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Pelvic Floor Symptoms and Bone Mineral Density in Women Undergoing Osteoporosis Evaluation

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Abstract

Objective—To characterize pelvic floor symptoms in post-menopausal women who had undergone osteoporosis evaluation, and examine their association with bone mineral density (BMD).

Methods—Pelvic floor symptom questionnaires were mailed to 4,026 women. Multivariable logistic regression models controlling for age, race, body mass index, and chronic obstructive pulmonary disease were performed comparing symptoms in women with osteoporosis (T-score: -2.5) and osteopenia (T-score: >-2.5 to <-1) at any site to women with normal BMD (T-score: -1 , referent).

Results—1774/4026 (44%) questionnaires were returned; 1655 were included in the analysis (362 osteoporosis, 870 osteopenia, 423 normal BMD). Overall prevalence of any urinary incontinence (UI) was 1226/1640 (75%), with UI 2–3 times/week in 699/1197 (58%), fecal incontinence over the past month in 247/1549 (16%), and prolapse in 162/1582 (10%). Multivariable analyses revealed that women with osteopenia had increased risk of incontinence of solid stool (aOR:1.7, 95% CI:1.1–2.4). Risk of UI 2–3 times/week was not increased in women with osteoporosis (aOR:0.9, CI:0.6, 1.3) and was lower in women with osteopenia (aOR:0.7, CI: 0.5, 0.9). In women with osteoporosis, the odds of moderate/large-volume urine loss versus small/none was higher for those in the lower T-score quartile (lower BMD; aOR:1.43, CI:1.1, 1.9).

Conclusions—In women undergoing osteoporosis evaluation, those with osteopenia were at increased risk of fecal incontinence, but not UI compared to normal women. Osteoporotic women with the lowest T-scores had higher risk of moderate/large volume UI. It is unclear whether there is a pathophysiologic link between BMD loss and development of pelvic floor symptoms.

Keywords

pelvic floor disorders; bone mineral density; pathophysiology

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Introduction

Pelvic floor disorders, including urinary (UI) and fecal incontinence (FI), and pelvic organ prolapse (POP), are prevalent conditions that significantly impact quality of life. [1–5] In a cross sectional analysis of the 2005–2006 National Health and Nutrition Examination Survey, investigators reported that the weighted prevalence of at least one pelvic floor symptom was 24%. [5] A number of clinical and demographic characteristics, including advancing age, have been found to be associated with the development of these conditions [1, 3, 4] and increasing numbers of surgeries are being performed to treat UI and POP. [6,7] Muscle weakness, collagen and other extracellular matrix abnormalities reflecting both qualitative and quantitative deficiencies or remodeling may weaken the support of the pelvic floor resulting in the development of these disorders. [8–10] Further, these processes have been shown to be modulated by estrogen and selective estrogen receptor modulators. [11,12]

Low bone mineral density (BMD), osteoporosis and insufficiency fractures are also prevalent conditions in postmenopausal women and are significant contributors to morbidity and mortality in this population. [13] Approximately fifty percent of Caucasian women over the age of 50 years will sustain an osteoporosis-related fracture in their lifetime. [14] The presence of BMD, osteoporosis, and fractures reflects deficits in bone connective tissue qualities, including mass, matrix and micro-architectural abnormalities. [15,16] Because of the similarity in the pathophysiology of these conditions, [11] we sought to characterize pelvic floor symptoms in women presenting to a university osteoporosis prevention and treatment clinic, and to examine the relationships between pelvic floor symptoms and BMD. We hypothesized that women with low BMD would report more symptoms of UI and FI, as well as bothersome POP symptoms as compared to women with normal BMD, controlling for known potential confounders.

Materials and Methods

After Institutional Review Board (IRB) approval, pelvic floor symptom questionnaires were mailed to patients in an IRB-approved osteoporosis database consisting of patients presenting for evaluation from January, 2007 through October, 2010. Methods, definitions, and units conform to the standards jointly recommended by the International Urogynecological Association (IUGA) and the International Continence Society (ICS), except where specifically noted. [17] Questions assessed the presence and type of UI in the past 3 months using the 3 Incontinence Questions (3IQ). [18] Stress urinary incontinence (SUI) was defined as leakage with some physical activity, such as coughing, sneezing, lifting or exercise, and urgency urinary incontinence (UUI) was defined as having the urge or the feeling that she needed to empty her bladder but could not get to the toilet fast enough. Women who reported any urine leakage in the prior 3 months were classified as UI-positive. UI frequency and severity were characterized utilizing the 4-item International Consultation on Incontinence Questionnaire-Short Form (ICIQ-SF). [19]

Incontinence of liquid or solid stool over the past month was ascertained utilizing questions obtained from the Modified Manchester Questionnaire. [20] Occurrence of one or more fecal incontinence episodes per month qualified as FI-positive, while responses of “never” were considered FI-negative. Bothersome prolapse was defined utilizing the prolapse symptom assessment question from the Pelvic Floor Distress Inventory questionnaire. POP was defined as a positive response to the question, “Do you experience bulging or something falling out that you can see or feel in the vaginal area?”. [21] A positive response has been shown to correlate with objective vaginal bulging on physical examination; however the question has a higher specificity than sensitivity for POP by examination. [22]

Other clinical information obtained from the mailed questionnaire included characterization of predominant stool type using the Bristol Stool Chart [23], whether the participant took any hormone replacement therapy, had undergone prior surgery for urinary incontinence or pelvic organ prolapse, and the number of vaginal deliveries. Other pertinent clinical-demographic information that was collected through the database included: age, ethnicity, body mass index (BMI), use of bone mineral density medications or steroids, menopausal status, smoker or drinker, or had a history of chronic obstructive pulmonary disease.

Bone mineral density (BMD) assessments were completed on a Hologic Inv (Bedford, MA) Discovery W scanner using Version 13.2:7 software. Data included T- and Z-scores from the femoral neck, total hip, lumbar spine and one-third radius (cortical bone). A diagnosis of osteoporosis was defined as the WHO criteria of a T-score ≤ -2.5 at any one site, osteopenia, T-score: >-2.5 to <-1 , and normal bone mineral density, T-score ≥ -1 or greater (referent). [24]

Statistical Analysis

Demographic characteristics of all women who responded to the survey were compared across the 3 BMD levels. Chi-square tests of association and Fisher's exact test, where appropriate, were used to compare categorical measures. Analysis of variance (ANOVA) and the Kruskal-Wallis test were used to compare group means and medians, respectively. These methods were also used to compare characteristics between responders and non-responders. Multivariable logistic regression models controlling for age, race, body mass index, BMD medications and COPD were performed to compare symptoms in women with osteoporosis and osteopenia at any site to women with normal BMD. Multivariable logistic regression was also used to compare symptoms with BMD severity among those women with osteoporosis. Analyses were performed using SAS version 9.2 (SAS Institute, Inc. Cary, NC).

Results

Forty four percent (1,774/4026) of mailed questionnaires were returned. One hundred and nine of the returned questionnaires were removed from those returned due to duplication, male gender, premenopausal status or deceased (Figure 1). A total of 1,655 (41%) postmenopausal women with BMD diagnoses were included in the analyses (362 osteoporosis, 870 osteopenia, 423 normal BMD). Overall, the mean ($\pm$ SD) age was 63.4($\pm$ 9.6) years, and women with osteoporosis and osteopenia were older, had a lower prevalence of African American race, and a higher proportion of normal weight, COPD, history of fractures, and taking BMD medications (Table 1). Eligible responders (n=1655) were statistically older, more likely to be of Caucasian race, be of normal BMI, take BMD medications and take estrogen hormone replacement, and less likely to have COPD, take steroids and be smokers than eligible non-responders, but did not differ on BMD (n=2160; Table 2).

Overall prevalence of any UI in the last 3 months was 1226/1640 (75%) with UI frequency 2–3 times/week in 699/1197 (58%), liquid stool incontinence in 489/1529 (32%), solid stool incontinence in 247/1549 (16%), and vaginal prolapse symptoms in 162/1582 (10%). Prevalence of any UI and UI type did not differ by BMD group ($p=0.44$). However, total ICIQ-SF score reflecting frequency, volume of urine leaked, and interference with everyday life were higher in the normal BMD group compared to those with lower BMD ($p<0.01$). Prevalence of solid stool incontinence was higher in women with osteoporosis and osteopenia ($p=0.04$), but not liquid stool incontinence. In women with FI, there was no difference in the frequency of liquid or solid stool loss across BMD groups. The median

stool type by Bristol Stool Classification did not differ by groups (Table 3). Prevalence of any prolapse symptoms did not differ by BMD group ($p=0.54$; Table 3).

In the overall cohort, multivariable analyses controlling for age, race, BMI, BMD medications and COPD revealed that women with osteopenia had increased risk of incontinence of solid stool (OR: 1.7, 95% CI: 1.1–2.5) compared to women with normal BMD; there was a trend toward increased FI in women with osteoporosis. However, risk of UI 2–3 times/week was lower in women with osteopenia (OR: 0.7, 95% CI: 0.5–0.9). Observed differences in total ICIQ-SF scores were nullified in the multivariable regression model controlling for the covariates listed above ($p = 0.52$). No associations were seen with any prolapse symptoms (Table 4).

Multivariable analysis performed including only the subset of women with osteoporosis ($n=362$) found that the odds of moderate/large volume urine loss versus small/none was higher in subjects in the lower T-score quartile, ie lower BMD (OR: 1.43, 95% CI: 1.08–1.89). Total ICIQ-SF did not differ by T-score quartile in univariate ($p=0.10$) or multivariable ($p=0.09$) analyses. No other associations were seen with T-score by quartile and pelvic floor symptoms in women with osteoporosis (Table 5).

Discussion

The results of this study demonstrate a very high prevalence (75%) of UI as well as FI (16%) in women undergoing evaluation for osteoporosis. The prevalence of UI in this study was high compared to population-based epidemiological studies.[1–5] However, it is consistent with the prevalence found in a similar sample of women with osteoporosis or osteopenia who presented to a clinic, in which 67% of women reported one or more symptoms of UI, and almost 40% reported at least weekly episodes.[25] The overall severity of incontinence symptoms based on the ICIQ total score places the women in the current study at a moderate severity level, reflecting significant amounts of urinary leakage and impact on quality of life.[26]

Although we thought that this high prevalence of UI might be attributed to a common pathophysiology between pelvic floor disorders and low BMD levels/osteoporosis, the women in this study with osteoporosis or osteopenia were not at increased risk of UI as compared to a normal BMD referent population. We had anticipated that the UI prevalence rate in the normal BMD referent population would be more reflective of a recent population based study where UI rates were similarly defined and ranged from approximately 17–40% in women 40 to greater than 80 years of age and that the prevalence rate in the osteoporosis group similar to that reported by Sran and colleagues.[5, 25] The sample size we had provided sufficient power to detect these estimated differences among groups. Based on these estimated prevalence rates in women with osteoporosis or osteopenia [25], and the noted UI prevalence rate in the normal BMD group in this study our achieved sample size restricted the ability to observe small but meaningful differences between normal BMD women and those with osteoporosis or osteopenia. For example, compared to the normal BMD women, we had low power to detect a 35% increase in the odds of UI in women with osteoporosis (<55% power) or osteopenia (<70% power). In summary, we had >80% power for differences of 10% or more, but had less power for differences <10%. This reflects the importance of having a referent population in studies such as this. In our study, 74% of women in each of the clinical groups reported UI, compared to 77% in the normal BMD group. However, in the subgroup of women with a diagnosis of osteoporosis, those in the lowest quartile of T-scores had increased risk of moderate/large volume UI, indicating an association between BMD and severity of urine loss in those with the most severe BMD loss. It is not surprising that women in the normal BMD group were more impacted by

pelvic floor symptoms as they were younger and may have an increased activity level such that these symptoms may have more impact. [27] Indeed, the difference in incontinence frequency and volume in the entire cohort were no longer significant once risk factors were controlled for by multivariable analysis. Being able to control for activity level may be an important issue to assess in future studies.

The lack of association between BMD level and both UI and POP in the overall population is somewhat inconsistent with two previous studies indicating a relationship between osteoporosis and UI and POP. In a prospective cohort study of 12,570 female patients registered with general practitioners, self-reported osteoporosis was associated with overactive bladder symptoms (OR = 1.8), but not with SUI.[28] In a population-based interview study including 3,010 men and women, self-reported osteoporosis emerged as a significant correlate of pelvic floor dysfunction (OR=1.8 p=.049) defined as current or past UI, FI, POP, or bladder or vaginal repair. [9] Further, in the Women's Health Initiative Estrogen Plus Progestin trial, an association was found between clinically significant (moderate to severe) POP, specifically rectocele, and low bone mineral density in postmenopausal women. [8] The authors suggest that "suboptimal collagen status purported to associate with POP may also involve bone collagen and hence translate into skeletal compromise." Unlike our study, where BMD was characterized using objectively obtained DEXA data and WHO criteria, the self-report of osteoporosis may introduce responder bias whereby women who report osteoporosis or history of fracture may be more likely to also report pelvic floor symptoms. Borderline significance (p=0.05) in the association of moderate/severe prolapse and lower whole body BMD was noted in a subset of women (6% of 11,086) undergoing objective BMD assessment. [8]

Compared to the number of studies linking connective tissue disorders to UI and POP, there are very few reports exploring a similar association with FI. One report suggested that changes in the fibrous tissue content of the internal anal sphincter (IAS) influenced muscle tone and responsiveness of the IAS in women with FI by reducing elasticity. [29] Our results showed that the differences in FI across the BMD groups did not reflect a dose-response relationship. Women with osteopenia were at increased risk of solid stool incontinence, but the effect for the osteoporosis group was weaker. A trend was noted but the relationship was not significant. It is possible that the lack of significance was related to the small sample size relative to the osteopenia group. Perhaps if there had been a similar number of patients in the osteoporosis group, the relationship with FI may have been significant.

Our results suggest that there may be an independent association between decreased BMD and fecal incontinence symptoms. This may be reflective of common pathophysiologic processes occurring in osseous and other collagen-based supportive connective tissue, that occur independent of age, race, BMI, use of BMD medications and a history of COPD, risk factors or treatments associated with FI and osteoporosis. This is the first study to robustly address pelvic floor symptoms in women seeking evaluation of and treatment for decreased BMD controlling for possible confounders. Due to the high prevalence of pelvic floor symptoms, women being seen in an osteoporosis clinic should be queried regarding the presence of these symptoms so that appropriate referrals may be offered.

Strengths of this study include a reasonably large patient population in which to characterize pelvic floor symptoms and BMD subgroups large enough to examine associations between symptoms and BMD. Also, BMD subgroups were determined by DEXA scan data. Several potential confounding variables were identified and included as covariates in multivariable analyses. Although there were significant differences in medical and demographic characteristics, there were no differences in the BMD characteristics. BMD was carefully characterized, and pelvic floor symptoms were measured using validated questionnaires.

Weaknesses include those inherent in the cross-sectional study design which limits inferences about causation. The results are generalizable mainly to Caucasian women due to limited representation of other racial/ethnic groups. The response rate was less than fifty percent, which is not unusual for a mailed survey, but may be open to response bias. If women with pelvic floor symptoms were more likely to be responders, this could have inflated the prevalence figures. Finally we do not have objective data with which to corroborate these findings, however, with the use of validated measures this is less of a concern.

Although not showing a dose related association, these study results suggest that FI and decreased BMD may have a common mechanism, which can result in significant morbidity and impact on quality of life. In women with osteoporosis, those with a lower quartile of BMD had an increased severity of UI controlling for confounding factors. It is important that larger studies with translational aims address the potential pathophysiologic link between BMD and incontinence, as prevention and early treatment may result in markedly improved quality of life.

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Figure 1.
Patient population under study

Table 1

Clinical-Demographic Characteristics of Participants

Characteristic	Overall (n=1655)	Osteoporosis (n=362)	Osteopenia (n=870)	Normal (n=423)	p
Age	63.4 ± 9.6	66.2 ± 10.3	63.7 ± 9.2	60.3 ± 9.2	<0.0001
Race					
Caucasian	1296 (78%)	307 (85%)	717 (82%)	272 (64%)	<0.0001
African-American	292 (18%)	34 (9%)	119 (14%)	139 (33%)	
Other/Unspecified	67 (4%)	21 (6%)	34 (4%)	12 (3%)	
BMI					
Underweight	43 (3%)	23 (6%)	14 (2%)	6 (1%)	<0.0001
Normal	706 (43%)	210 (58%)	404 (46%)	92 (22%)	
Overweight	497 (30%)	84 (23%)	285 (33%)	128 (30%)	
Obese	409 (25%)	45 (12%)	167 (19%)	197 (47%)	
Vaginal deliveries *					
0	379 (24%)	76 (23%)	193 (23%)	110 (27%)	0.56
1	254 (16%)	52 (16%)	139 (17%)	63 (16%)	
1	921 (59%)	202 (61%)	491 (60%)	228 (57%)	
Previous surgery for UI and/or prolapse	242 (15%)	50 (14%)	125 (14%)	67 (16%)	0.69
Any Bone Mineral Density Medications	481 (29%)	182 (50%)	273 (31%)	26 (6%)	<0.0001
Steroid Use	114 (7%)	30 (8%)	49 (6%)	35 (8%)	0.10
Smoker	99 (6%)	24 (7%)	47 (5%)	28 (7%)	0.58
Drinker	21 (1%)	3 (1%)	14 (2%)	4 (1%)	0.42
Estrogen	88 (5%)	12 (3%)	50 (6%)	26 (6%)	0.15
COPD	50 (3%)	23 (6%)	22 (3%)	5 (1%)	<0.0001
BMD T-score	-1.61 ± 1.06	-2.93 ± 0.48	-1.73 ± 0.41	-0.24 ± 0.67	<0.0001
High BMD (Z score ≥ 2.5)	191 (12%)	8 (2%)	71 (8%)	112 (26%)	<0.0001

Characteristic	Overall (n=1655)	Osteoporosis (n=362)	Osteopenia (n=870)	Normal (n=423)	p
Fracture	206 (12%)	74 (20%)	110 (13%)	22 (5%)	<0.0001

* 101 incomplete responses

p-values are based on chi-square test of association (Fisher's exact test where appropriate) for categorical measures

p-values are based on ANOVA for quantitative measures

Table 2

Clinical-Demographic Characteristics of Eligible Responders and Eligible Non-Responders

Characteristic	Responder (n=1655)	Non- responder* (n=2160)	P
Age	63.4 ± 9.6	61.8 ± 10.9	<0.0001
Race			
Caucasian	1296 (78%)	1534 (71%)	<0.0001
African-American	292 (18%)	522 (24%)	
Other/Unspecified	67 (4%)	100 (5%)	
BMI			
Underweight	43 (3%)	78 (4%)	<0.0001
Normal	706 (43%)	792 (37%)	
Overweight	497 (30%)	622 (29%)	
Obese	409 (25%)	668 (31%)	
Any Bone Mineral Density Medications	481 (29%)	509 (24%)	0.0001
Steroid Use	114 (7%)	226 (10%)	0.0001
Smoker	99 (6%)	230 (11%)	<0.0001
Drinker	21 (1%)	12 (<1%)	0.02
Estrogen	88 (5%)	63 (3%)	0.0002
COPD	50 (3%)	97 (4%)	0.02
BMD T-score	-1.61 ± 1.06	-1.62 ± 1.18	0.95
High BMD (Z-score ≥ 2.5)	191 (12%)	224 (10%)	0.25
Fracture	203 (12%)	276 (13%)	0.76

* excludes premenopausal and pregnant women, men and deceased patients.

Table 3

Unadjusted Pelvic Floor Symptom Outcomes

Characteristic	Overall (n=1655)	Osteoporosis (n=362)	Osteopenia (n=870)	Normal (n=423)	p
Any UI Leaking in Last 3 months *	1226 (75%)	265 (74%)	638 (74%)	323 (77%)	0.44
Stress	819 (67%)	170 (64%)	432 (68%)	217 (67%)	0.58
Urge	906 (74%)	192 (72%)	475 (74%)	239 (74%)	0.82
Other UI	237 (19%)	48 (18%)	117 (18%)	72 (22%)	0.29
Most Often †					
Stress	356 (34%)	77 (34%)	185 (33%)	94 (34%)	0.28
Urge	507 (48%)	121 (53%)	263 (47%)	123 (45%)	
Other UI	55 (5%)	9 (4%)	30 (5%)	16 (6%)	
About Equally	141 (13%)	20 (9%)	80 (14%)	41 (15%)	
Frequency **					
Never or 1 per week	498 (42%)	109 (42%)	286 (46%)	103 (33%)	<0.01
2-3 per week or more frequent	699 (58%)	149 (58%)	337 (54%)	213 (67%)	
Volume ‡					
None to Small	926 (78%)	200 (78%)	499 (80%)	227 (71%)	<0.01
Moderate to Large	268 (22%)	55 (22%)	122 (20%)	91 (29%)	
Interference Rating ††	2.6 ± 2.7	2.6 ± 2.8	2.4 ± 2.6	2.9 ± 2.6	<0.01
Total ICIQ Score £	7.1 ± 4.2	6.9 ± 4.4	6.8 ± 4.1	7.9 ± 4.3	<0.01
Any Liquid Stool Incontinence ***	489 (32%)	111 (34%)	256 (31%)	122 (31%)	0.59
Frequency of Liquid Stool Incontinence					
1-3 times per month	355 (71%)	76 (68%)	180 (70%)	89 (73%)	
Once a week or more	144 (29%)	35 (32%)	76 (30%)	33 (27%)	

Characteristic	Overall (n=1655)	Osteoporosis (n=362)	Osteopenia (n=870)	Normal (n=423)	p
Any Solid Stool Incontinence ^{†††}	247 (16%)	55 (16%)	145 (18%)	47 (12%)	0.04
Frequency of Solid Stool Incontinence 1–3 times per month	166 (67%)	38 (69%)	101 (70%)	27 (57%)	0.29
Once a week or more	81 (33%)	17 (31%)	44 (30%)	20 (43%)	
Vaginal Prolapse ^{††}	162 (10%)	37 (11%)	79 (9%)	46 (11%)	0.54
Any Prolapse Bother ^{††}	137 (85%)	31 (84%)	66 (84%)	40 (87%)	0.87
Predominant Bristol Classification Stool Type, Median, (range) ^{††††}	3 (1 – 7)	3 (1 – 7)	3 (1 – 7)	4 (1 – 7)	0.42

^{*} 15 incomplete responses,
[†] 167 incomplete responses,
^{**} 29 incomplete responses,
[‡] 32 incomplete responses
^{††} 58 incomplete responses,
^{***} 126 incomplete responses,
^{†††} 106 incomplete responses,
^{††††} 73 incomplete responses,
^{†††††} Type 1=hard lumps, Type 7=entirely liquid
[£] 1131 complete responses to all 3 questions. Significant differences between normal and osteopenia (p<0.01) and between normal and osteoporosis (p=0.01)

Table 4

Adjusted odds ratios (aOR) and 95% confidence intervals for association between BMD diagnosis (with Normal as referent) and pelvic floor symptoms.

Symptom	Osteoporosis		Osteopenia	
	aOR	95% CI	aOR	95% CI
Any UI vs. None	0.86	0.59 – 1.26	0.83	0.61 – 1.13
Frequency of Leakage 2–3 per week vs. Never or 1 per week	0.87	0.59 – 1.29	0.70	0.52 – 0.96
Volume of Leakage Moderate to Large vs. None to Small	0.92	0.58 – 1.46	0.78	0.55 – 1.12
Any Liquid Stool vs. None	1.21	0.85 – 1.74	1.05	0.79 – 1.40
Any Solid Stool vs. None	1.44	0.90 – 2.33	1.67	1.14 – 2.45
Any Prolapse vs. None	1.10	0.65 – 1.88	0.90	0.60 – 1.37

Models are adjusted for age, race, BMI, BMD medications, and COPD

Table 5

Association of t-score quartile on pelvic floor symptoms in women with osteoporosis.

Symptom	OR	95% CI	aOR	95% CI
Any Urinary Leakage	0.96	0.79 – 1.17	0.96	0.77 – 1.18
Frequency of Leakage 2–3 per week vs. Never or 1 per week	1.06	0.86 – 1.31	1.12	0.90 – 1.40
Volume of Leakage Moderate to Large vs. None to Small	1.38	1.06 – 1.78	1.43	1.08 – 1.88
Any Liquid Stool vs. None	0.96	0.77 – 1.20	1.01	0.81 – 1.28
Any Solid Stool vs. None	0.88	0.68 – 1.16	0.89	0.68 – 1.18
Any Prolapse vs. None	1.10	0.82 – 1.47	1.08	0.80 – 1.46

Models adjusted for age, race, BMI, BMD medications, and COPD.