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# Breaking barriers in women's pelvic health: claims-based economic analysis and healthcare utilization of an AI care program compared to usual care

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**ABSTRACT**

**Aim:** To compare healthcare utilization and spending among women enrolled in an employer-sponsored, artificial intelligence (AI) structured pelvic care program with those receiving usual in-person care for pelvic floor dysfunction (PFD) in routine clinical settings.

**Methods:** This retrospective payor-perspective economic evaluation used exact and propensity score-matched cohorts derived from a third-party U.S. nationwide claims database from July 2022 to May 2025. Eligible participants were adult females with a pelvic-related condition, at least 24 months of continuous health-insurance coverage, and a minimum of one pelvic claim in the prior year. Intervention group (IG) comprised women who participated in the AI pelvic care program (consisting of biofeedback-mediated pelvic floor muscle training asynchronously monitored by a physical therapist specialized in pelvic health). Comparator group (CG) included women who sought a medical or physical therapy evaluation visit for PFD. Self-reported clinical outcomes available for the IG were assessed using latent-basis growth analysis.

**Results:** The matched cohort included 602 women (301 per group). Relative to CG, IG patients had substantially lower healthcare spending over 12 months, with mean gross per-person pelvic-related savings of \$3,082.4 (95% CI \$1,270.2 to \$4,894.7, $p<.001$). Savings were primarily associated with fewer surgical procedures (per-person difference of \$2,534.2; 95% CI \$831.2 to \$4,237.2, $p=.004$), with differences also noted in medical office visits and imaging utilization. IG participants demonstrated significant improvements in pelvic floor symptom burden, work productivity, and mental health.

**Limitations:** Claims-based analyses cannot exclude unmeasured confounding, misclassification, or selection bias. The one-year follow-up limits assessment of long-term economic impact.

**Conclusions:** Participation in this AI pelvic care program was associated with markedly lower healthcare utilization and spending compared with usual care, largely linked to fewer surgical interventions. These findings highlight the potential of accessible, guideline-concordant AI pelvic care to lessen healthcare spending associated with PFD and inform payor-oriented care delivery models.

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## Introduction

Women's health is an underserved dimension of public health [1–3], resulting in women spending ~25% more of their lives in poor health compared to men [1]. Pelvic floor dysfunction (PFD), such as urinary incontinence, pelvic organ prolapse, and chronic pelvic pain, affects approximately 1 in 3 women in the United States (U.S.) [4]. PFD is a major cause of disability [5–9], yet its financial burden remains poorly characterized, with most estimates outdated. Data from 2012 estimated $49.1 billion in direct U.S. healthcare costs attributable to urgency urinary incontinence alone [10]. Further compounding the economic burden, PFD significantly impacts productivity and can lead to early retirement [7,10–14].

Clinical guidelines recommend pelvic floor muscle training (PFMT), education, and behavioral change strategies as first-line approaches [15–18], given their proven effectiveness across diverse PFDs [19–22]. However, access to these evidence-based interventions remains limited. In many regions, there is a shortage of pelvic health physical therapists (PTs) [23–25]. Even when available, conventional in-person therapy often requires repeated visits typically over extended periods, creating barriers related to geography, cost, and time [23,26–30]. Low awareness of treatment options, combined with stigma and misconceptions that PFD symptoms are a normal part of life, further discourage women from seeking care [28,30–32]. These barriers contribute to delayed care and symptom progression, increasing the likelihood of costly or invasive interventions [33].

Digital pelvic programs offer patient-centered, scalable solutions that can increase access and adherence to pelvic care. Despite well-documented effectiveness [34–36], the economic impact of such programs remains unclear, a crucial step for informing clinical decision-making, resource allocation, and ultimately support a widespread implementation.

Herein, we evaluate the impact of an artificial intelligence (AI) pelvic care program on pelvic-related healthcare spending and utilization compared to usual care as observed in real-world claims data. In this context, usual care included medical office or physical therapy visits, reflecting variability in referral patterns, access to pelvic physical therapy, and patient adherence as it occurs in routine clinical practice. The study captures downstream healthcare resource use among an eligible population given the opportunity to choose between structured, remote, AI-supported, clinician-managed care and in-person care pathways. Rather than assessing clinical effectiveness of specific interventions, this analysis focuses on observed differences in subsequent healthcare utilization and spending. This distinction is particularly relevant given known barriers to access and adherence in pelvic care, which may limit receipt or completion of guideline-recommended first-line physical therapy for reasons unrelated to clinical appropriateness. We hypothesized that undergoing the AI pelvic care program, owing to its greater accessibility and flexibility, would be associated with lower pelvic-related healthcare spending and utilization.

## Methods

### *Study design*

This is a retrospective, claims-based economic analysis of matched cohorts from a payor perspective. This study compares pelvic-related and total healthcare utilization and spending over 12 months among patients with PFD who initiated the AI pelvic care program (intervention group – IG) to a non-participant cohort that opted for in-person usual care (comparator group – CG), covering the period from July 2022 to May 2025. Usual care included medical office or physical therapy visits, reflecting standard in-person pelvic health management. Claims data was obtained for both groups through a large third-party platform (PurpleLab) [37].

The study was conducted in accordance with the Declaration of Helsinki and all applicable guidelines, including Consolidated Health Economic Evaluation Reporting Standards (CHEERS) guidelines [38] (Supplementary Table S1). Since no identifiable private information was accessed by the researchers, the regulatory definition of human subjects research [39–41] was not met and therefore, IRB review or additional informed consent was not required. Participants were not offered any form of compensation. For participants in the AI pelvic care program, clinical and engagement data was also collected, as part of a prospective, U.S. nationwide observational clinical trial of the AI pelvic care program (ClinicalTrials.gov: NCT05513417) submitted on August 24th 2022, and approved by the Advarra IRB (Pro00064510).

## Study population

Female adults (≥18 years) located in the U.S. with employer-sponsored commercial insurance offering the AI pelvic program, and who had a pelvic-related index event from July 2023 to May 2024, were included. Eligibility required ≥12 months of continuous coverage before and after the index event (≥24 months total). The pelvic index event date corresponded either to the date of enrollment in the AI pelvic care program for the IG, or to the date of the in-person pelvic care evaluation visit in the CG (see 'Comparator group'). Targeted pelvic conditions were identified through claims with relevant International Classification of Diseases 10th Revision (ICD-10) diagnostic codes indicating bladder or bowel conditions, pelvic organ prolapse, pelvic pain, and sexual dysfunction (available in Supplementary Table S2), reflecting conditions addressable by the remote program. To ensure comparability and interpretability of outcomes, patients were required to have at least one pelvic-related medical claim in the 12 months preceding their index date. This requirement established a clear pre-index baseline for matching, improved comparability across groups, and reduced misclassification of incidental pelvic-related encounters as index events.

Exclusion criteria were: ongoing cancer treatment; pelvic infection or inflammatory bowel disease; and dementia or conditions impairing one's ability to follow program directions (identified through ICD-10 codes - Supplementary Table S3), as well as outlier total annual medical expenses detected through claims data (>$500,000) during the full study period. These criteria were applied consistently to both the IG and CG.

### Intervention group

The AI pelvic care program was offered at no cost to patients, through 53 employers as a health benefit for employees and dependents. This program consisted of PFMT, functional exercises, and education (Figure 1, Supplementary Table S4) [42]. Patients self-enrolled through a secure website, where a structured onboarding form was completed including demographics, clinical information, and red flags screening. Upon onboarding, each patient was assigned a doctor of physical therapy specialized in pelvic health who conducted a videocall assessment to confirm eligibility and prescribe an individualized, guideline-based care plan [15–18] PFMT was performed using an Food and Drug Administration (FDA)-listed Class II device consisting of an intravaginal sensor, a mobile app, and a cloud platform (data storage). Gamified exercises were displayed with real-time biofeedback from the sensor on the prescribed contraction and relaxation targets (Figure 1). At the end of each session, AI was applied to collect and relay structured information to the PT, assisting them in the management of program monitoring and intervention adjustments.

Educational videos or articles on pelvic health were made available throughout the program *via* the app, covering topics tailored to each specific PFD (e.g. bladder retraining, toilet habits) and mental health (Supplementary Table S4). This content was based on clinical guidelines [15–18] and curated by the PT.

### Comparator group

The CG consisted of individuals drawn from the claims dataset who never enrolled in the AI pelvic care program but had an in-person physical therapy evaluation or medical office visit, according to the Restructured BETOS Classification System [43] (Current Procedural Terminology (CPT) and Healthcare Common Procedure Coding System (HCPCS) codes listed in Supplementary Table S5), with a pelvic-related ICD-10 code (Supplementary Table S2) as the primary diagnosis. An in-person physical therapy or medical evaluation is a recognized entry point into conventional pelvic floor care pathways and represents the standard first step for patients seeking treatment for PFD [4,33].

## Data sources and privacy

De-identified, Health Insurance Portability and Accountability Act of 1996 (HIPAA)-compliant medical claims were sourced from a large third-party platform (PurpleLab; Supplementary Material S1) for both groups (schematic flow depicted in Supplementary Figure S1), ensuring comparable data completeness,

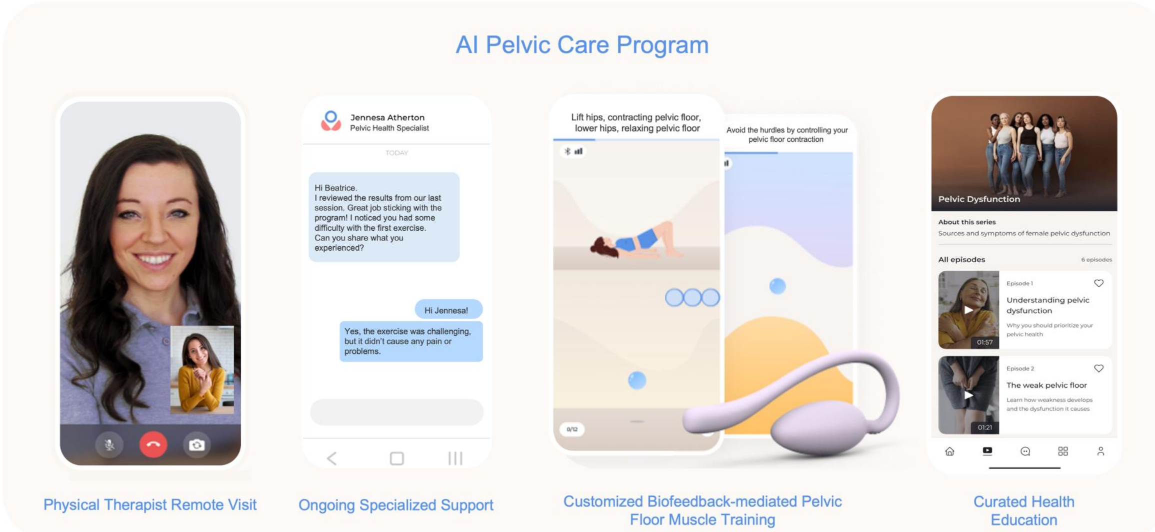


**Figure 1.** AI pelvic care program. Screenshots of the patient app showcasing the content offered upon onboarding physical therapist selection, during video calls, and during text messaging along the AI care pelvic program (no real patients are portrayed in this figure).

processing timelines, and availability windows across groups. All claims data were tokenized by PurpleLab using Datavant Tokens prior to transfer to the study team. Sword Health applied the same Datavant tokenization process to its member eligibility and enrollment data, enabling secure linkage between datasets while maintaining full de-identification. Both data streams remained anonymous throughout analysis, and the study team had no access to any identifiable information. Promeed Inc [44] was the software provider used to ensure privacy compliance certification, including expert review to assess and mitigate re-identification risks.

Before analysis, claims data were prepared to ensure accurate and consistent code classifications and service groupings, following recommendations [45–47] (Supplementary Material S2).

Claims data encompassed: a) de-identified patient demographics (e.g. age, gender, and geographic region); and b) administrative medical claims data, which are generated in the U.S. when healthcare providers submit standardized billing information to payors. These claims include fields such as diagnosis (ICD-10 codes), healthcare procedure codes (CPT/HCPCS), service dates, and place-of-service.

Data obtained from Sword Health included longitudinal clinical data and engagement metrics of patients in the IG. This data was collected under a prospective observational clinical trial (see 'Study Design'). Clinical data was not available for individuals in the CG, as they did not enroll in the AI pelvic care program.

## *Matching procedures*

Patients in the IG and CG were matched using a combination of exact matching and propensity score matching (Table 1) (Matchit package in R (version 4.2.2, R Foundation for Statistical Computing)), aligned with best practices [48]. Exact matching was first applied on pelvic floor dysfunction (Table 1), while the other variables followed propensity scores estimation (e.g. geographic region, acuity, pre-index costs of care) using a generalized linear model. Matching was performed using 1:1 nearest neighbor matching without replacement and a caliper width of 0.1. To ensure robustness, we conducted a sensitivity analysis running the algorithm using five different random seeds, which consistently produced identical matched pairs; a fixed seed was then applied for final analysis. Variable-specific calipers were used to limit maximum distance between matched pairs on the selected continuous variables (Supplementary Figure S2 and Table S6). Balance between matched groups was assessed using standardized mean differences, with values $<0.15$ considered indicative of acceptable balance (Supplementary Figure S2).

**Table 1.** Variables used to match patients across groups.

| Matching | Variables | Type | Description | Rationale for inclusion |
|---|---|---|---|---|
| *Exact* | Pelvic floor dysfunction | Categorical | Primary pelvic floor dysfunction grouped by ICD-10 codes for pelvic pain, bladder or bowel conditions, pelvic organ prolapse, and sexual dysfunction | To reflect condition type, influencing care needs. |
| *Propensity* | Age | Categorical | 18–40; 41–59; 60+ | To account for differences in care access, cost structures, and treatment patterns. |
| | Geographic region | Categorical | Midwest; Northeast; South; West | |
| | Acuity | Categorical | Short-term condition; Chronic; Recurrent Short-term condition: episode spanning less than 12 weeks; Chronic: episode lasting more than 12 weeks; Recurrent: episode reappearing after a resolved period, with prior claims occurring more than 4–7 months before the index event [49] | To reflect condition severity and prognosis, influencing care needs. |
| | Weighted Elixhauser Comorbidity Index [50,51] | Categorical | Weighted score calculated based on ICD-10 codes [50,51] $<0$; 0; 1–4; $\geq 5$ | To account for overall health status and chronic disease complexity. |
| | Social Deprivation Index (SDI) [52–54] | Categorical | 0-20; 21–40; 41–60; 61–80; 81–100 | To reflect the impact of social determinants of health. |
| | Pre-index pelvic-related healthcare spending | Continuous | Healthcare costs related to pelvic conditions | To reflect care intensity and condition burden, which are predictive of future healthcare utilization. |
| | Pre-index pelvic-related service type stratification spending and visits | Continuous | Healthcare costs and visits stratified by surgery, medical office visits, rehabilitation visits, and imaging | |
| | Pre-index total all-cause costs of care (TCOC) | Continuous | Total healthcare costs | |

Abbreviations. ICD, International Classification of Diseases; SDI, Social Deprivation Index; TCOC, total all-cause costs of care.
*Note*. All costs were standardized using the Centers for Medicare & Medicaid Services (CMS) Fee Schedules and expressed in 2025 U.S. dollars.

## Outcomes

### Comparing AI care to In-person pelvic care

Cost outcomes consisted of mean per-person-per-year (PPPY) direct medical spending, including pelvic-related and total all-cause costs of care (TCOC), calculated first at the individual level for the 12 months preceding and following the pelvic index event (pre- and post-index, respectively), using PurpleLab's provided adjusted allowed amounts—payor-approved reimbursements—to reflect actual healthcare expenditures. PurpleLab adjusted costs for geography, line of business, and inflation applying the Centers for Medicare & Medicaid Services (CMS) Fee Schedules, which are expressed in 2025 U.S. dollars. A discount rate was not applied given the 12-month time horizon. All individuals were required to have continuous claims availability during these periods; therefore, PPPY measures were not prorated by member-months, and observation windows were identical across study groups. Pelvic-related healthcare spending and utilization (counts) PPPY (associated with PFD diagnoses described in Supplementary Table S2) were stratified into: surgery, imaging, medical office visits, rehabilitation, and others (e.g. laboratory testing, medical supplies, and procedure-related materials).

As the AI pelvic care program fee was not captured in claims, differences in claims-based spending values across groups reflect gross savings (excluding program delivery costs). Net pelvic-related healthcare savings were calculated by accounting for the AI pelvic care program's standard per-patient market price ($850.0).

### AI care intervention clinical outcomes

Patients in the IG completed clinical assessment surveys at baseline, and at the 9th, 19th, and 24th sessions, including:

1. Pelvic Floor Impact Questionnaire—short form 7 (PFIQ-7; range 0–300) to assess impact on quality of life and daily activities [55];
2. Work Productivity and Activity Impairment questionnaire - General Health v2.0 (WPAI-Overall; range: 0–100%); and daily activities impairment (WPAI-activities; range 0–100) [56]
3. Generalized Anxiety Disorder 7-item scale (GAD-7; range: 0–21) [57];
4. Patient Health 9-item Questionnaire to assess depression (PHQ-9; range: 0–27) [58];

In all the above higher scores denote worse symptoms.
The AI pelvic care program's engagement was measured through the intervention duration and number of biofeedback-mediated PFMT sessions.

## Statistical analysis

Baseline characteristics of the matched cohorts were descriptively reported through means, median with interquartile ranges (IQR), and proportions, and compared through independent t-test, Mann–Whitney U tests, and chi-square tests, as appropriate.

Mean TCOC and pelvic-related healthcare spending and visits (total and by service type) were calculated pre- and post-index for both groups. Pre-post changes were compared between groups using two-tailed independent t-tests and generalized difference-in-differences (DID). The difference-in-differences methodology, as well as the matching process, had previously been reviewed and validated by Risk Strategies Consulting [59], an independent U.S. consulting and actuarial services business (Supplementary Material S3). Catastrophic claims (top 1% outliers) were truncated in a separate analysis (detailed in Supplementary Table S7).

Odds ratio (OR) for surgery was calculated from post-index incidence proportions, with 95% confidence intervals estimated using the Wald method. E-values were then computed to evaluate the robustness of the observed associations to potential unmeasured confounding, following the approach described by VanderWeele and Ding [60,61]. For protective associations (OR $< 1$), E-values were calculated using the inverse odds ratio. E-values were reported for both the point estimate and the confidence interval limit closest to the null.

Mean changes in IG clinical outcomes were analyzed using latent-basis growth analysis (LBGA) within an intention-to-treat approach [62]. LBGA offers model fit measures and handles missing data using full information maximum likelihood [63]. The analysis was also performed for patients with baseline clinically-relevant scores (i.e. WPAI-Overall $> 0$, WPAI-Activities $> 0$). A robust sandwich estimator was used for standard errors.

Response rates were calculated for PFIQ-7, GAD-7 $\geq 5$, and PHQ-9 $\geq 5$, using the following minimal clinically important change (MCIC) thresholds: 12% [55], 3.8 points [64], and 5 points [65], respectively.

## Sensitivity analysis

A negative control analysis comparing respiratory conditions (identified through the CCSR groups RSP008-9) related healthcare spending and utilization between groups was conducted to detect residual confounding or systematic error, as this outcome should not plausibly be influenced by pelvic care.

As an additional sensitivity analysis, two-part models were used to account for the skewed and zero-inflated distribution of cost data. The models separately estimated the probability of any spending and the level of spending among individuals with positive costs, with additive DID estimates derived from predicted mean costs. Uncertainty was assessed using member-level cluster bootstrap procedures that preserved within-person correlation across pre- and post-index periods.

A quantitative sensitivity analysis was used to evaluate how large a deviation from the parallel-trends assumption would need to be to overturn the observed DID estimate [66,67]. Differential counterfactual trends were parameterized as 20–100% of the CG's observed pre-to-post change in pelvic-related spending, with bias-adjusted DID estimates recalculated under each scenario.

All analyses were conducted using R (version 4.2.2, R Foundation for Statistical Computing) and SPSS software (v22, IBM, Armonk, NY). The level of significance was set at $p < .05$ for all 2-sided hypothesis tests.

## Results

### Baseline characteristics

Eligible population included 336 individuals in the IG and 6,290 in the CG (study cohort flowchart in Figure 2). The matched cohort yielded a final analytical sample of 602 participants ($N = 301$ each group; Figure 2).

Both the IG and CG primarily consisted of middle-aged patients (mean: IG: 47.0 years, SD 11.3; CG: 48.4 years, SD 13.1, SMD 0.1 (95% CI −0.0;0.3)), residing predominantly in the Midwest region of the U.S. (IG: 83.7%, n/N = 252/301; CG: 80.7%, n/N = 243/301) (Table 2). Bladder conditions were the most common PFD in both cohorts (56.1%, n/N = 169/301).

### Costs analysis

The IG achieved mean annual cost savings per person of $3,082.4 (95%CI $1,270.2; $4,894.7, $P = <.001$) in pelvic-related healthcare spending and of $7,688.1 (95%CI $2,785.1; $12,591.0, $P = <.001$) in TCOC, compared to the CG (Table 2). Truncated results showed cost savings in a comparable trend (Supplementary Table S8).

Pelvic-related savings were associated with lower surgery rate in the IG, with mean annual savings of $2,534.2 (95% CI $831.2; $4,237.2, $p = .004$) per person (Table 4). Considering the pre-post increase of 35 surgeries in the CG and of 4 surgeries in the IG, the DID corresponded to 31 fewer surgeries in the IG (88.6% [31/(41-6)] fewer procedures) (post-index surgical procedure codes available in Supplementary Table S9). The AI pelvic care program was associated with lower odds of undergoing surgery during follow-up compared with the CG (OR = 0.20; 95% CI: 0.09;0.44, E-value = 9.42 (lower CI 3.97)).

Significant savings were also derived from fewer pelvic-related medical office visits in the IG alongside an increase in the CG, yielding average $406.4 (95% CI $99.5; $713.4, $p = .007$; Table 4) PPPY savings.

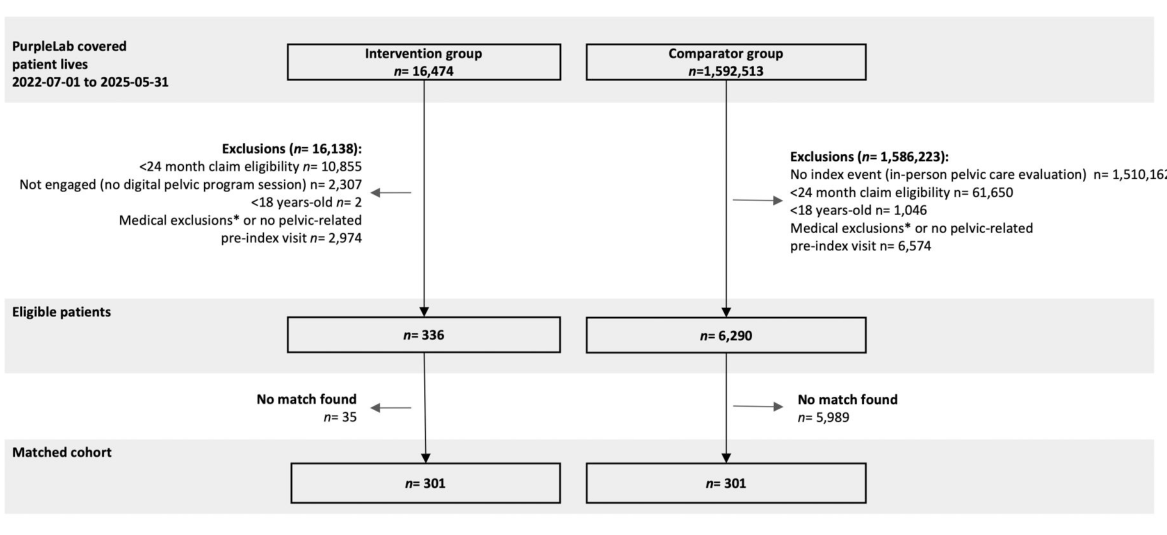


Figure 2. Study cohort flowchart.

**Table 2.** Baseline characteristics of matched cohorts.

| | Intervention group (*N* = 301) | Comparator group (*N* = 301) | *P* |
|---|---|---|---|
| *Demographic characteristics* | | | |
| *Age (years), mean (SD)* | 47.0 (11.3) | 48.4 (13.1) | .167 |
| *Age categories (years),* N *(%):* | | | .148 |
| 18–39 | 81 (26.9) | 66 (21.9) | |
| 40–59 | 172 (57.1) | 171 (56.8) | |
| 60+ | 48 (15.9) | 64 (21.3) | |
| *Geographic U.S. Region,* N *(%):* | | | .815 |
| Midwest | 252 (83.7) | 243 (80.7) | |
| Northeast | 7 (2.3) | 8 (2.7) | |
| South | 34 (11.3) | 41 (13.6) | |
| West | 8 (2.7) | 9 (3.0) | |
| *Social Deprivation Indexa,* N *(%):* | | | .622 |
| 0–20 | 108 (35.9) | 108 (35.9) | |
| 21–40 | 69 (22.9) | 68 (22.6) | |
| 41–60 | 64 (21.3) | 77 (25.6) | |
| 61–80 | 33 (11.0) | 25 (8.3) | |
| 81–100 | 27 (9.0) | 23 (7.6) | |
| *Clinical data* | | | |
| *Pelvic Floor Dysfunction,* N *(%):* | | | 1.000 |
| Bladder conditions | 169 (56.1) | 169 (56.1) | |
| Bowel conditions | 30 (10.0) | 30 (10.0) | |
| Pelvic organ prolapse | 29 (9.6) | 29 (9.6) | |
| Pelvic pain | 31 (10.3) | 31 (10.3) | |
| Sexual dysfunction | 42 (14.0) | 42 (14.0) | |
| *Acuityb,* N *(%):* | | | .312 |
| Short-term condition | 208 (69.1) | 222 (73.8) | |
| Chronic | 69 (22.9) | 63 (20.9) | |
| Recurrent | 24 (8.0) | 16 (5.3) | |
| *Weighted Elixhauser Comorbidity Index, mean (SD):* | −1.1 (4.4) | −1.4 (4.3) | .396 |
| *Weighted Elixhauser Comorbidity Index,* N *(%):* | | | .594 |
| <0 | 118 (39.2) | 126 (41.9) | |
| 0 | 150 (49.8) | 136 (45.2) | |
| 1–4 | 17 (5.6) | 17 (5.6) | |
| ≥ 5 | 16 (5.3) | 22 (7.3) | |
| *Pre-index utilization and spending* | | | |
| *Pelvic-related spending* | | | |
| mean (*SD*) ($) | 1,173.3 (2,988.0) | 1,163.4 (3,009.4) | .968 |
| median (IQR) ($) | 460.4 (565.6) | 436.3 (677.7) | .612 |
| *Pelvic-related visits by service type, mean (SD):* | | | |
| Surgery | 0.0 (0.1) | 0.0 (0.2) | .780 |
| Imaging | 0.4 (0.6) | 0.4 (0.6) | .732 |
| Medical office visits | 1.3 (1.2) | 1.4 (1.3) | .698 |
| Rehabilitation | 0.3 (1.3) | 0.3 (1.2) | .768 |
| *Pelvic-related visits by service type, median (IQR):* | | | |
| Surgery | 0.0 (0.0) | 0.0 (0.0) | .996 |
| Imaging | 0.0 (1.0) | 0.0 (1.0) | .962 |
| Medical office visits | 1.0 (1.0) | 1.0 (1.0) | .466 |
| Rehabilitation | 0.0 (0.0) | 0.0 (0.0) | .482 |
| **TCOC** | | | |
| mean (*SD*) ($) | 15,623.4 (18,178.8) | 15,611.0 (18,024.1) | .993 |
| median (IQR) ($) | 9,785.9 (15,898.1) | 9,185.9 (15,948.6) | .983 |
| *Comorbidities-related spending[c], mean (SD) ($)* | 2,558.9 (5,649.6) | 2,500.6 (6,868.5) | .909 |
| *Mental health[d] spending, mean (SD) ($)* | 1229.4 (3081.6) | 1367.9 (3831.9) | .625 |
| *Mental health[d] visits, mean (SD)* | 3.00 (7.3) | 3.2 (8.0) | .766 |

Abbreviations. IQR, interquartile range; SD, standard deviation; TCOC, total all-cause costs of care.
*Notes.* [a]Higher Social deprivation index values correspond to higher level of social deprivation [52–54]; [b]Short-term condition: episode spanning less than 12 weeks; Chronic: episode lasting more than 12 weeks; Recurrent: episode reappearing after a resolved period, with prior claims occurring more than 4–7 months before the index event [49]. [c]Comorbidity-related costs were estimated using the CCSR (Clinical Classifications Software Refined) groupings for ICD-10-CM codes [68]. [d]CCSR groups FAC007 and MBD001-MBD013.

While pre-post differences in imaging spending between groups were not significant, the IG had fewer imaging procedures (mean PPPY DID of 0.2 95%CI 0.1; 0.3, $p<.001$; Table 4). No differences were observed regarding in-person rehabilitation visits.

Although not captured by claims, the IG had access to remote physical therapy sessions (see 'Outcomes of the AI Care Intervention'). Accordingly, the estimates associated with rehabilitation (Table 4) as well as pelvic-related or TCOC spending (Table 3) reflect gross savings rather than net savings. Considering the AI care pelvic program fee, the estimated annual net pelvic-related savings for the IG were $2,232.4 (95% CI 420.2; 4,044.7) per person compared to the CG.

**Table 3.** Medical expenditures (stratified by pelvic-related spending and TCOC) for both intervention and comparator groups (spending expressed as PPPY).

| Type of spending ($) | Intervention group | | | Comparator group | | | Difference in differences | P |
|---|---|---|---|---|---|---|---|---|
| | Pre | Post | P | Pre | Post | P | | |
| | Mean (SD) | Mean (SD) | | Mean (SD) | Mean (SD) | | Mean (95%CI) | |
| *Pelvic-related spending PPPY* | 1,173.3 (2,988.0) | 1,164.4 (6,062.4) | .981 | 1,163.4 (3,009.4) | 4,236.9 (14,233.5) | <.001 | 3,082.4 (1,270.2; 4,894.7) | <.001 |
| **TCOC PPPY** | 15,611.0 (18,024.1) | 9,365.0 (14,780.3) | <.001 | 15,623.4(18,178.8) | 17,065.5 (31,775.9) | .420 | 7,688.1 (2,785.1; 12,591.0) | <.001 |

Abbreviations. PPPY, per person per year; TCOC, Total all-cause costs of care.

**Table 4.** Pelvic-related spending and counts stratified by service type (with spending reported PPPY and service counts reported PPPY and as total counts).

| Type of service | | Intervention group | | | Comparison group | | | Difference in differences | P |
|---|---|---|---|---|---|---|---|---|---|
| | | Pre | Post | P | Pre | Post | P | | |
| | | Mean (SD) | Mean (SD) | | Mean (SD) | Mean (SD) | | Mean (95%CI) | |
| *Surgery* | Spending PPPY ($) | 246.1 (2,412.2) | 860.9 (5,922.4) | .098 | 224.8 (2,307.1) | 3,395.1 (13,862.3) | <.001 | 2,534.2 (831.2; 4,237.2) | .004 |
| | Counts PPPY | 0.0 (0.1) | 0.0 (0.2) | .318 | 0.0 (0.2) | 0.1 (0.4) | <.001 | 0.1 (0.1; 0.2) | <.001 |
| | Total Counts | 5 | 9 | – | 6 | 41 | – | 31 | – |
| *Imaging* | Spending PPPY ($) | 157.7 (359.0) | 42.4 (184.8) | <.001 | 122.9 (300.8) | 66.3 (301.6) | .019 | 58.7 (−7.6; 125.0) | .242 |
| | Counts PPPY | 0.4 (0.6) | 0.1 (0.3) | <.001 | 0.4 (0.6) | 0.3 (0.7) | .229 | 0.2 (0.1; 0.3) | <.001 |
| | Total Counts | 112 | 35 | – | 117 | 100 | – | 60 | – |
| *Medical office* | Spending PPPY ($) | 587.0 (1,452.2) | 161.7 (605.8) | <.001 | 619.2 (1,470.8) | 600.4 (1,656.7) | .882 | 406.4 (99.5; 713.4) | .007 |
| | Counts PPPY | 1.3 (1.2) | 0.5 (1.1) | <.001 | 1.4 (1.3) | 1.7 (1.4) | <.001 | 1.2 (0.9; 1.5) | <.001 |
| | Total Counts | 405 | 146 | – | 417 | 525 | – | 367 | – |
| *Rehabilitation** | Spending PPPY ($) | 82.1 (420.8) | 32.6 (157.3) | .053 | 68.3 (353.4) | 78.7 (517.8) | .776 | 59.8 (−27.3; 146.9) | .178 |
| | Counts PPPY | 0.3 (1.3) | 0.2 (1.1) | .424 | 0.3 (1.2) | 0.4 (2.6) | .303 | 0.2 (−0.1; 0.6) | .197 |
| | Total Counts | 92 | 69 | – | 83 | 135 | – | 75 | – |
| *Other* | Spending PPPY ($) | 100.4 (478.9) | 66.7 (409.7) | .298 | 128.1 (599.7) | 96.4 (481.4) | .478 | 2.0 (−110.4; 114.3) | .971 |

Abbreviation. PPPY, per person per year.
*Note.* *As this is a claims-based analysis, the AI care pelvic program fee ($850.0 per participant) is not captured in post-index rehabilitation claims. Accordingly, the rehabilitation spending shown reflects gross (claims-based) savings rather than net savings after program costs.

## *Sensitivity analysis*

Respiratory-related visits and spending were examined as a negative control outcome not plausibly influenced by pelvic care. No statistically significant differences were observed between the intervention and comparator groups in either the pre or post-index periods (all $p>.05$), suggesting the absence of residual systematic bias (Supplementary Table S10).

In sensitivity analyses using two-part models, findings were consistent with the primary DID results, with confidence intervals excluding the null for surgery and office visit spending (Supplementary Table S11).

The DID estimate remained substantial under moderate deviations from parallel trends and was attenuated only under large, assumed violations (of 100%), indicating robustness to plausible departures from the parallel-trends assumption (Supplementary Table S12).

## *Outcomes of the AI care intervention*

The intervention had a mean duration of 10.4 weeks (SD 10.4), with patients completing on average 17.6 biofeedback-assisted PFMT sessions (SD 27.8). Patients demonstrated significant improvements in the impact of pelvic floor symptoms on daily activities (response rate: 66.7%, $N = 110/165$), work productivity, and mental health. Further information is available in Supplementary Figure S3 and Table S13.

## Discussion

This claims-based study showed that a fully remote AI pelvic care program was associated with substantial annual savings compared with usual care, including gross per-individual savings of $3,082.4 in pelvic-related spending (net savings of $2,232.4) and $7,688.1 in TCOC. These were observed alongside lower healthcare utilization including pelvic-related surgeries. The observed associations were further examined through multiple sensitivity analyses, including negative control outcomes, E-value estimation, and alternative cost-modeling approaches, which provided additional context regarding the robustness of these findings. To our knowledge, this is the first real-world, claims-based economic evaluation of a pelvic AI intervention for a broader female population with PFDs.

The persistent challenges in women's health—including access disparities, stigma, and misinformation [23,26–30]—highlight the current insufficiency of usual care, and the need for clinically- and economically-valid alternatives for PFD management. There is a significant gap in the literature regarding the economic burden of pelvic floor disorders and the cost-effectiveness of interventions, with most available studies being outdated [69,70] or conducted outside the U.S. healthcare system [71–73]. Notably, a recent U.S.-based budget impact model analysis of a remote digital PFMT intervention versus usual care for female urinary incontinence found a substantial reduction in two-year treatment costs (estimated total health plan 24-month savings was $25,782,112) [74]. This study expands the literature by offering a current perspective on pelvic-related healthcare spending while also demonstrating the cost-offsets associated with remote solutions for pelvic care. The matching process ensured balanced characteristics across groups including demographics, but also clinical and baseline healthcare expenditure characteristics. The latter were applied as a proxy of condition severity to promote comparable evaluation among different prognosis and comorbidities [75,76]. The matched cohort characteristics were aligned with those expected for a female population with PFDs, with bladder conditions being the most prevalent [6,77].

In line with studies exploring the potential of digital solutions to reduce avoidable healthcare utilization among other medical conditions [78–80], this study showcases that for pelvic-related care, savings were primarily linked to lower surgery rates. While the association between early physical therapy and surgery avoidance is well established for musculoskeletal conditions [81–85], further research is needed to support this finding across pelvic disorders. Nevertheless, research shows that women traveling longer for in-person pelvic care are more likely to have surgery over non-invasive care (such as physical therapy) [26,27], which may be magnified in regions with a lack of physical therapists specialized in pelvic care [23–25,86]. Alongside fewer surgeries, utilization of other healthcare resources was also lower among patients who underwent the AI pelvic care program compared to usual care, namely imaging procedures and medical office visits. While rates of in-person rehabilitation visits were comparable across groups, the IG engaged in remote physical therapy sessions, supporting a higher overall rehabilitation utilization.

The study's observational and retrospective nature precludes causality inference. Mindful of this limitation, the lower healthcare utilization and savings with the AI pelvic program were obtained in the context of high engagement and reported significant clinical outcomes improvement, within the range of prior studies assessing in-person [87–90] and digital interventions [91–94]. This convergence supports the clinical plausibility of cost avoidance, where the facilitated access to guideline-concordant care promoted by the AI pelvic intervention could curb the pathway to care escalation.

While AI pelvic care interventions are not an all-encompassing solution for PFD management, this study suggests that there is a large subset of conditions for which its application should be considered as an alternative in women's healthcare decision-making. This is particularly true for those facing structural barriers to care access or challenges to treatment adherence, where the remote approach may help mitigate these discontinuities, alongside substantial cost savings and clinical benefits.

These findings are insightful across the healthcare ecosystem. For payors and self-insured employers, remote AI pelvic care programs that avert additional care procedures may represent a pragmatic lever for the escalating healthcare spend. For policy-makers concerned with equity, the ability to deliver guideline-concordant care in patients' homes offers a scalable strategy to reach rural and resource-limited communities. Finally, for researchers, the study sets the stage for future cost-benefit and comparative-effectiveness analyses that incorporate control-group clinical outcomes.

### *Strengths and limitations*

This investigation provides the first claims-based economic evaluation of a fully-remote pelvic program, drawing on a U.S. national, multi-payor cohort and employing comprehensive and rigorous propensity-score matching to mitigate confounding. Moreover, by using a claims-based methodology, we reduce recall bias and overcome the limited level of detail present in patient diaries and single-system billing data. Detailed reporting of data provenance, matching procedures, and analyses, renders the results highly relevant to payors, employers and policy-makers evaluating large-scale deployment of digital pelvic interventions.

This study has inherent limitations. As a consequence of the de-identification process, information granularity was removed, precluding further matching on employment, geographic information other than U.S. region, and other geography-related factors (e.g. education, income). Unmeasured variables and residual confounding may have influenced the results, as individuals who opted into the AI pelvic care program may differ from the CG in ways not captured by the data, such as higher motivation, health literacy, or technology readiness, and preferences for surgical care, meaning that self-selection bias can not be fully eliminated. In claims-based studies (as herein) confounding may be mitigated by comprehensive matching procedures as the one applied, including pre-index demographics, clinical characteristics, healthcare spending, and care-seeking patterns. As all individuals included in both cohorts were commercially insured, the findings may not be generalizable to other populations including the uninsured. Propensity score matching was used to improve comparability by restricting analyses to the region of common support. As such, findings are most relevant among commercially insured individuals in usual care with observed characteristics comparable to program participants, and generalizability to broader usual care populations outside this overlap may be limited. Analgesic consumption and costs were not assessed, as it is extremely difficult to attribute a specific medication to PFD in pharmacy claims given that most of these patients have concomitant pain and psychiatric conditions that would warrant similar treatments (e.g. antidepressants for anxiety, depression, spinal pain, headaches) [95–97]. Administrative claims are generated for billing rather than research purposes; miscoding, omissions and censoring of services paid entirely out of pocket may have introduced misclassification and measurement error in both utilization and cost variables [45,47]. Clinical outcome data were not available for the comparator cohort, precluding direct cost-effectiveness or cost-utility estimation. Patient-reported outcomes measures were presented as within-group descriptive changes and do not support causal inference. Finally, cost savings were assessed for one year, limiting insights into the potential long-term economic impact of the AI pelvic care program, including whether surgical interventions were avoided or postponed beyond 12 months. Future work should evaluate longer follow-up periods, incorporate comparator-group clinical outcomes, and examine cost-effectiveness in diverse insurance populations including Medicare and Medicaid to further understand scalability and generalizability.

## Conclusions

This cost-offset analysis shows the potential of this AI pelvic care program to bridge critical gaps in care by being associated with significant cost savings ($3,082.4 in pelvic-related savings per person annually), alongside positive clinical outcomes. By circumventing the long-standing barriers in conventional interventions, these findings highlight the potential of accessible, guideline-concordant AI pelvic care to lessen healthcare spending associated with PFD and inform payor-oriented care delivery models.

## Transparency

### Declaration of funding

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### Declaration of financial/other relationships

The authors declare the following competing interests: A.P.P., A.M.S., B.D., D.J., A.P., A.C.A., V.Y., F.D.C., J.A., L.B. and F. Costa are employees of Sword Health, the sponsor of this study. V.B., V.Y., and F.D.C. also holds equity in Sword Health, and V.B. is the CEO of the same company. S.P.C. is an independent scientific and clinical consultant who received an adviser honorarium from Sword Health. XT received a scientific advisor honorarium from Sword Health.

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### Author contributions

All authors made a significant contribution to the work reported as follows:

F.D.C., L.B. and F. Costa conceptualized the study. A.C.A., A.P.P., D.J., A.M.S., and A.P. curated the data, while A.P., A.M.S., and A.P.P. conducted the formal analysis. A.P.P., B.D., D.J., A.C.A., J.A., and F. Costa contributed to the interpretation of the data. V.B. provided the necessary resources for the research. A.P.P, B.D., D.J., A.C.A. and F. Costa drafted the original manuscript, and all authors participated in reviewing and editing the final version. All authors have read and approved the published version of the manuscript.

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### Data availability statement

The data that support the findings of this study are available on request from the corresponding author, [FC]. The data are not publicly available due to commercial restrictions.

### Declaration of generative AI

During the preparation of this work the author(s) used ChatGPT-4.0 in order to support copyediting and grammar checking. After using this tool/service, the authors reviewed and edited the content as needed and takes full responsibility for the content of the publication.

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