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Body weight through adult life and risk of urinary incontinence in middle aged women: results from a British prospective cohort

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Abstract

Objectives—To determine whether the onset and duration of being overweight or obese are associated with symptoms of urinary incontinence.

Design—Nationally representative cohort study

Subjects—1201 women followed up since their birth in 1946 and annually from 48 to 54 years

Measurements—BMI at ages 20, 26, 36, and 43, and symptoms of stress, urge, and severe incontinence at 7 consecutive years from ages 48 to 54

Results—In each year from ages 48 to 54, almost half (46-49%) reported symptoms of stress incontinence, urge incontinence rose from 22% to 25% and severe incontinence from 8% to 11%. At ages 20, 26, 36, and 43, BMI was positively associated with stress symptoms and severe incontinence in midlife. BMI transition was found to have accumulation effects on symptoms of severe incontinence; women who were overweight/obese since age 20 years were more likely to report severe incontinence than women whose BMI remained below 25kg/m^2 (OR (95%CI): 2.30(1.36-3.93)), or who became overweight or obese at 43 years (1.85(0.97-3.51)). These relationships existed beyond the effects of aging, childhood enuresis, kidney infection, childbirth characteristics, menopause, educational attainment, GP consultations, and smoking status. BMI was not associated with symptoms of urge incontinence.

Conclusions—Across adult life, higher BMI for women was linked with subsequent symptoms of stress and severe incontinence in midlife; those who were overweight or obese since early in adult life more than doubled their risk of severe incontinence. Women, and especially young women, should be encouraged to keep their weight in a normal range throughout adult life.

Keywords

BMI; stress incontinence; urge incontinence; severe incontinence

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Introduction

Urinary incontinence adversely impacts upon quality of life and participation in everyday activities.[1] It is associated with poor self-rated health and depressive symptoms,[2;3] and imposes substantial costs both on the individual[4] and the public health service.[5] For community-dwelling women it costs the UK NHS approximately £233 millions annually (at 1999/2000 prices) to treat clinically significant urinary storage symptoms cases. This represents approximately 0.5% of overall NHS budget for 1999/2000.[5]

For women, urinary incontinence is commonly experienced during midlife. While the prevalence of stress incontinence peaks during perimenopausal years (45- to 49- years), for urge incontinence it increases with age.[6;7] Depending upon definitions used and the study population involved, urinary incontinence afflicts from 12% to 47% of middle- aged and younger women compared with 17% to 55% of older women.[8-10] From our previous findings from the Medical Research Council (MRC) National Survey of Health and Development (NSHD) cohort, one out of two women at age 48 years reported symptoms for stress incontinence over the past year and one out of five women for symptoms of urge incontinence.[11] It was the first prospective study to show that childhood enuresis was associated with urge incontinence at 48 years of age (regular bedwetters at age 6 years had twice the risk) than the remaining sample.[11]

Studies that have identified a relationship between higher body weight in midlife and incontinence have been either cross sectional,[12-18] or short-term studies.[19-22] Obesity, particularly in the abdominal area, may cause incontinence through increased intra-abdominal pressure.[23;24] Given rising childhood and adolescent obesity[25] and as high BMI is likely to persist over the life course, important questions remain regarding the influence of weight trajectories, in terms of the duration or timing of overweight/obese status, on urinary incontinence.

Using data from the NSHD this study investigates the effect of post menarcheal BMI transition on urinary incontinence in midlife while taking into account reproductive factors, socio-economic circumstances, and other lifestyle factors. Specifically, it investigates whether the onset and duration of being overweight or obese are associated with symptoms of different clinical types of urinary incontinence (stress and urge) and the severity of urinary incontinence.

Methods

The MRC NSHD, also known as the 1946 British Birth Cohort, is a longitudinal study of health based on a social class stratified, random sample of 5362 singleton births in England, Scotland or Wales during one week in March, 1946. The whole cohort have been followed up 20 times between their birth and age 53 years.[26] The cohort is still generally representative of the population born in Britain at that time.[27] From 1993, when cohort members were age 47, to 2000, a postal questionnaire to collect information on health symptoms, the menopause, and change in life circumstances has been sent annually to the 1778 (70%) women with whom there was then contact.[28] Of the original cohort, 6% had died, 12% had refused to take part at earlier follow-ups, 9% lived abroad and were no longer in contact with the study, and 3% could not be traced. Non-responders were sent questionnaires for two consecutive years.

This paper particularly draws upon data collected annually from 1994 to 2000, when the participants reported on the symptoms of urge and stress incontinence from ages 48 to 54 years. During this time a total of 1525 out of 1778 women (86%) completed at least one

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questionnaire. Of these women, 1025 (67.2%) completed all seven questionnaires. Ethical approval for this study was given by the North Thames Multicentre Research Committee.

Incontinence and other urinary symptoms

Each year, between 1994 and 2000, women who replied positively to the question "Do you ever lose any urine when you cough, sneeze, laugh, run, or exercise?" were classified as having the symptoms of stress incontinence (hereafter referred to as just stress incontinence). Those who replied positively both to the question "Do you ever have an urgent and strong desire to pass urine which is difficult to control?" and to the follow up question "Do you ever lose any urine before you reach the toilet?" were classified as having the symptoms of urgency and urge incontinence (hereafter referred to as urge incontinence). Severe incontinence was defined as involuntary loss occurring twice a month or more over the previous year and the reported loss of more than a few drops of urine. [11]

BMI across adult life

Heights and weights were measured at 36 and 43 years and self reported at 20 and 26 years. Body mass index (BMI), defined as weight/height^2, was calculated at each age. BMI was categorized according to WHO guidelines as 'underweight' (BMI < 20 kg/m^2), 'normal' weight (BMI ≥ 20 - < 25 kg/m^2), 'overweight' (BMI ≥ 25 - < 30 kg/m^2), or 'obese' (BMI ≥30 kg/m^2).[29] Age at which the women first became overweight or obese was also calculated. BMI transition between ages 20 and 43 years were defined:

- **a.** remained underweight/normal weight: BMI < 25 kg/m^2 at age 20 and 43
- **b.** remained overweight/obese: BMI ≥ 25 kg/m^2 at age 20 and 43
- **c.** gained weight: BMI < 25 kg/m^2 at age 20 and ≥ 25 kg/m^2 at age 43
- **d.** lost weight: BMI ≥ 25 kg/m^2 at age 20 and < 25 kg/m^2 at age 43.

Other risk factors or potential confounding factors

Other risk factors included in the analysis that have been shown previously to be associated with urinary incontinence were: childhood enuresis, parity, mode of delivery, menopausal status, physical and mental health.[30] Childhood enuresis was defined from maternal reports of bedwetting 'occasionally' or at least 'several nights a week' or wetting 'sometimes' during the day when study members were 6 years old. Information on the birth of children was updated at each adult survey (the last one occurring at age 53 years old). In addition, at age 49 years women were asked to recall the number of caesarean deliveries. Menopausal status was assessed from each postal questionnaire completed annually between age 48 and 54 years and was defined on the basis of self-reporting of regularity of menstrual bleeding as premenopausal (still had periods and reported no change in regularity), perimenopausal (between 3 and 12 months of amenorrhoea or irregular periods in the preceding 12 months), and postmenopausal (amenorrhoea for at least 12 months).[31] Women who had undergone hysterectomy or whose menopausal status could not be determined because they were on HRT were classified into two separate groups.

When cohort members were 43 years old, women with a history of kidney or bladder infections were identified from answers to a list of health problems completed by research nurses during a home visit. Health care utilisation was indicated by the number of general practitioner (GP) consultations in the previous 12 months was classified as: no more than 2 visits, or 3 or more visits.

Potential confounders, identified because of their possible association with the experience of urinary incontinence and with BMI, were adult socioeconomic status, and lifelong cigarette

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smoking status. Women were classified according to their current or most recent occupation provided at age 43 as being in manual or non-manual groups. Educational qualifications achieved by age 26 years were grouped into degree level or equivalent, advanced secondary ('A'-levels or equivalent, usually attained at 18 years), lower secondary level qualifications ('O'-levels or equivalent, usually attained at 16 years), and no qualifications. Cigarette smoking status was obtained in six waves (at ages 20, 25, 31, 36, 43, 53 years). Cohort members were classified into one of four smoking trajectories: 'never smoker' (a non-smoker at all available data collections), 'predominantly non-smoker' (a non-smoker for at least three data collections), 'predominantly smoker' (a smoker at four or more of the data collections), or 'lifelong smoker' (a smoker at all available data collections).[32]

Statistical methods

Chi-squared analysis was used to test the associations between each of the BMI variables and the symptoms of stress, urge, and severe urinary incontinence at age 54. Repeat measure analyses of data on urinary incontinence from ages 48 to 54 years were conducted by utilizing Generalised Estimating Equations (GEE)[33] for binary data and with the Logit link function in PROC GENMOD in SAS.[34] First, these were used to determine the relationships between each of the BMI variables and symptoms of stress incontinence, adjusting only for age. Other risk factors and confounding factors for symptoms of stress incontinence were identified by repeating the analysis with childhood enuresis, each of the reproductive factors, and each of the social and behavioural factors. Variables that were associated with urinary incontinence at the 10% level were retained for further analysis. Menopausal transition status was treated as a time-dependent covariate in the GEE models. The fully adjusted model was then constructed by incorporating all the factors identified above. These procedures were repeated for symptoms of urge incontinence and severe incontinence.

Results

In each year just under half of the women reported the symptom of stress incontinence (46-49%) ($p = 0.8$ for linear trend across age), while there was a slight increase evident in the percentage experiencing urge incontinence from 22% at 48 years to 25% at age 54 ($p = 0.0001$ for linear trend across age). The prevalence of severe incontinence also increased slightly from 8% to 11% ($p < 0.0001$ for linear trend across age).

BMI at ages 20, 36, and 43 was strongly associated with stress incontinence at 54 years and BMI at all ages with severe incontinence (Table 1). Of the women who had gained weight substantially (by increasing at least one BMI category) over the duration of the study, the majority reported the symptom of stress incontinence; with similar results found for those who had been overweight or obese from early adult life. Three times more women in the "obese since ages 20 or 26 group" had severe incontinence compared with those who had become obese at age 43 years (21.1% versus 7.3%). No evidence for an association was found between BMI at any age and urge incontinence at age 54 (Table 1).

Using the repeat measures of urinary incontinence and after adjusting for age, childhood enuresis, kidney infection, childbirth characteristics, menopausal status, GP consultations, and educational qualifications, it was found that higher BMI at each age was a risk factor for stress incontinence (Table 2). Women who were underweight at ages 20 and 26 years were less likely to report stress incontinence in midlife compared with women who were of normal weight. Those who were obese at ages 26, 36, and 43 had higher odds of stress incontinence compared with women who were of normal weight. Women who gained weight (and changed BMI category) between ages 20 and 43 were at increased risk of stress incontinence compared with those who maintained a BMI below 25kg/m^2. Similarly women

who were always overweight or obese throughout the study period had increased risk of experiencing stress incontinence. The effect size of becoming obese at any age for stress incontinence was of similar magnitude (Table 2).

Only BMI at ages 36 and 43 years were positively associated with urge incontinence in the univariable analyses (Table 3). However these relationships were no longer significant ($p > 0.1$) when adjusted for childhood enuresis, parity, lifetime smoking trajectories, GP consultations, menopause status, and educational qualifications. With BMI in the normal range set as the reference category, the adjusted results for each BMI category at age 36 were: BMI <20: 0.87 (0.58-1.21); 25 ≤ BMI < 30: 1.30 (0.95-1.78); BMI ≥ 30: 1.42 (0.86 - 2.32), while the results for age 43 were: BMI <20: 0.81 (0.54-1.19); 25 ≤ BMI < 30: 0.99 (0.72-1.37); BMI ≥ 30: 1.46 (0.92 - 2.31).

The weight of evidence was strong regarding accumulation effects of obesity on severe incontinence (Table 4). Women who became overweight or obese at ages 20 or 26 or those who were overweight or obese throughout the study period were at more than twice the odds of experiencing severe incontinence during midlife compared with those who had maintained a BMI below 25kg/m^2. Using a different reference group, women who were overweight or obese by age 20 also had higher odds of severe incontinence compared with those who became overweight or obese at age 43 (odds ratios (95%CI): 1.85 (0.97 - 3.51). The magnitudes of all these relationships were only slightly attenuated after adjustment and hence were not fully accounted for by the confounders.

Discussion

For adult women, BMI was associated with stress incontinence and severe incontinence in later midlife, beyond the effects of ageing, childhood enuresis, kidney infections, childbirth characteristics, menopausal status, GP visits, and educational qualifications. Obesity during adult life increased the risk of stress incontinence, while more than one in five of this group also reported severe incontinence. There was, moreover, evidence for the accumulative effects of BMI on severe incontinence. Women who had been overweight or obese since age 20 were at more than double the risk of suffering from the condition compared with women who remained with BMI in the normal range or below. Women who were overweight or obese *by* age 20 had higher risk of severe incontinence than those who were first classified as overweight or obese at age 43.

The main strengths of our study are the size and representativeness of the sample, its high response rate, and the wide-ranging prospective and longitudinal data available. Numerous studies on BMI and urinary incontinence have relied on retrospective self-reported weights and heights, which may be subject to recall bias, and obtained concomitant to, or only a few years prior, to the information on urinary incontinence. [14;16;18-21;21] In contrast, since the NSHD is a prospective study with BMI obtained throughout the life course it permits a detailed investigation of relationship between BMI in early adult life and BMI transition categories with urinary incontinence in midlife. Although height and weight were self-reported at 20 and 26 years, we would have expected even stronger associations with severe incontinence had measured data been used. The BMI transition categories seem appropriate as they capture large weight change in women from ‘normal BMI or below’ to ‘overweight or above’. Those in the “remained underweight/normal weight” had a modest gain of about 1.6 kg/m^2 (median); those in the “always overweight/obese” category had a median weight gain of 3.5 kg/m^2. However the median increase for the “gained weight” category was 6.0 kg/m^2, while the median decline in the “lost weight” category was 3 kg/m^2.

The same incontinence questions were asked on an annual basis between ages 48 to 54 years and permitted classification of symptoms by clinical type (stress and urge) and by severity. The definition of women with severe incontinence captures a majority (60%) of women with both stress and urge symptoms. For women who were classified as having severe incontinence: 30% of the women said that the incontinence bothered them a lot, 25% passed urine at least twice in an hour during the daytime, and 29% passed urine at least twice during the night.[11] Although the prevalence of urinary incontinence in women peaks in midlife (between the ages 50 and 54 years),[7;15] the study does not provide information regarding the age of its onset. Self-reported information on urinary incontinence reflects symptoms rather than the diagnosis urodynamic abnormalities; nevertheless these have direct clinical consequences since such an experience may prompt the decision to seek medical help and intervention.

There have been very few longitudinal studies on urinary incontinence in midlife.[8] From the Study of Women across the Nation it was found that women who were overweight at baseline (mean age 45.8 years) had a higher risk of developing incontinence over the next 5 years.[8] However that study did not consider BMI at earlier ages or include confounders across the life course. A number of cross-sectional studies have also found a significant association between BMI and incontinence, but have not distinguished between symptoms of stress or urge incontinence.[12;13;16;17] While BMI has been most closely linked with stress incontinence, only a handful of studies have shown an association with urge incontinence in women.[8;15;35] In this study the raised risk of urge incontinence was only restricted to women who were obese at ages 36 and 43 years and was considerably attenuated in the fully adjusted model. As has been described previously,[11] this may be that both are due to a common underlying “anxiety state”.

A few studies have investigated the role of weight loss on urinary incontinence. Most of these studies were in overweight or obese women[19-22] and have found that weight loss resulted in significant improvement in continence. There was a suggestion of an increase in the odds of urinary incontinence in the women who have lost weight compared to those who have maintained a BMI below 25 kg/m^2. This could indicate the effect of early overweight/obesity status on urinary incontinence, although the results must be interpreted with caution due to the small sample size of the group that have lost weight (n=20). We found that being underweight at ages 20 or 26 years was associated with lower risk of experiencing symptoms of stress incontinence, which could be due to the fact that at age 43 the majority of these women (69%) had BMI in the normal range.

Our study reinforces the view that high BMI has chronic effect on urinary incontinence. Across adult life, high BMI may lead to mechanical stress on the urogenital tissues. Noblett et al[36] has found strong correlations between BMI and intra-abdominal pressure and intravesical pressure that suggested obesity may cause a chronic state of increased pressure that stresses the pelvic floor. This supports the theory that BMI acts as an aggravating condition rather than a true risk factor.[37] While the results here also point towards the accumulative effects of the duration of overweight/obese status on the risk of experiencing severe incontinence, we are unable to disentangle these fully from those of the timing of weight gain. It was found that a higher proportion of long-term overweight or obese women had already experienced symptoms of severe incontinence by the time of first report at age 48 years compared with women who were underweight or of normal weigh (16% versus 6%). This difference widens by the age of 54 (22% versus 8.0%), which suggests that their symptoms may worsen over time. Given such deleterious effects and the worldwide rise in the prevalence of obesity, further research should consider as a priority questions on both the timing of onset of urinary incontinence and its severity with age so as to help target public health messages more effectively.

Conclusion

Across adult life, higher BMI for women was linked with subsequent symptoms of stress incontinence in midlife. For severe incontinence there was evidence to suggest an accumulative impact of excessive BMI, with those who were overweight or obese since early in adult life having more than doubled their risk of severe incontinence compared with women whose BMI remained below 25kg/m^2. Women who became overweight or obese by age 20 were also at greater risk than women who were first classified as such at the age of 43 years. The results provide further strong incentive for young women to maintain their weight in a normal range throughout adult life. Future research should consider both the timing and duration of obesity and urinary incontinence to understand better the aetiology of the condition and to assist with targeting public health messages more effectively.

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Table 1

Lifelong body mass index by symptoms of urinary incontinence at age 54

		Symptoms of urinary incontinence				
Body Mass Index (kg/m^2)	**N**	**Stress**	**p-value***	**Urge**	**p-value***	**Severe**	**p-value***
Body mass index at 20			0.01		0.8		0.002
BMI < 20	260	42.3		24.2		7.7	
20 ≤ BMI <25	635	52.6		26.7		10.4	
25 ≤ BMI < 30	87	49.4		26.7		20.7	
BMI ≥ 30	22	68.2		31.8		22.7	
Body mass index at 26			0.07		0.9		0.001
BMI < 20	207	42.5		24.2		7.7	
20 ≤ BMI <25	695	50.2		24.8		9.8	
25 ≤ BMI < 30	130	56.2		26.9		20.0	
BMI ≥ 30	25	56		28.0		20.0	
Body mass index at 36			0.02		0.2		<0.0001
BMI < 20	140	40.7		25.7		9.3	
20 ≤ BMI <25	678	49.3		24.6		8.7	
25 ≤ BMI < 30	195	56.9		30.4		17.0	
BMI ≥ 30	67	58.2		32.8		23.9	
Body mass index at 43			0.009		0.2		<0.0001
BMI < 20	74	47.3		29.7		9.5	
20 ≤ BMI <25	626	46.3		24.7		8.8	
25 ≤ BMI < 30	284	54.2		26.2		10.2	
BMI ≥ 30	130	60.8		33.9		23.9	
BMI transition between 20 to 43 years			0.02		0.6		0.0004
Always underweight/normal weight	577	46.7		25.7		8.0	
Lost weight†	20	40.0		30.0		20.0	
Gained weight‡	262	56.1		29.0		12.2	
Always overweight/obese	80	59.3		28.4		22.2	
Age at onset of overweight/obesity			0.2		0.3		<0.0001

Body Mass Index (kg/m²)	N	Symptoms of urinary incontinence					
		Stress	p-value*	Urge	p-value*	Severe	p-value*
Always underweight/normal weight	492	46.8		25.0		7.8	
Age 20	109	53.2		27.8		21.1	
Age 26	90	56.7		27.5		21.1	
Age 36	133	55.6		33.8		14.3	
Age 43	151	51.7		24.7		7.3	

*p-value corresponds to the test for heterogeneity across the categories;

†decreasing at least one BMI category;

‡increasing at least one BMI category.

Table 2

Odds ratios (95% confidence intervals) obtained from GEE analysis for the symptom of stress incontinence by each measure of BMI across the adult life

Body Mass Index (kg/m^2)	Age adjusted	p-value*	Fully adjusted§	p-value*
Body mass index at 20		0.03		0.035
BMI < 20	0.68 (0.52 - 0.89)		0.71 (0.54 - 0.94)	
20 ≤ BMI <25	Reference		Reference	
25 ≤ BMI < 30	1.02 (0.69- 1.52)		1.11 (0.75 - 1.64)	
BMI ≥ 30	1.32 (0.66 - 2.66)		1.61 (0.80 - 3.26)	
BMI (per unit kg/m^2)	1.04 (1.00 - 1.08)	0.03	1.05 (1.01 - 1.09)	0.02
Body mass index at 26		0.01		0.002
BMI < 20	0.69 (0.52 - 0.93)		0.68 (0.51 - 0.92)	
20 ≤ BMI <25	Reference		Reference	
25 ≤ BMI < 30	1.11 (0.81 - 1.53)		1.24 (0.89 - 1.74)	
BMI ≥ 30	1.73 (0.93 - 3.22)		2.17 (1.18 - 3.98)	
BMI (per unit kg/m^2)	1.05 (1.01 - 1.08)	0.005	1.06 (1.03 - 1.10)	0.0006
Body mass index at 36		0.01		0.01
BMI < 20	0.78 (0.55 - 1.09)		0.76 (0.54 - 1.07)	
20 ≤ BMI <25	Reference		Reference	
25 ≤ BMI < 30	1.19 (0.90 - 1.58)		1.15 (0.86 - 1.55)	
BMI ≥ 30	1.79 (1.16 - 2.74)		1.82 (1.18 - 2.81)	
BMI (per unit kg/m^2)	1.05 (1.02 - 1.08)	0.0002	1.05 (1.03 - 1.09)	0.0002
Body mass index at 43 (kg/m^2)		0.008		0.009
BMI < 20	1.04 (0.66 - 1.63)		1.04 (0.66 - 1.66)	
20 ≤ BMI <25	Reference		Reference	
25 ≤ BMI < 30	1.39 (1.08 - 1.78)		1.44 (1.12 - 1.85)	
BMI ≥ 30	1.59 (1.15 - 2.20)		1.56 (1.10 - 2.21)	
BMI (per unit kg/m^2)	1.05 (1.03 - 1.08)	<0.0001	1.05 (1.03 - 1.08)	<0.0001
BMI transition between 20 to 43 years		0.02		0.02
Always underweight/normal weight	Reference		Reference	
Lost weight†	1.15 (0.47 - 2.87)		1.38 (0.57 - 3.34)	
Gained weight‡	1.43 (1.12 - 1.85)		1.44 (1.12 - 1.89)	
Overweight/obese	1.41 (0.97 - 2.06)		1.53 (1.04 - 2.24)	
Age at onset of overweight/obesity		0.1		0.07
Always underweight/normal weight	Reference		Reference	
Age 20	1.33 (0.93 - 1.91)		1.45 (1.01 - 2.09)	
Age 26	1.45 (0.99 - 2.12)		1.59 (1.06 - 2.39)	
Age 36	1.31 (0.93 - 1.85)		1.21 (0.84 - 1.75)	
Age 43	1.34 (0.96 - 1.87)		1.36 (0.97 - 1.92)	

* p-value corresponds to the test for heterogeneity across the categories;

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[§] adjusted for age, childhood enuresis, kidney infection, childbirth characteristics, menopausal status, GP consultations, and educational qualifications.

[†] Decreasing at least one BMI category;

[≠] increasing at least one BMI category.

Table 3

Odds ratios (95% confidence intervals) obtained from GEE analysis for urge incontinence by each measure of BMI across the adult life

BMI (kg/m^2)	Age adjusted	p-value*
Body mass index at 20		0.6
BMI < 20	0.88 (0.68 – 1.15)	
20 ≤ BMI <25	Reference	
25 ≤ BMI < 30	1.07 (0.73- 1.56)	
BMI ≥ 30	1.40 (0.68 – 2.87)	
BMI (per unit kg/m^2)	1.03 (0.99 - 1.07)	0.07
Body mass index at 26		0.3
BMI < 20	1.05 (0.80 – 1.39)	
20 ≤ BMI <25	Reference	
25 ≤ BMI < 30	1.25 (0.92 – 1.72)	
BMI ≥ 30	1.64 (0.89 – 3.00)	
BMI (per unit kg/m^2)	1.03 (1.00 - 1.06)	0.05
Body mass index at 36		0.05
BMI < 20	1.01 (0.72 – 1.42)	
20 ≤ BMI <25	Reference	
25 ≤ BMI < 30	1.37 (1.04 – 1.75)	
BMI ≥ 30	1.61 (1.08 – 2.40)	
BMI (per unit kg/m^2)	1.04 (1.01-1.07)	0.003
Body mass index at 43		0.02
BMI < 20	1.20 (0.78 – 1.86)	
20 ≤ BMI <25	Reference	
25 ≤ BMI < 30	1.14 (0.89 – 1.48)	
BMI ≥ 30	1.69 (1.25 – 2.27)	
BMI (per unit kg/m^2)	1.04 (1.02 - 1.06)	0.0004
BMI transition between 20 to 43 years		0.1
Always underweight/normal weight	Reference	
Lost weight†	1.63 (0.75 – 3.55)	
Gained weight‡	1.33 (1.04 – 1.70)	
Always overweight/obese	1.22 (0.82 – 1.81)	
Age at onset of overweight/obesity		0.2
Always underweight/normal weight	Reference	
Age 20	1.26 (0.89 – 1.80)	
Age 26	1.46 (1.01 – 2.11)	
Age 36	1.38 (1.00 – 1.91)	
Age 43	1.12 (0.81 – 1.53)	

*p-value corresponds to the test for heterogeneity across the categories;

†decreasing at least one BMI category;

≠increasing at least one BMI category

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Table 4

Odds ratios (95% confidence intervals) obtained from GEE analysis for severe incontinence by each measure of BMI across the adult life

BMI (kg/m^2)	Age adjusted	p-value*	Fully adjusted§	p-value*
Body mass index at 20		0.03		0.08
BMI < 20	0.82 (0.51 - 1.30)		0.87(0.54 - 1.39)	
20 ≤ BMI <25	Reference		Reference	
25 ≤ BMI < 30	1.75 (0.992- 3.08)		1.47 (0.81 - 2.67)	
BMI ≥ 30	4.63 (2.04 - 10.46)		3.29 (1.51 - 7.18)	
BMI (per unit kg/m^2)	1.11 (1.06 - 1.17)	<0.0001	1.07 (1.03 - 1.12)	0.001
Body mass index at 26		0.0006		0.006
BMI < 20	0.55 (0.32 - 0.95)		0.59 (0.35 - 1.00)	
20 ≤ BMI <25	Reference		Reference	
25 ≤ BMI < 30	1.81 (1.13 - 2.91)		1.54 (0.95 - 2.50)	
BMI ≥ 30	3.27 (1.53 - 7.00)		2.53 (1.26 - 5.06)	
BMI (per unit kg/m^2)	1.08 (1.05 - 1.12)	<0.0001	1.06 (1.03 - 1.10)	0.001
Body mass index at 36		0.0001		0.002
BMI < 20	0.51 (0.26 - 1.02)		0.54 (0.27 - 1.04)	
20 ≤ BMI <25	Reference		Reference	
25 ≤ BMI < 30	1.76 (1.15 - 2.68)		1.56 (0.99 -2.43)	
BMI ≥ 30	2.86 (1.64 - 4.99)		2.30 (1.33 -3.98)	
BMI (per unit kg/m^2)	1.08 (1.04 - 1.11)	<0.0001	1.06 (1.03 - 1.10)	0.001
Body mass index at 43		0.0005		0.01
BMI < 20	0.52 (0.20 - 1.35)		0.63 (0.26 - 1.51)	
20 ≤ BMI <25	Reference		Reference	
25 ≤ BMI < 30	1.42 (0.94 - 2.15)		1.35 (0.88 - 2.09)	
BMI ≥ 30	2.66 (1.67 - 4.22)		2.11 (1.32 - 3.39)	
BMI (per unit kg/m^2)	1.08 (1.04 - 1.11)	<0.0001	1.07 (1.03 - 1.10)	0.0001
BMI transition between 20 to 43 years		0.002		0.02
Always underweight/normal weight	Reference		Reference	
Lost weight†	2.61 (0.88 - 7.76)		2.69 (0.76 - 9.55)	
Gained weight‡	1.72 (1.14 - 2.60)		1.60 (1.03 - 2.47)	
Always overweight/obese	3.14 (1.82 - 5.41)		2.37 (1.38 - 4.06)	
Age at onset of overweight/obesity		0.004		0.05
Always underweight/normal weight	Reference		Reference	
Age 20	2.92 (1.74 - 4.89)		2.30 (1.36 - 3.93)	
Age 26	2.39 (1.37 - 4.18)		1.93 (1.05 - 3.55)	
Age 36	1.51 (0.87 - 2.61)		1.34 (0.75 - 2.38)	
Age 43	1.28 (0.73 - 2.25)		1.25 (0.71 - 2.24)	

* p-value corresponds to the test for heterogeneity across the categories;

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§ adjusted for age, childhood enuresis, kidney infection, childbirth characteristics, menopausal status, GP consultations, and educational qualifications.

† Decreasing at least one BMI category;

≠ increasing at least one BMI category.