom of urge; stress provocation and the urge symptom overlapped such that 7.1% had mixed UI (Table 1). Furthermore, Table 1 shows UI prevalences distributed by BMI. Also, after correction for age, all prevalences increased significantly ($P < 0.00001$) with increasing BMI. At a BMI of 30 and over, the prevalences were high but lower than those for the preceding BMI group. In comprehensive multiple logistic regression models, UI prevalence was found to be significantly associated with BMI ($P < 0.0001$) after correction for age, childbirth, exposure to surgical intervention in the abdominal and pelvic regions, experience with cystitis, and occupation (Table 2).

BMI interacted with having experienced at least one childbirth – but not with the number of childbirths – in predicting all UI ($OR_{interaction}$, 0.93; $P < 0.05$) and stress UI (Fig. 1) and with cystitis experience in the prediction of urge UI (Fig. 2). Curves identical to those shown in Figs. 1 and 2 were achieved when parous versus nonparous women and women with a history of cystitis versus those without such a history were analyzed separately (parous: OR_{BMI}, 1.06/unit; $P < 0.0001$; nulliparous: OR_{BMI}, 1.17; $P < 0.0001$; history of cystitis: OR_{BMI}, 1.12; $P < 0.0001$; no history of cystitis: OR_{BMI}, 1.05; $P \sim 0.05$). The association between BMI and urge UI was borderline significant in the 1,412 women with no history of cystitis, whereas other associations appeared highly significant. Accordingly, BMI was found to interact significantly ($P < 0.05$) with both childbirth and cystitis in predicting mixed UI.

To evaluate the relative weight of the individual UI types' associations with BMI, linear regressions were performed using BMI as the dependent variable and specific UI types as predictors besides the confounders mentioned. When included in the prediction, all UI was associated with BMI ($P < 0.0001$), whereas subtypes were not. Moreover, when all UI was excluded, only stress UI ($P < 0.0001$) proved to be significantly associated with BMI.

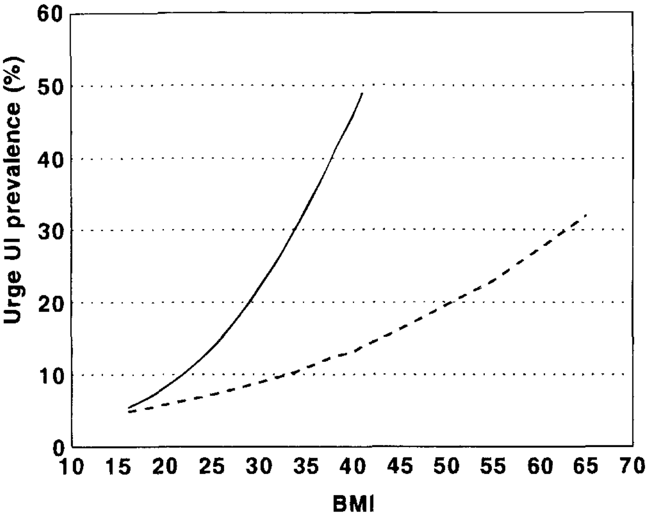

Fig. 2. Estimated urge UI prevalence by BMI (kg/m^2) and cystitis experience in 2,589 women aged 30–59 years in Aarhus, Denmark, 1988. Estimations were made by logistic regression. Model: OR_{BMI} 1.05, $P \sim 0.05$, $OR_{cystitis}$ 1.12, $P < 0.70$, $OR_{interaction}$ 1.07, $P < 0.05$; combined, $P < 0.00001$. Model fit, $P > 0.50$. Reported to have had cystitis as an adult: 1,177 women (45.5%); – cystitis, - - - - no cystitis

Discussion

The validity of our population data depends on the participants' willingness and ability to report correctly, e.g., body weight and height. The BMI distribution of our data, however, is in accordance with the findings of a recent Danish population study in which weight and height were measured [8]. The BMI increase by parity may be recognized from previous research [4]. The hypothesis of an association between UI and obesity is so little known by the general population that this might lead to differential misclassification and, thus, to information bias away from the null hypothesis [10]. Taking the high rate of response to the questionnaire and the strength of association into account, we thus think that the finding is likely to represent a real phenomenon.

The association is in accordance with the findings of previously published reports. From a random population sample of 1,000 women aged 18 years and over (participation, 87.8%), Yarnell et al. [20] reported sligthly raised mean BMIs in incontinent as compared with continent women. Among 901 healthy women sampled from a driver's license registry (participation, 60%), Burgio et al. [2] found BMI to be significantly associated with the frequency of episodes of UI. In both studies, data were collected by interview, and in the study by Burgio et al. [2], the height and weight were measured. Dwyer and coworkers [4] found patients with genuine stress UI (232 patients) or with detrusor instability (136 patients) to have a higher mean BMI than did the general population of the same age. Apart from Dwyer et al.'s [4] and Yarnell et al.'s [20] data being age-stratified, none of these reports presents any control for other UI risk factors.

If obesity induces UI, it should be expected to act primarily through the balance between the intrapelvic pressure and urethral continence mechanisms. The intrapelvic pressure is a function of the interaction between the amount of intraabdominal and intrapelvic tissue and the tone and flexibility of the abdominal wall and the perineum. Accordingly, we found stress UI to be the UI type closest related to BMI. However, published empirical findings concerning BMI and stress UI parameters seem to some extent to be mutually conflicting. In comparing 193 genuine stress-incontinent with 43 continent female patients, Kölbl and Riss [11] found no association between UI itself and BMI. They found that urethral pressure increased with raised BMI. As markedly increased BMI correlated with a positive clinical stress test, Kölbl and Riss [11] concluded that continence seemed to depend on the balance of urethral pressure and urethral closing pressure. On the other hand, Dwyer and colleagues [4] found no association between BMI and any urodynamic parameter measured in 368 incontinent patients, such as residual urine, volume micturated at first sensation to void, bladder capacity, detrusor pressure on filling and provocative testing, and peak flow rate.

The theory concerning the balance between the intrapelvic pressure and urethral continence mechanisms may be sustained by the finding of an interaction between parity and BMI (Fig. 1). Childbirths have previously been found to be associated with increased stress UI prevalence [6], probably due to damage to the pelvic floor muscles and, not least, to their innervation [16–18]. In the present context, parous women showed a relatively high initial UI prevalence level, which increased markedly with increasing BMI. Contrastingly, lean nulliparous women showed a low stress UI prevalence level, which, however, accelerated rapidly with increasing BMI. This acceleration, starting at BMI level 25–30, may be interpreted as a consequence of a comparatively high abdominal wall and perineal tone and, thus, more raised intrapelvic pressure in obese nulliparous women. However, further empirical evidence in support of this hypothesis is lacking.

We have previously found cystitis to be correlated to prevalent UI [14]. Moreover, in the present analysis, BMI was found to correlate with urge UI prevalence in women who reported having had one or more episodes of cystitis, whereas the association in women with no history of cystitis was weak (Fig. 2). In other words, urge UI and cystitis seem to interact with growing strength by increased BMI. This may be hypothesized to be due to infectious exposure because of problems of personal hygiene in the obese woman. BMI did not prove to be a general determinant of cystitis experience in our data. However, no published evidence has been found in support of such a hypothesis or in support of a hypothesis of an association between cystitis and BMI. A recent report [15] on risk factors for urinary tract infection did not address the issue. Considering the strength of the association, we think that the relationship of UI to obesity deserves further consideration in prospective population and patient studies.

In conclusion, irrespective of other UI prevalence risk factors, stress UI seems to be associated with an increased BMI. This has not been demonstrated previously. The mechanism of the hypothesized causative process may be mechanical and dependent on the balance between the amount of intrapelvic tissue and the flexibility of the abdominal wall and the perineum as indicated by a relatively rapid increase in stress UI prevalence along with an increasing BMI in nulliparous women. Urge UI and cystitis seemed to interact with growing strength by increased BMI, possibly due to infectious exposure because of problems of personal hygiene in the obese woman.

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