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ORIGINAL ARTICLE

Obesity: how much does it matter for female pelvic organ prolapse?

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Abstract
Introduction and hypothesis The objective was to determine the association between body mass index (BMI) and symptoms and signs of female pelvic organ prolapse (POP).
Methods An observational cross-sectional study of 964 archived datasets of women seen for symptoms and signs of lower urinary tract and pelvic organ dysfunction between September 2011 and February 2014 at a tertiary urogynaecology centre in Australia was carried out. An in-house standardised interview, the International Continence Society Pelvic Organ Prolapse Quantification (ICS POP-Q) and 4-D translabial ultrasound, followed by analysis of ultrasound volumes for pelvic organ descent and hiatal area on Valsalva, were performed, blinded against other data.
Results There is a positive association between BMI and posterior compartment prolapse on clinical examination and ultrasound imaging, but not for the anterior and central compartments. There was no association with prolapse symptom bother and a negative association with symptoms of prolapse.
Conclusions In this observational study, we found a strong association between all tested measures of posterior compartment descent and BMI, both clinical and on imaging.

Keywords Pelvic organ prolapse · BMI · Obesity · Translabial ultrasound

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Introduction

Female pelvic organ prolapse (POP) is a common condition, with the incidence of objective prolapse on clinical examination ranging from 14% to 50% [1–3]. However, the prevalence of symptoms of prolapse is much lower, at 3–6% [4]. Prolapse can be burdensome in terms of reduced quality of life, workforce productivity, and cost to both the individual and the health care system as a whole. The aetiology of POP is not fully understood, but is likely to be complex and multifactorial. Risk factors for POP include age, menopause, vaginal birth, connective tissue disorders, levator trauma and obesity [5–7]. Several studies found obesity to be associated with an increased risk of uterine prolapse, cystocele, rectocele and symptomatic prolapse [2, 8–10], but other studies have challenged obesity as an aetiological factor [11]. The prevalence of obesity is increasing worldwide, and this is also true for Australia. In 2011–2012, 56% of Australian women aged 18 years and older were either overweight or obese (body mass index [BMI] >25) according to the Australian Bureau of Statistics [12]. Hence, it appears crucial for the best management of women to determine if there is an association between obesity and POP and to determine the exact nature of any such association.

The objective of this study is to determine the association between symptoms and signs of POP of all three compartments and BMI. Our null hypothesis was: there is no association between symptoms and signs of POP and BMI.

Materials and methods

This observational cross-sectional study was a sub-analysis of an ethics approved research project (NBMLHD HREC Ref. 12–74). Between September 2011 and February 2014, a total of 1,043 women were seen in a tertiary urogynaecology unit for investigation and management of lower urinary tract and pelvic floor dysfunction. All women were subjected to a non-validated in-house standardised clinical interview and International Continence Society Pelvic Organ Prolapse Quantification (ICS POP-Q) prolapse assessment [5] followed by 4D translabial or perineal ultrasound (TLUS). Visual analogue scales (VAS) were utilised to quantify the bother of symptoms of prolapse (symptoms of a vaginal lump or bulge, or a dragging sensation). Women were asked "how much are you bothered by the sensation of a lump in the vagina and/or the dragging sensation?" and were required to move a sliding indicator along a non-segmented, continuous 0- to 10-cm scale indicating their bother from "not at all" to "the worst imaginable". The bother was rounded to the nearest millimetre and was presumed to be zero in women who reported an absence of symptoms of prolapse [13]. BMI measures of height and weight were self-reported.

Four-dimensional TLUS was performed in the supine position, after voiding, using GE Kretz Voluson 730 Expert or Voluson I systems (GE Medical Systems, Zipf, Austria), at rest and on maximal Valsalva manoeuvre, at 85° acquisition angles, as previously described [14]. Levator co-activation on Valsalva manoeuvre was avoided with meticulous observation and patient education by visual biofeedback. At least three volume cine loops on Valsalva were acquired. The volume on maximum Valsalva manoeuvre resulting in the greatest degree of pelvic organ descent was used for analysis [15]. Postprocessing analysis of TLUS volumes was performed at a later date for pelvic organ descent and hiatal area on Valsalva manoeuvre, using proprietary software (4D View version 9.0–10.0; GE Medical Systems, Zipf, Austria), blinded against all other data.

Clinically significant POP was defined as ICS POP-Q stage 2 or higher, for the anterior and posterior compartments and stage 1 or higher for the central compartment [16]. Sonographically, prolapse was determined relative to a line placed through the inferior symphyseal margin [17]. The definition of "significant prolapse on ultrasound" was based on previously established cut-offs, i.e. cystocele and rectal ampulla descent to ≥10 mm and >15 mm below the symphysis pubis (SP) respectively; enterocoele descent to the level of the SP and below; and uterine descent to <15 mm above the SP [18]. A true rectocele, i.e. an outpouching or herniation of the rectal ampulla indicative of a defect of the rectovaginal septum (RVS), was diagnosed in the presence of a discontinuity in the anterior contour of the internal anal sphincter and anterior anorectal muscularis, resulting in herniation of the ampulla into the vagina. Maximal rectocele depth was determined as previously described [19] by assessing the entire Valsalva manoeuvre and selecting the volume showing the rectocele at its deepest (Fig. 1). A test–retest series for all ultrasound parameters was conducted before the analysis and showed good interobserver agreement, with intraclass correlation coefficients of 0.75 (95% CI 0.46–0.89), 0.7 (95% CI 0.39–0.87) and 0.8 (95% CI 0.4–0.93), for rectal ampulla, uterine and bladder descent respectively; and 0.61 (95% CI 0.18–0.84) and 0.89 (95% CI 0.73–0.95) for true rectocele depth and hiatal area on Valsalva respectively.

Statistical analysis was performed using SPSS V20 (SPSS, Chicago, IL, USA), SAS 9.3 (SAS Institute, Cary, NC, USA) and Minitab 16 (Minitab® Statistical Software, State College, PA, USA) using ANOVA, Spearman's correlation, Chi-squared tests and multivariate regression. Normality of continuous data was assessed using the Kolmogorov–Smirnov method. P <0.05 was considered statistically significant. Univariate analysis assessing the association between BMI with symptoms and signs of POP was performed using ANOVA for categories of BMI, as per the WHO classification (normal <25, overweight 25 to <30, obese class I: 30 to <35, class II: 35 to <40, class III: ≥40) [20] and Pearson's correlation. Any effect of potential confounders such as age, parity, operative vaginal delivery, previous prolapse/incontinence surgery and levator avulsion on associations between BMI and POP were explored using multivariate regression analysis.

Results

Of 1043 patients seen during the inclusion period, ultrasound volumes or BMI datasets were missing in 35 and 44 respectively, leaving 964 for analysis. There were no other exclusions. All results pertain to those 964 women. Out of the 964 women, 294 (30.5%) had a previous hysterectomy, leaving 670 for the assessment of uterine prolapse. Demographic characteristics of the study population are presented in Table 1.

Mean BMI was 28.89 (SD 6.19, range 15–55) kg/m^2. The study population was stratified into BMI categories based on the WHO criteria (Table 2). Most presented with stress and urge incontinence, i.e. 695 (72.2%) and 704 (73.1%). 511 (53%) complained of symptoms of POP such as vaginal mass and/or a dragging sensation. 321 (33.4%), 430 (44.7%), 345 (35.8%) and 23 (7.8%) complained of urinary frequency, nocturia, voiding dysfunction and splinting respectively.

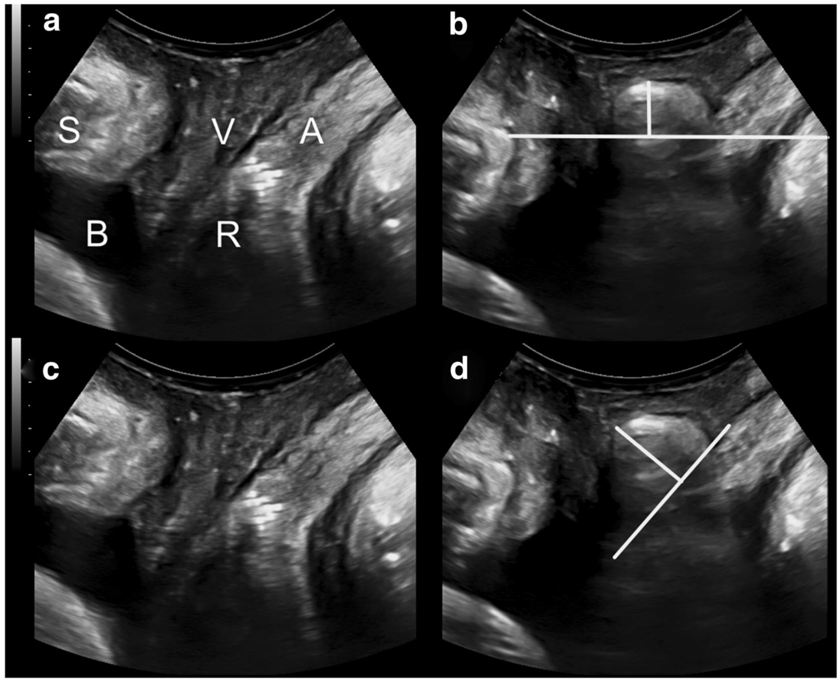

Fig. 1 Translabial ultrasound imaging in the midsagittal plane. **a**, **b** Images show descent of the rectal ampulla, **c**, **d** illustrate rectocele depth. **a**, **c** Images were obtained at rest, **b**, **d** on Valsalva. *S* symphysis pubis, *V* vagina, *A* anus, *B* bladder, *R* rectum

Symptoms of obstructed defecation, i.e. of straining at stool, sense of incomplete bowel emptying and digitation were reported in 614 (63.8%).

On clinical examination, 751 (77.9%) had significant POP in the form of an anterior (56.9%), central (39.6%) and posterior compartment (55.8%) POP with mean Ba, C and Bp of −1 (SD 1.89, range − 3 to 7.5) cm, −4.29 (SD 2.76, range − 9 to 8) cm and −1.05 (SD 1.48, range − 9 to 7) cm respectively. Mean genital hiatus + perineal body was 7.87 (SD 1.36, range 3.5 to 12.5) cm.

A total of 643 (66.7%) had significant POP on TLUS: 37.8% cystocoele, 50.8% uterine prolapse and 39% rectocoele. Mean bladder, uterine and rectal ampulla descent was −5.59 (SD 18.3, range − 62.1 to 32.1) mm, 12.11 (SD 20.2, range − 51 to 53) mm and −8.86 (SD 15.1, range − 49.8 to 37.3) mm respectively. Sonographic/true rectocoele was diagnosed in 449 (46.6%) women at a mean depth of 17.18 (SD 6.8, range 5 to 47.1) mm. Mean hiatal area on Valsalva was 29.7 (SD 9.3, range 7.97 to 61.37) cm^2. Levator avulsion was diagnosed in 223 (23.1%).

On univariate analysis, BMI was weakly negatively associated with symptoms of prolapse (odds ratio 0.979, 95% confidence interval 0.96 to 1.0), $P = 0.045$, but not with symptom bother, as defined by VAS scale (R2 0.0027, $P = 0.12$. On

Table 1 Demographic characteristics of the study population (*n* = 964)

Demographic characteristics and presenting symptoms	
Mean age (SD, range) years	56 (13.66, 17–89)
Mean BMI (SD, range) kg/m^2	28.89 (6.19, 15–55)
Postmenopausal (%)[a]	588 (61.1)
HRT use (%)[a]	60 (6.2)
Median parity (IQR, range)	3 (2–3, 0–9)
Operative vaginal delivery (%)[a]	249 (25.8)
Previous hysterectomy (%)[a]	294 (30.5)
Previous prolapse and/or anti-incontinence surgery (%)	221 (22.9)
Stress urinary incontinence (%)	695 (72)
Urgency urinary incontinence (%)	700 (73)
Symptoms of voiding dysfunction (%)[b]	345 (36)
Symptoms of prolapse (%)	511 (53)

[a] Categorical data expressed as *n* (%)

[b] Including hesitancy, stop–start voiding and straining to void

Table 2 Proportion of study population stratified into WHO BMI categories

BMI categories	*n* (%)
Normal, BMI <25	283 (29.4)
Overweight, BMI 25–29.9	311 (32.3)
Obese, class I BMI 30–34.9	217 (22.5)
Obese, class II BMI 35–39.9	93 (9.6)
Extreme obesity, class III BMI > 40	60 (6.2)

clinical examination, BMI was not associated with Ba and C point on ICS POP-Q; however, it was strongly associated with Bp (P < 0.0001) and genital hiatus + perineal body (P < 0.0001). On testing for any association with imaging, we found that WHO BMI categories were strongly associated with both rectal ampulla descent (P < 0.0001) and rectocele depth (P < 0.0001) on ultrasound (Fig. 2), as described in Table 3, but again measures of anterior and central compartment descent showed no statistical relationship with BMI. Significant associations all remained so (P = 0.002 or lower) after controlling for potential confounders such as age, vaginal birth, age at first delivery, levator avulsion, forceps, hysterectomy and previous incontinence and/or prolapse surgery, in multivariate modelling.

Discussion

As far as the authors are aware, this is the first study to demonstrate an association between BMI on the one hand and rectocele on clinical examination and translabial ultrasound in addition to rectocele depth on ultrasound on the other hand. This was not the case for prolapse of the anterior and central compartments. Likewise, there was no positive association between symptoms of prolapse or prolapse bother and BMI.

This study is limited by its observational design and it is therefore not suitable for assessing a causal relationship between obesity and POP. A future prospective case control trial is recommended to address this issue. We performed imaging in the supine position for reasons of convenience. Although the difference between supine and standing seems almost negligible for the posterior compartment [21], it is acknowledged that assessment in the standing position may alter findings. Another weakness of this study is that we relied on self-reporting of height and weight. Ideally, these measurements should be obtained at the time of assessment. Finally, our study population involved women who were symptomatic of pelvic floor dysfunction and mainly of Caucasian ethnicity. Hence, our result may not be extrapolated to the general population and populations of other ethnic backgrounds. Further studies involving asymptomatic cohorts and different ethnicities may be beneficial.

The strengths of this study include the large dataset containing nearly 1,000 patients. Furthermore, it is, to our knowledge, the first attempt to utilise imaging of pelvic organ descent for this particular research question. TLUS provides an objective measurement of organ descent and allows prolapse assessment in volume data saved and utilised for post-processing at a later date, by an operator blinded to BMI data. Body habitus is in no way deducible from stored TLUS data sets. On the other hand, blinding is virtually impossible using clinical prolapse grading as an outcome measure, as the clinical examination necessarily informs the examiner of the patient's body habitus.

Our findings are at least partly consistent with those of several other studies [8, 9, 22, 23] investigating the role of obesity in prolapse. Handa et al. conducted a longitudinal study in over 400 menopausal women enrolled in the oestrogen plus progestin trial of the Women's Health initiative, and demonstrated that increasing BMI was strongly associated with rectocele, but not with other forms of prolapse [22]. Hendrix et al. conducted a cross-sectional analysis of women enrolled in the Women's Health Initiative HRT trial and found that obesity was strongly associated with increased risks for uterine prolapse, cystocoele and rectocoele using the Baden–Walker grading system, performed without a speculum [8]. In a large questionnaire-based study, Whitcomb

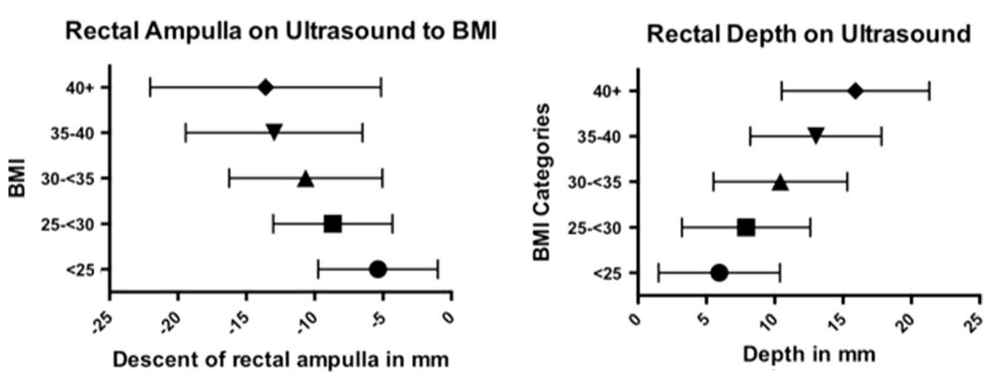

Fig. 2 Analysis of variation (ANOVA) of the association between BMI categories and descent of the rectal ampulla (lower values implying greater descent) and rectocele depth, both P < 0.001, symbols illustrating the mean and standard deviation

Table 3 Results of univariate analysis of the association between BMI and signs of POP. For the association between BMI and clinically or sonographically determined pelvic organ descent, BMI was stratified into WHO categories, as described in Table 2

Parameters	F statistic, F(df)	R2 statistic (adjusted), %	*P* value
ICS POP-Q			
Ba	2.45		n.s.
C	0.39		n.s.
Bp	5.39	1.91	0.0003
GH + PB	7.08	2.48	<0.0001
Pelvic organ position (on maximal Valsalva) on TLUS			
Bladder	1.66		n.s.
Uterine^	0.33		n.s.
Rectal ampulla	7.44	2.60	<0.0001
Rectocele depth	21.61	7.88	<0.0001
Hiatal area on Valsalva	1.8		n.s.

Results are expressed as F (degree of freedom) and adjusted R2 statistics for one-way ANOVA

Analysis of uterine descent on TLUS was performed in women without previous hysterectomy (n = 660)

ICS POP-Q International Continence Society Pelvic Organ Prolapse Quantification, *GH* genital hiatus, *PB* perineal body, *TLUS* translabial ultrasound, *n.s.* not significant

et al. found no association between BMI and prolapse bother on VAS; however, the prevalence of prolapse symptoms was marginally increased with higher grades of obesity [23].

An obvious potential explanation for increased prolapse prevalence in obese women may be a chronically raised intra-abdominal pressure in such individuals. Noblett et al., who retrospectively reviewed multi-channel cystometrograms, have provided supporting evidence in that they found a strong association between intra-abdominal pressure and BMI, with a Pearson coefficient correlation of 0.76 [24]. It is intriguing to speculate that increased intra-abdominal pressure may have varying effects on different compartments, just as pelvic floor trauma seems to affect the three compartments in different ways [25].

However, it needs to be mentioned that some investigators have found no relationship between BMI and pelvic organ descent. A cross-sectional study similar to the one presented here was conducted by Washington et al., who documented no difference in stage ≥II prolapse in obese (BMI ≥30) and non-obese women in any compartment [11]. Obesity was, however, associated with increased distress on two disease-specific colorectal questionnaires. In this study, 35.8% of patients were obese (BMI >30), similar to the prevalence in our study, in which 38% of the patients had a BMI over 30, and other demographic descriptors were also similar. Glazener et al. [1] of the PROLONG study group showed that a BMI greater than 25 was associated with higher POP-SS scores (feeling of something coming down, discomfort or pain when standing, dragging the tummy/back, incomplete bladder emptying sensation, bowel not completely empty) in a prospectively followed cohort of women seen 12 years after childbirth. However, BMI was not associated with objective measures of prolapse on examination. It is likely that such discrepancies are due to the non-standardised nature of prolapse assessment [26, 27] and differences in the populations assessed.

Finally, the weak negative association between BMI and symptoms of prolapse deserves to be mentioned. It is conceivable that higher grades of obesity reduce the likelihood of individuals noticing a lump, simply because of the impossibility of direct observation. However, this weakly significant result should not be over-interpreted given the substantial number of tests performed by us. At any rate, even if true, our results would indicate a small effect size that would make this finding clinically irrelevant.

Conclusion

The effect of obesity on POP seems to be complex. Our study showed no evidence of an association between BMI and anterior or central compartment descent. However, there was a strong association between BMI and all tested measures of posterior compartment descent, both clinical and on imaging.

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Compliance with ethical standards

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