

## GYNECOLOGY

# Breastfeeding and pelvic floor disorders one to two decades after vaginal delivery



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**BACKGROUND:** Postpartum recovery from pelvic floor trauma associated with vaginal delivery may be impaired by the transient hypoestrogenic state associated with breastfeeding.

**OBJECTIVE:** The aim of our study was to examine the association between exclusive breastfeeding and pelvic floor disorders 1–2 decades after the first vaginal delivery. We hypothesize that compared with women who did not breastfeed following vaginal delivery, women who breastfeed would have a higher proportion of pelvic floor disorders, and those women who practiced sustained exclusive/unsupplemented breastfeeding would have the highest proportion.

**STUDY DESIGN:** This is a secondary analysis of the Mothers' Outcomes After Delivery study, a prospective cohort study of pelvic floor disorders after childbirth. Participants were recruited 5–10 years after their first delivery and followed up annually for up to 9 years. This analysis focused on participants who experienced at least 1 vaginal delivery. Each participant completed a self-administered questionnaire regarding breastfeeding. Based on questionnaire responses, breastfeeding status was classified into 3 ordinal categories: unexposed (did not breastfeed or breastfed <1 week); limited exclusive breastfeeding (breastfed without supplementation for  $\geq 1$  week but <12 weeks); and sustained exclusive breastfeeding (unsupplemented breastfeeding  $\geq 12$  weeks). Our primary outcomes of interest were the proportions of stress urinary incontinence, anal incontinence, and pelvic organ prolapse. The outcomes of interest were defined using the Epidemiology of Prolapse and Incontinence Questionnaire and the Pelvic Organ Prolapse Quantification Examination at enrollment and annually for up to 9 years thereafter. Additionally, a subanalysis examined the relationship between breastfeeding and anal

incontinence in an obstetric anal sphincter injury—specific population. Generalized estimating equations were utilized to determine the relationship between breastfeeding and the outcomes of interest.

**RESULTS:** Among 705 women, 189 (27%) were classified as unexposed, 145 (20%) were categorized as limited exclusive breastfeeding, and the remaining 371 women (53%) met our definition of sustained exclusive breastfeeding. Median follow-up was 5 years, contributing to a total of 3079 person years. The proportion of each pelvic floor disorder, based on 3079 person-years of follow-up was: stress urinary incontinence (27%), pelvic organ prolapse (20%), or anal incontinence (25%). Using generalized estimating equations adjusting for race, education, parity, and body mass index, sustained exclusive breastfeeding was not significantly associated with stress urinary incontinence (adjusted odds ratio, 0.82, 95% confidence interval, 0.55–1.23), pelvic organ prolapse (adjusted odds ratio, 0.78, 95% confidence interval, 0.49–1.26), and anal incontinence (adjusted odds ratio, 0.67, 95% confidence interval, 0.44–1.00). Regarding our obstetric anal sphincter injury subanalysis, 123 women within our cohort experienced obstetric anal sphincter injuries at delivery. Anal incontinence was reported in 32% of these women. However, there was no observed relationship between breastfeeding and the development of anal incontinence during study follow-up in this population.

**CONCLUSION:** Breastfeeding after vaginal childbirth was not associated with the development of stress urinary incontinence, pelvic organ prolapse, or anal incontinence 1–2 decades after the first vaginal delivery.

**Key words:** anal incontinence, breastfeeding, pelvic floor disorders, pelvic organ prolapse, stress urinary incontinence

Breastfeeding is associated with several known maternal and newborn benefits and is a prevalent and appropriately encouraged practice. However, one potentially negative aspect of breastfeeding is its transient impact on the pelvic floor. Studies have demonstrated a statistically significant relationship between breastfeeding duration and urinary incontinence up to 2 years following childbirth. The Eden Cohort

observed a relationship between breastfeeding  $\geq 3$  months and persistent postpartum incontinence at 24 months (odds ratio [OR], 1.54, 95% confidence interval [CI], 1.08–2.19), while Burgio et al reported an association between the duration of breastfeeding and urinary incontinence at 12 months postpartum (OR, 1.17;  $P = .023$ ).<sup>1,2</sup>

The association between breastfeeding and stress incontinence has been attributed to hypoestrogenism during lactation. Indeed, estrogen receptors are found throughout the urogenital tract, and obstetric and endocrine literature demonstrates breastfeeding mothers may experience estrogen depression, vaginal atrophy/dyspareunia, and prolonged postpartum amenorrhea.<sup>3–6</sup>

In postmenopausal women, the absence of estrogen is associated with decreased ratios of type I collagen and the impairment of connective tissue tensile strength.<sup>7</sup> Additionally, animal studies suggest that estrogen deprivation following injury impairs the process of muscle regeneration and repair, leading to increased scarring through fibrosis.

Scar tissue cannot contract; hence, significantly damaged muscle loses strength and endurance and is at increased risk of reinjury.<sup>8–11</sup> Considering the potential for pelvic floor trauma at the time of vaginal delivery,<sup>12</sup> it is plausible that the unique hormonal milieu of the breastfeeding mother may lead to fibrosis and a higher incidence of pelvic floor disorders (PFDs) remote from delivery.

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## AJOG at a Glance

**Why was this study conducted?**

The study was conducted to determine whether postpartum hypoestrogenism associated with breastfeeding impairs recovery from vaginal childbirth and therefore increase pelvic floor disorders later in life.

**Key findings**

In this cohort of parous women, there was no significant relationship between breastfeeding and pelvic floor disorders 1–2 decades after vaginal delivery, regardless of breastfeeding duration or exclusivity.

**What does this add to what is known?**

While prior studies have demonstrated a short-term increase in urinary incontinence during breastfeeding, these results suggest there is no long-term consequences or increase in pelvic floor disorders among women who breastfeed after vaginal delivery.

Little is known regarding the long-term consequences of breastfeeding on the pelvic floor. Our primary aim was to examine the association between breastfeeding and PFDs remote from vaginal childbirth. Our secondary aim specifically targeted women with obstetric anal sphincter injuries (OASIS) to examine the relationship between breastfeeding and anal incontinence in the setting of confirmed delivery related trauma. In both populations we hypothesize that compared with women who did not breastfeed following vaginal delivery, women who breastfeed would have a higher proportion of PFDs, and women who practiced sustained un-supplemented/exclusive breastfeeding would have the highest proportion.

**Materials and Methods****Subjects**

This is a secondary data analysis of the Mothers' Outcomes After Delivery (MOAD) study, a prospective cohort study examining the incidence of pelvic floor disorders in parous women. This study was coordinated by investigators from Johns Hopkins University and the Greater Baltimore Medical Center. Recruitment methods have been previously described.<sup>13</sup> In brief, women were recruited from a large community hospital 5–10 years after their first delivery. Cesarean and vaginal delivery groups were matched to ensure similar age and

time intervals from delivery to enrollment. All participants in the MOAD study completed an informed consent, and institutional review board approval was obtained.

MOAD participants were seen for an initial visit and then annually thereafter up to 9 years. At each visit, questionnaires were completed and a structured physical examination was performed. Study personnel were blinded to both the obstetric history and current symptoms. This analysis focused on MOAD participants who experienced at least 1 vaginal delivery. Among multiparous participants, we considered total parity but only the obstetric characteristics associated with the participant's index vaginal delivery.

**Exposures**

Breastfeeding following vaginal delivery was the primary exposure of interest. Breastfeeding data were collected via a self-administered questionnaire completed by each participant at the time of MOAD study enrollment. The breastfeeding questions were adopted from the National Immunization Survey.<sup>13,14</sup> For each delivery, the participant was asked whether she breastfed. Women who reported breastfeeding were then prompted to answer 2 follow-up questions regarding duration ("How old was this child when he/she completely stopped breastfeeding?") and exclusivity ("How

old was this child when you first fed him/her something other than breastmilk?"). Exclusive/unsupplemented breastfeeding is defined as the duration for which the child's solitary source of nutrition came from breast milk.

As previously reported by Handa et al,<sup>13</sup> the first delivery was the birth most likely to cause harm to the pelvic floor. Hence, among multiparous women within this cohort, we focused on breastfeeding and obstetric exposures relevant to the first vaginal birth.

For the purpose of this analysis, 3 ordinal breastfeeding categories were described: Unexposed (did not breastfeed or breastfed <1 week), limited exclusive breastfeeding (Limited ExBF; women who breastfed exclusively  $\geq 1$  week but <12 weeks), and sustained exclusive breastfeeding (Sustained ExBF; women who breastfed exclusively for  $\geq 12$  weeks) as reported on the study questionnaire.

Women were assigned to breastfeeding categories based on the duration of breastfeeding exclusivity alone; once supplementation was introduced and exclusivity was broken, concomitant breastfeeding did not further affect assignment. The breastfeeding categories were designed considering the available literature reporting a return of menses in nonbreastfeeding women between 8 and 11 weeks postpartum and prolonged postpartum amenorrhea in those individuals who continued to breastfeed exclusively.<sup>4,5</sup>

Obstetric exposures were obtained from review of hospital delivery records and included the following: maternal age at first vaginal delivery, prolonged second stage of labor (>120 minutes), macrosomia (neonatal weight  $\geq 4000$  g), years between delivery and MOAD enrollment, and operative vaginal delivery (forceps or vacuum-assisted vaginal delivery).

OASIS were defined as vaginal delivery associated third- and fourth-degree perineal lacerations. For the small percentage of subsequent births (3.5%) occurring at outside hospitals, maternal recall of delivery events was substituted for a formal review of obstetric records.

Potential demographic confounders were considered including parity (described as  $\geq 3$  vaginal deliveries vs  $< 3$  vaginal deliveries), race (self-reported and classified as black or nonblack), education, body mass index (measured at each study visit and calculated in kilograms per square meter), cigarette smoking (described as never or ever, based on smoking  $\geq 100$  cigarettes in her lifetime), and age at MOAD enrollment.

## Outcomes

The pelvic floor outcomes of interest were stress urinary incontinence (SUI), pelvic organ prolapse (POP), and anal incontinence (AI). SUI and AI were determined using the Epidemiology of Prolapse and Incontinence Questionnaire, a validated self-administered questionnaire.<sup>15</sup> Scores greater than previously validated threshold values have been shown to correspond to clinically significant pelvic floor symptoms (SUI: score  $> 47$  mm, AI: score  $> 23$  mm).

POP was evaluated using the Pelvic Organ Prolapse Quantification examination.<sup>16</sup> The examination was performed by physicians and a research nurse, each of whom demonstrated competency in performing the examination prior to study initiation, with competency periodically reconfirmed throughout the study. While there is no universally accepted definition for pelvic organ prolapse, the consensus recognizes both subjective and objective findings must be considered.<sup>17</sup> For this research, POP was defined as descent or prolapse of the vaginal walls and/or cervix beyond the hymen.

At each study visit, subjects were questioned about PFDs and interventions. Positive responses would lead to a follow-up question regarding specific PFD treatment modalities, including physical therapy, medications, pessary, and surgery. Participants who confirmed treatment for a PFD were considered to have the condition, regardless of current symptoms. If a participant met the previously defined criteria for SUI, POP, or AI at any visit during her longitudinal follow-up, she was categorized as ever having the

disorder. In this way, we were able to assess the proportion of women who had each PFD throughout the entire study.

## Statistical analysis

We described maternal and obstetric characteristics by the 3 exposure categories (Unexposed, Limited ExBF, and Sustained ExBF) and tested associations utilizing Pearson  $\chi^2$  tests for categorical variables and Kruskal-Wallis tests for continuous variables. In these analyses, each of the 3 PFDs of interest (SUI, POP, and AI), were considered separately.

Because of the longitudinal nature of the data, each participant had a variable number of follow-up visits (1–9); therefore, study visits were described in person-years for each exposure group. Our analysis accounted for the possibility that outcomes measured at each follow-up visit may be related; hence, subsequent visits for a single participant could not be viewed as independent measures. The described correlation prevents the use of standard logistic regression while adjusting for potential confounders.

To account for the loss of independence associated with within-woman longitudinal measures and to analyze the longitudinal measures collectively, generalized estimating equations (GEE) were utilized to determine the relationship between breastfeeding and the PFDs of interest. Multivariable models were used to control for potential confounders including race, education, parity, and body mass index and to adjust for baseline imbalances between the previously defined exposure groups. Unadjusted and adjusted ORs are presented as measures of associations between the PFDs of interest and the 3 breastfeeding categories.

We also performed a subanalysis of our study population to examine the association between breastfeeding and AI specific to OASIS. Only women who experienced OASIS during their first vaginal delivery were included in this analysis. GEEs were similarly used to account for longitudinal data collection and to measure the relationship between breastfeeding and AI in the OASIS

population. All statistical analysis was completed using STATA (StataCorp 2015, version 14SE, College Station, TX). Statistical significance was defined at the 5% significance level.

## Results

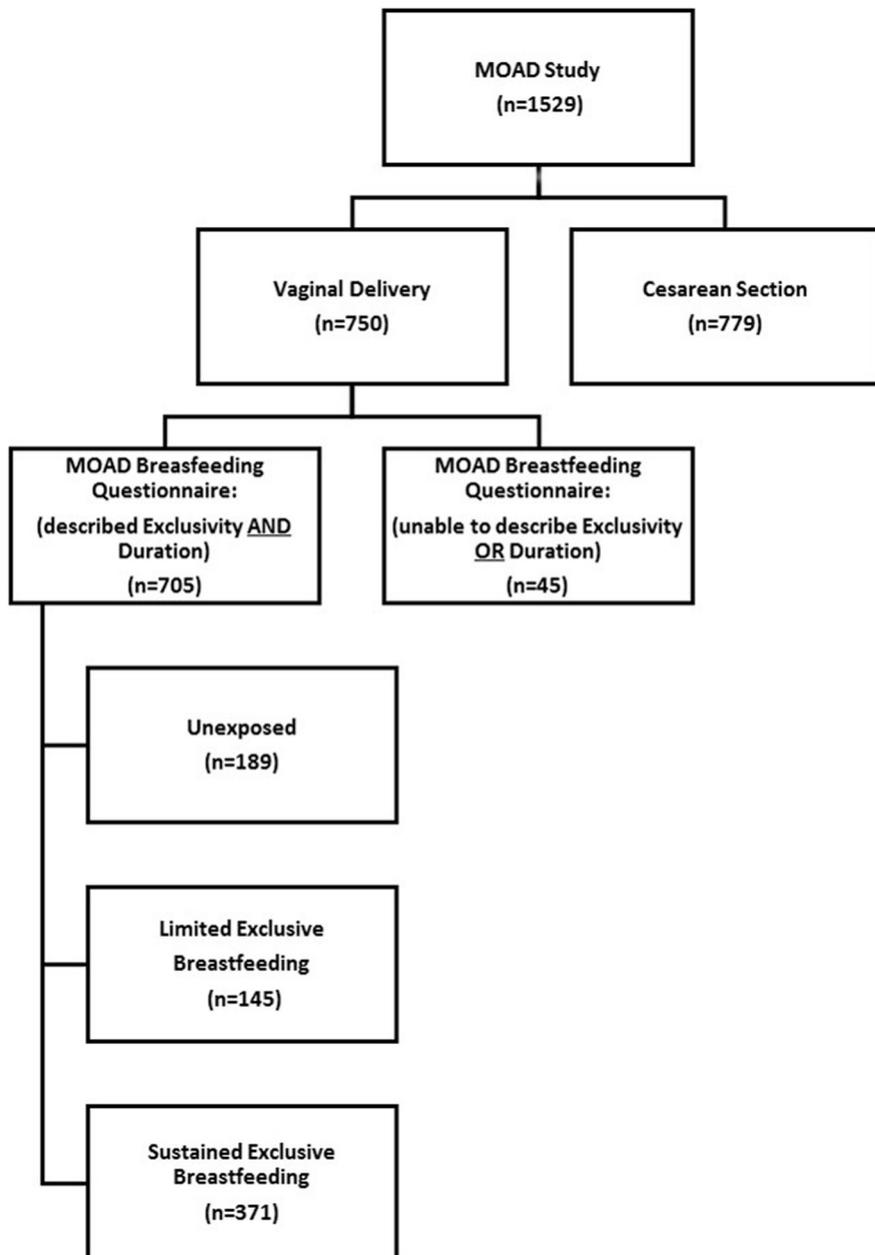
Of the 1529 participants who enrolled in the MOAD study, 750 experienced at least 1 vaginal delivery. MOAD participants who did not enter a self-reported breastfeeding status for the first vaginal delivery ( $n = 1$ ) and those who reported breastfeeding without providing a definitive duration ( $n = 44$ ) were not included in the analysis. Thus, a total of 705 women are included in our longitudinal study (Figure).

Of 705 women, 371 participants (53%) met the definition of Sustained ExBF, while 334 participants (47%) did not. Of those who did not breastfeed exclusively for at least 12 weeks, 189 (27%) were categorized as Unexposed and 145 (20%) were categorized as Limited ExBF. Breastfeeding data were obtained from the self-assessment questionnaire a median of 6.2 years (interquartile range [IQR], 5.5–7.7) after the primary vaginal delivery. Women in the Limited ExBF group, exclusively breastfed for a median of 4 [IQR, 2–8] weeks compared with 20 (IQR, 17–26) weeks among the women in the Sustained ExBF group.

In this study population, the median age of participants at the time of the vaginal delivery was 32 years, and the median age of participants at the time of study enrollment was 38 years. Characteristics of the study population did not differ significantly by breastfeeding category, with the exception of education, body mass index, and parity, as described in Table 1.

Study participants who did not breastfeed were more likely to be obese at enrollment than those who practiced Sustained ExBF (25% compared with 15%;  $P < 0.01$ ). Alternatively, women who breastfed were more likely have a graduate degree (Sustained ExBF, 44%; Limited ExBF, 43%; Unexposed, 31%;  $P = .03$ ) and be multiparous (Sustained ExBF, 24%; Limited ExBF, 16%; Unexposed, 11%;  $P < .01$ ).

**FIGURE**  
Flow diagram of study population



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The longitudinal nature of our cohort captured a variable number of annual follow-up visits (between 1 and 9) for each individual participant. Median follow-up was 5 years, and the 705 study participants contributed to a total of 3079 person-years of follow-up.

The percentage of women who met the criteria of each PFD at any point during follow-up was 188 of 705 SUI

(27%), 143 of 705 POP (20%), and 173 of 705 AI (25%) (Table 1). Within the cohort, 7% (14 of 188) of SUI cases, 6% (9 of 143) of POP cases, and only 2% (3 of 173) of AI cases were diagnosed based on reported prior PFD treatment alone.

Using GEE, unadjusted and adjusted ORs based on breastfeeding exposures were reported in Table 2. There was no

statistically significant relationship between breastfeeding and the development of SUI, POP, and AI in the unadjusted modes. In models adjusting for potential confounders including race, education, body mass index, and parity, the lack of association persisted between breastfeeding and SUI (Limited ExBF adjusted odds ratio [aOR], 1.29, 95% CI, 0.81–2.08, and Sustained ExBF aOR, 0.82, 95% CI, 0.54–1.23), POP (Limited ExBF aOR, 0.91, 95% CI, 0.51–1.61, and Sustained ExBF aOR, 0.77, 95% CI, 0.47–1.23), and AI (Limited BF aOR, 0.78, 95% CI, 0.47–1.30, and Sustained ExBF aOR, 0.66, 95% CI, 0.44–1.01).

Within our cohort, 123 women experienced OASIS during the first delivery; these women contributed 528 person-years of follow-up. The number of these women (32%) had AI during study participation. The median age of this population was 39 years at enrollment. Of these women, 33 (27%) were categorized as Unexposed, 23 (19%) were categorized as Limited ExBF, and the remaining 67 (54%) met the study definition of Sustained ExBF.

Among the women who sustained OASIS, there was no statistically significant relationship between the development of AI and Sustained ExBF (OR, 0.65; 95% CI, 0.29–1.47). However, our results suggest that Limited ExBF (OR, 0.25; 95% CI, 0.06–0.99) may be associated with reduced odds for AI within the OASIS population.

Additionally, there was no statistically significant relationship between breastfeeding and the development of SUI (Limited ExBF: OR, 0.60; 95% CI, 0.15–2.33, and Sustained ExBF: OR, 0.80; 95% CI, 0.31–2.11) or POP (Limited ExBF: OR, 0.31; 95% CI, 0.06–1.53, and Sustained ExBF: OR, 0.39; 95% CI, 0.14–1.10) in the OASIS subanalysis population.

## Comment

### Principal findings

The most important observation in our study was that there was no association between breastfeeding and SUI, POP, and AI 1–2 decades after vaginal delivery.

**TABLE 1**  
**Obstetric and demographic characteristics of 705 vaginally parous women, by breastfeeding category**

Characteristics <sup>a</sup>	Unexposed (n = 189, PY = 769)	Limited exclusive breastfeeding (n = 145, PY = 607)	Sustained exclusive breastfeeding (n = 371, PY = 1703)	Pvalue
Black race	26 (14%)	22 (15%)	37 (10%)	.19
Age at first vaginal delivery, y				.11
<30	57 (30%)	30 (21%)	107 (29%)	
30 to <35	77 (41%)	74 (51%)	178 (48%)	
≥35 years	55 (29%)	41 (28%)	86 (23%)	
Macrosomia (≥4 kg) <sup>b</sup>	10 (5%)	16 (11%)	28 (8%)	.15
Episiotomy <sup>b</sup>	102 (54%)	68 (48%)	204 (55%)	.30
OASIs (third/fourth degree) <sup>b</sup>	33 (18%)	23 (16%)	67 (18%)	.86
Prolonged second stage of labor (>2 h) <sup>b</sup>	52 (28%)	37 (26%)	101 (28%)	.85
Vacuum-assisted vaginal delivery <sup>b</sup>	20 (11%)	17 (12%)	37 (10%)	.83
Forceps-assisted vaginal delivery <sup>b</sup>	28 (15%)	18 (13%)	43 (12%)	.53
Age at study entry, y				.64
<40	112 (59%)	89 (62%)	235 (63%)	
40 to <45	56 (30%)	44 (30%)	109 (29%)	
≥45	21 (11%)	12 (8%)	27 (7%)	
Education level at study entry				.03
High school graduate or less	8 (4%)	3 (2%)	11 (3%)	
College degree	123 (65%)	79 (54%)	197 (53%)	
Graduate degree	58 (31%)	63 (43%)	163 (44%)	
BMI at study entry, kg/m <sup>2</sup>				< .01
Normal (18.5 to <25)	84 (44%)	75 (52%)	211 (57%)	
Overweight (25 to <30)	58 (31%)	51 (35%)	106 (29%)	
Obese (≥30)	47 (25%)	19 (13%)	54 (15%)	
Tobacco use (≥100 cigarettes in lifetime) at study entry	49 (26%)	50 (35%)	107 (29%)	.244
Parity (≥3 vaginal deliveries) at study entry	22 (11%)	23 (16%)	89 (24%)	< .01
Longitudinal follow-up, y	5.0 [1.6, 6.1]	4.4 [2.6, 6.1]	5.1 [3.0, 7.0]	.032
Stress urinary incontinence <sup>c</sup> (n = 188/705 [27%])	53 (28%)	43 (30%)	92 (25%)	.47
Pelvic organ prolapse <sup>c</sup> (n = 143/705 [20%])	36 (19%)	29 (20%)	78 (21%)	.86
Anal incontinence <sup>c</sup> (n = 173/705 [25%])	52 (28%)	34 (23%)	87 (23%)	.54

BMI, body mass index; OASIS, obstetric anal sphincter injuries; PY, person-years.

<sup>a</sup> Variables are reported as n (percentage) for categorical and median [interquartile range] for continuous; missing data include episiotomy: n = 3; OASIS: n = 16; prolonged second stage: n = 20; vacuum-assisted delivery: n = 1; forceps-assisted delivery: n = 1; <sup>b</sup> Characteristics are reported at the first vaginal delivery; <sup>c</sup> Proportion of pelvic floor disorders, criteria for pelvic floor disorder at some point during follow-up.

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**TABLE 2**  
**Associations<sup>a</sup> between breastfeeding categories and pelvic floor disorders**

Pelvic floor disorders		Unexposed	Limited exclusive BF	Prolonged exclusive BF
Stress urinary incontinence	Odds ratio	1	1.10 [0.69–1.77]	0.75 [0.50–1.12]
	aOR	1	1.29 [0.81–2.08]	0.82 [0.54–1.23]
Pelvic organ prolapse	Odds ratio	1	0.84 [0.47–1.50]	0.73 [0.46–1.17]
	aOR	1	0.91 [0.51–1.61]	0.77 [0.47–1.23]
Anal incontinence	Odds Ratio	1	0.75 [0.45–1.25]	0.70 [0.47–1.05]
	aOR	1	0.78 [0.47–1.30]	0.66 [0.44–1.01]

aOR, adjusted odds ratio; CI, confidence interval; OR, odds ratio.

<sup>a</sup> Unadjusted odds ratios (95% CI) are from univariable logistic regression models using generalized estimating equations and adjusted odds ratios (95% CI) from multivariable models adjusting for race, education, body mass index at study entry, and parity ( $\geq 3$ ) at study entry.

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## Results

We are unaware of any previous studies exploring the relationship between breastfeeding and pelvic floor disorders remote from delivery for comparison. However, there are studies that demonstrate an association between persistent postpartum urinary incontinence and prolonged duration of breastfeeding.

Quiboeuf et al<sup>1</sup> demonstrated a statistically significant relationship between mothers who breastfed  $\geq 3$  months and persistent urinary incontinence at 24 months postpartum (OR, 1.54; 95% CI, 1.08–2.19).

Burgio et al<sup>2</sup> also reported a relationship between the length/duration of breastfeeding and urinary incontinence at 12 months postpartum (OR, 1.17,  $P = .023$ ). We believed Sustained ExBF would contribute to the cumulative development of PFDs and potentially account for the described persistence of de novo postpartum PFDs. However these relationships were not observed.

We further found that breastfeeding women who experienced a known pelvic floor trauma in the form of OASIS did not demonstrate an increased proportion of AI when compared with non-breastfeeding women, suggesting breastfeeding does not cause long-term consequences secondary to impaired anal sphincter recovery. Of note, an isolated observation appears to suggest that Limited ExBF (OR, 0.25; 95% CI, 0.06–0.99) may be associated with

reduced odds for AI within the OASIS population. However, we exercise caution in the interpretation of this finding because it remains the lone outlier of significance within our statistical analysis and an appropriate dose response was not observed within the Sustained ExBF group.

## Clinical implications

Despite the growing body of evidence describing estrogen's role in facilitating regeneration and repair of skeletal muscle, one must consider that all musculoskeletal traumas are not created equal. More severe injuries may require months to heal, but some may be so severe that recovery simply is not possible (ie, levator avulsion).

Alternatively, less severe injuries may complete the healing process in days to weeks. Considering that the hormonal differences assumed present between the exposed and the unexposed populations are thought to not be physiologically observed until after 8–11 weeks postpartum,<sup>4,5</sup> any injury that heals prior to that critical juncture would avoid the hormonal influence of our study's intended exposure.

Ripperda et al,<sup>18</sup> using a rodent model, demonstrated that the application of vaginal estrogen after trauma results in divergent effects on the vaginal stromal and epithelial compartments. It was observed that although intravaginal estrogen promotes vaginal epithelial

wound healing, in the stroma (fibromuscular tissue), estrogen resulted in decreased collagen content and decreased the expression of transcripts for matrix components. These results suggest that vaginal estrogen may actually have adverse effects on the early phases of stromal healing.<sup>18</sup>

The surprising findings of Ripperda et al<sup>18</sup> were specific to the epithelial and stromal compartments of the rat vagina and cannot be generalized to the other structures; however, their observations highlight the complex relationship between estrogen and the pelvic floor and provide alternative mechanisms to consider as we evaluate our own results.

It is also worth noting the relatively young age of our study population. Of the 705 women in our analysis, only 49 women (7%) were categorized as postmenopausal prior to the conclusion of the study. Our study hypothesized that sustained breastfeeding was but 1 potential contributing factor, among several, in the cumulative development of PFDs.

There is consensus that PFDs are likely multifactorial rather than the result of a singular catastrophic event and that the prevalence of PFDs significantly increases with age<sup>19</sup>; hence, it is reasonable to consider how our results may change as the cohort ages, and inadequately healed pelvic floor musculature is further burdened by the eventual impact of the menopausal transition.

Lastly, it is possible that breastfeeding behaviors are representative of a woman's health literacy and focus on general wellness. In fact, breastfeeding women in our cohort were less likely to be obese and more likely to have completed a higher level of education. Population-based studies demonstrate an association between education and improved nutrition, greater access to healthcare resources, and a more expansive support network.<sup>20</sup> These factors support consideration that nonbreastfeeding mothers may be exposed to a greater number of potential risk factors for PFDs than their breastfeeding counterparts.

### Research implications

We have a poor understanding of the healing and repair mechanisms of the pelvic floor following obstetrical trauma. Future research evaluating these processes on a cellular level is essential to improve our understanding of PFDs as well as estrogen's role in this complex recovery process. A more robust understanding of pelvic floor regeneration and recovery could direct future prophylactic interventions and assisted recovery strategies.

### Strengths and limitations

The strengths of this study include the large study population, longitudinal study design, and observation 1–2 decades after vaginal delivery. Obstetric exposures of the index delivery were determined by hospital records rather than maternal recall, and SUI, AI, and POP were defined by validated questionnaires or examination.

Despite its strengths, our study was limited by our inability to confirm delivery trauma to the pelvic floor. Additionally, we were unable to measure postpartum estrogen levels. While exclusive breastfeeding acted as a proxy for hypoestrogenism, we are unable to say with certainty that the Sustained ExBF group indeed experienced a hypoestrogenic state or that the hypoestrogenic state resolved promptly in women not breastfeeding  $\geq 12$  weeks. Similarly, no data were collected regarding hormonal contraception use

and its potential influence upon the breastfeeding mother's hormonal milieu.

Seventeen percent of vaginal deliveries in our cohort were diagnosed with OASIS. While our rate is high, it is similar to the 17.7% rate reported by Fenner et al (2003).<sup>21</sup> In 1998, the rate of OASIS in the United States was estimated at 5.7%, but rates vary substantially between hospitals, influenced by patient and hospital characteristics. Since 1998–2008, when this population delivered, OASIS in the United States has declined by almost 50%.<sup>22</sup> The increased OASIS rate in this population provided a relatively large sample to address AI after OASIS at a single institution. However, this also raises the question of whether the findings from this study, particularly regarding anal incontinence (but also SUI and POP), are generalizable to other vaginal delivery populations.

A post hoc power calculation demonstrated our ability to detect clinically meaningful differences in PFDs between exposure groups (OR,  $>1.65$ ). However, statistical power was more limited for the OASIS subanalysis because our sample size limited our detection to only larger differences (OR, at 3.10 at 80% power).

Finally, breastfeeding data obtained from the self-assessment questionnaire were entirely reliant on participant recall 5–10 years after delivery (median, 6.2 years [IQR, 5.5–7.7] years) and is susceptible to response bias, differential misclassification, and sampling bias. Additionally, as with all observational studies, we cannot exclude the possibility that unmeasured characteristics/variables were relevant to our statistical findings and outcomes.

### Conclusion

In conclusion, in both the vaginal delivery and the OASIS-specific populations, there was no observed relationship between breastfeeding and SUI, POP, and AI, regardless of exclusivity or duration of breastfeeding exposure 1–2 decades after the first vaginal delivery.

Despite reports of prolonged postpartum incontinence and dyspareunia associated with lactation, our findings should offer reassurance regarding potential long-term consequences of breastfeeding on the pelvic floor. ■

### Acknowledgment

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