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Association Between Patient Characteristics and Treatment Procedure Among Patients With Uterine Leiomyomas

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Abstract

Objective—To analyze the association between patient characteristics and the probability of undergoing any uterine-sparing procedure (endometrial ablation, myomectomy, and uterine artery embolization) compared with hysterectomy as the first uterine leiomyoma (index) procedure, and the probability of undergoing a specific uterine-sparing procedure.

Methods—We conducted a retrospective analysis using a commercial insurance claims database containing over 13 million enrollees annually. Based on the index procedure performed 2004–2009, women were classified into one of the four procedure cohorts. Eligible women were aged 25–54 years on the index date, continuously insured through 1-year baseline and 1-year follow-up, and had a baseline uterine leiomyoma diagnosis. Logistic regression was used to assess the association between patient characteristics and leiomyoma procedure.

Results—The study sample comprised 96,852 patients (endometrial ablation=12,169; myomectomy=7,039; uterine artery embolization=3,835 and hysterectomy=73,809). Patient characteristics associated with undergoing any uterine-sparing procedure compared with hysterectomy included health maintenance organization health plan enrollment, Northeast region residence, the highest income and education quintiles based on ZIP-code, an age-race interaction, and baseline diagnoses including menstrual disorders, pelvic pain, anemia, endometriosis, genital

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prolapse, and infertility. Among those that had a uterine-sparing procedure, characteristics associated with undergoing uterine artery embolization or endometrial ablation compared to myomectomy included increasing age, being from Midwest relative to Northeast, and certain baseline conditions including menstrual disorder, pelvic pain, endometriosis, and infertility.

Conclusion—Both clinical and nonclinical factors were associated with the receipt of alternatives to hysterectomy for uterine leiomyomas in commercially insured women.

Introduction

Uterine leiomyomas are a benign and very common gynecologic condition in reproductive age women, and are associated with significant morbidity including menstrual disorders, anemia, and adverse reproductive outcomes.(1) Evidence is limited regarding comparative effectiveness between existing uterine leiomyoma treatment procedures, and uncertainty remains regarding how different patient characteristics are associated with different procedures.(2) Although hysterectomy is the most commonly performed procedure for uterine leiomyoma treatment, a recent national survey of women found that hysterectomy is the least preferred procedure irrespective of whether they desire future pregnancies.(3)

Better understanding of the factors that influence the probability of undergoing a specific uterine leiomyoma treatment procedure would help deliver patient-centric uterine leiomyoma care. Based on limited data, the authors of the Agency for Healthcare Research and Quality (AHRQ) systematic review identified the evidence gap that exists with regard to how the uterine leiomyoma features and patient risk factors likely influence the operative procedures that patients undergo for uterine leiomyoma treatment.(2, 4) Therefore, the primary aims of this study are twofold: (i) to analyze the association between patient characteristics and the probability of undergoing any uterine-sparing procedures (USPs) [myomectomy, endometrial ablation, and uterine artery embolization] versus hysterectomy as the first uterine leiomyoma treatment procedure; and (ii) among those who underwent a USP, to quantify the patient characteristics that are associated with the specific USP that they choose.

Materials and Methods

This retrospective analysis drew data from Truven's *MarketScan*® *Commercial Claims and Encounters* (CCAE) database. Details of this database have been published (5, 6). Briefly, the CCAE database compiles data from U.S. employer-sponsored private health plans containing medical and drug claims of over 13 million employees and their dependents annually covered under a variety of fee-for-service and capitated health plans. This study includes patients enrolled under comprehensive fee-for-service indemnity plans, exclusive provider organizations (EPOs), health maintenance organizations (HMOs), point-of-service (POS) plans, preferred provider organizations (PPOs) and consumer directed health plan or high deductible health (CDHP or HDHP) plan. Medical claims are linked to deidentified individual enrollment information. Inclusion in the database is contingent on whether or not Truven provided technical infrastructure for administering a particular claim. In that sense, the Truven database is a large convenience sample. Moreover, CCAE database blinds provider identifiers to protect business-sensitive information; as such, the provider type for

each patient cannot be assessed. The CCAE database has data from all 50 U.S. states. Geographic regions were defined by census data. Approximately 47% of the patients are from the South, 21% from the Midwest, 19% from the West and 13% from the Northeast. Since the CCAE database primarily collects data from large self-insured employers, the study sample used in the present study may be considered representative of commercially insured patients from large employers in the U.S.. (5, 6) CCAE captures adjudicated health care claims through automated electronic data capture. Within one year of service, the database has a complete record of claims for nearly 99% of cases, with a low risk of error since the claims are closed. (6)

We used 2003–2010 CCAE data for women aged 25–54 with uterine leiomyoma diagnosis (defined as one inpatient claim, or two outpatient claims at least 30 days apart) who had myomectomy, endometrial ablation, uterine artery embolization or hysterectomy between 2004 and 2009. The date of the first procedure during the study period (2004–2009) was defined as the *index date*, and the procedure on the index date defined the corresponding study cohort. *Baseline* for each patient was defined as the 366-day period ending two weeks prior to the index date. A 2-week period prior to the index date was allowed for pre-operative diagnostic assessments (*pre-operative period*). All patients were required to have a uterine leiomyoma diagnosis during the baseline, and to be continuously insured during the baseline through the 1-year follow-up including the pre-operative period. The organization of the timeline for the study ensured capture of at least one year of baseline and follow-up data for each patient.

Patients were excluded if they had any uterine leiomyoma-related procedure other than those analyzed in our study between 2003 and the index date, if they had any malignancy diagnosis, or if they became pregnant during the study period.

The first outcome measure was represented by a dichotomous variable indicating whether the patient had a USP or hysterectomy. The second outcome measure was the specific USP that the patient underwent on the index date. (See Appendix 1, available online at <http://links.lww.com/xxx>, for the corresponding Current Procedural Terminology or CPT codes.)

Multiple independent variables were captured in the CCAE database. Prior to the analysis, we decided to categorize age on the index date into the following three age categories: 25–34 years, 35–44 years and 45–54 years. The rationale for assessing age effects in these categories was due to the fact that both the likelihood of pregnancy and the likely outcomes of pregnancy are different for the 3 groups: women aged 25–34 years have high fecundity, low risk of adverse pregnancy outcomes and those aged 35–44 years have low fecundity, higher risk of adverse pregnancy outcomes. Finally, the age group 45–54 years is generally perimenopausal, so reproductive concerns are generally minimal; in addition, since the average menopausal age in the U.S. is 51, therefore we restricted our sample to women of age 54 or below. Baseline comorbidity profile for each patient was captured through the Charlson Comorbidity Index (CCI), which was categorized into three categories : CCI =0, CCI=1 and CCI>1, with CCI=0 representing the healthiest patients.(7) Presence of comorbid conditions during the baseline period was captured through dichotomous variables and broadly categorized into three categories: uterine leiomyoma-related conditions, other

gynecologic conditions and non-gynecologic conditions. (See Appendix 2, available online at <http://links.lww.com/xxx>, for relevant codes) Since baseline inpatient (IP) admission or emergency room (ER) visit may indicate additional patient severity, presence of an all-cause baseline IP and ER admission was reported and adjusted in the multivariate models. Baseline use of prescription-strength non-steroidal anti-inflammatory drug (NSAID) and hormone therapy as captured in the claims database were also used, which might be used to mitigate uterine leiomyoma symptoms. (See Appendix 3, available online at <http://links.lww.com/xxx>, for the detailed list.)

We obtained the socioeconomic characteristics associated with each of the 5-digit ZIP-code residence from the 2000 U.S. Census data, including the percent of black residents, median household income, and percent of residents with a college degree. Quintiles of the distribution of these variables were reported and adjusted in the multivariate models.

Patient characteristics were described by their frequencies and corresponding percentages for the individual study cohorts. Differences in patient characteristics between the study cohorts were assessed by Chi-square test. A logistic regression was used to assess the association between patient characteristics and the probability of a USP versus hysterectomy. The association between patient characteristics and the probability of undergoing a specific USP (uterine artery embolization, endometrial ablation or myomectomy) was modeled using a multinomial logistic (MNL) regression model.⁽⁸⁾ The MNL framework models log odds of a procedure relative to a reference procedure as a linear function of the independent variables, which can then be used to estimate the relative risk ratio (RRR) of a procedure compared to the reference procedure. The assumption of independence of irrelevant alternatives underlying the MNL model was tested through Hausman test.⁽⁹⁾ We also tested for potential interactions of race with age, income and education in both the logit and the MNL models. For the interacting covariates, marginal effects (effects on the predicted probability of undergoing a specific procedure) were estimated.⁽¹⁰⁾ In order to correct for multiple tests, the p-values and the 95% confidence intervals in the logit and multinomial logit models were corrected using Bonferroni correction ⁽¹¹⁾. Stata SE 11.2 (StataCorp LP, College Station, TX) was used for all analyses.

Since the study used deidentified data, it was deemed exempt by the Institutional Review Board of Mayo Clinic Rochester, Minnesota.

Results

The final analytic sample had 96,852 patients (myomectomy=7,039 or 7.27%; endometrial ablation=12,169 or 12.56%; uterine artery embolization=3,835 or 3.96%; and hysterectomy=73,809 or 76.21%). (See Appendix 4, available online at <http://links.lww.com/xxx>, for details on how the sample size was obtained from the database). The dominant route for myomectomy was abdominal (73.95%), followed by laparoscopic (17.76%), vaginal (6.34%) and others (1.96%). The dominant route for hysterectomy was also abdominal (55.69%) followed by laparoscopic or robotic (23.76%), and vaginal (12.64%); the rest of the hysterectomies did not have information on the routes of hysterectomy (7.91%).

Patient characteristics are provided in Table 1 by uterine-sparing procedure versus hysterectomy as well as by specific uterine-sparing procedures (UAE, EA, and myomectomy). Myomectomy was more common among younger women with 27% and 57% of the women undergoing myomectomy aged 25–34 years and 35–44 years compared to 16% women aged 45–54 years having myomectomy. In contrast, endometrial ablation and hysterectomy were more frequently used by older women, with 53% of women in each cohort aged 45–54 years compared to 43% and 4% of women aged 35–44 years and 25–34 years in the endometrial ablation cohort, and 42% and 5% of women aged 35–44 years and 25–34 years in the hysterectomy cohort ($p<0.001$). The South had disproportionately more of all of the procedures (between 46% and 56%) than other regions ($p<0.001$). The percent of patients with baseline CCI=0 ranged from 81% for the hysterectomy cohort to 86% for the myomectomy cohort, indicating an overall healthy cohort. Over 90% of the patients in each cohort were enrolled in PPO, HMO or POS health plans. The thresholds for the quintiles of the ZIP code level variables are provided in Table 1. In general, higher quintiles of the ZIP-code level variables – percent of black residents, median household income, and percent of college graduates – were more likely to undergo a uterine-sparing procedure.

Women in each of the procedure groups significantly differed for all uterine leiomyoma-related symptoms, except for constipation or gas (Table 1). Prevalence of menstrual disorders ranged from 45% for myomectomy patients to 80% for endometrial ablation patients. Among the treatment groups, the prevalence of pelvic pain ranged between 23–32% and anemia ranged from 18% to 29%. Baseline infertility was highest for the myomectomy cohort at 9%, and less than 1% for the other cohorts ($p<0.001$).

Table 2 presents odds ratios associated with each patient characteristic included in the logistic regression that modeled the probability of uterine-sparing uterine leiomyoma procedure versus hysterectomy. Although the odds ratios associated with the interaction of race and age were not significant, it was the marginal effects of the interaction terms that provided the relevant information on the effects of interactions on the probability of undergoing USP versus hysterectomy. (10) As seen from Figure 1 and Appendix 5 (Appendix 5 is available online at <http://links.lww.com/xxx>), the marginal effects for race-age interaction indicate that women from the two younger age groups (25–34 years and 35–44 years) were more likely to undergo a USP than older women (45–54 years), and this likelihood increases as the proportion of black residents in the patient's ZIP-code area increases. For example, the probability of undergoing a USP for a woman from the youngest age group (25–34 years) was as high as 50% if she lived in the ZIP code area with the highest concentration of black residents (top quintile), and this probability slides down to 43%, 35%, 22% and 20% if she was from areas with proportion of black residents in the fourth, third, second and first quintile, respectively. Similar patterns are observed for the two older age groups.

Table 2 shows that, compared to the Northeast, patients from the South, West and Midwest were 44% (OR=0.56, 95% CI: 0.51–0.61), 40% (OR=0.60, 95% CI: 0.54–0.67) and 36% (OR=0.64, 95% CI: 0.58–0.71) less likely to undergo a USP. Patients from areas with higher median household income were more likely to undergo a USP, with 14% (OR=1.14, 95% CI: 1.01–1.28) and 44% (OR=1.44, 95% CI: 1.27–1.63) higher likelihoods of undergoing a

USP for patients in the 4th and 5th income quintiles, respectively compared to patients in the 1st income quintile.

Menstrual disorders (OR=1.51, 95% CI: 1.43–1.59) and infertility (OR=5.66, 95% CI: 4.52–7.09) were key baseline comorbid conditions that were associated with increased likelihood of receiving a USP than hysterectomy. On the other hand, women with baseline endometriosis (OR=0.56, 95% CI: 0.48–0.65) and genital prolapse (OR=0.24, 95% CI: 0.18–0.31) were less likely to have a uterine-sparing uterine leiomyoma procedure compared to hysterectomy, respectively.

Table 3 presents the results of the multinomial logistic regression that models the probability of undergoing either uterine artery embolization or endometrial ablation, compared with myomectomy as the reference procedure. The relative risk of undergoing uterine artery embolization was about 7 and 26 times higher for women in the age groups 35–44 (Relative risk ratio or RRR=6.66, 95% CI: 4.72–9.40) and 45–54 (RRR=25.82, 95% CI: 18.07–36.89) relative to the age group 25–34 years.

Patients with baseline uterine conditions including menstrual disorder, anemia and disorders of uterus were 1.5, 1.4 and 1.5 times more likely to receive uterine artery embolization than a myomectomy. Patients with endometriosis and infertility at the baseline were 0.60 and 0.12 times less likely to undergo uterine artery embolization.

Compared to the youngest patient group (25–34 years), those in the older age groups, 35–44 years (RRR=5.19, 95% CI: 4.20–6.41) and 45–54 years (RRR=21.22, 95% CI: 16.81–26.79) had higher relative risk of undergoing endometrial ablation than myomectomy. Having endometriosis (RRR=0.60, 95% CI: 0.42–0.86) or infertility (RRR=0.05, 95% CI: 0.03–0.09) at the baseline was associated with significantly less likelihood of undergoing endometrial ablation compared to myomectomy. Patients' geographic location was also associated with the receipt of endometrial ablation, with patients from the Midwest (RRR=2.08, 95% CI: 1.65–2.61) and South (RRR=1.76, 95% CI: 1.44–2.15) regions were 2.1 and 1.8 times more likely to receive endometrial ablation than myomectomy. Patients from ZIP-code areas with the highest proportion of black residents were less likely to receive endometrial ablation compared to myomectomy (RRR=0.27, 95% CI: 0.10–0.69 for patients from the top quintile of the percent of black residents). Patients from the highest income quintile were more likely to undergo endometrial ablation over myomectomy (RRR=1.38, 95% CI: 1.02–1.88); in contrast, patients from areas with highest proportion of college graduates (top quintile) were less likely to have endometrial ablation over myomectomy (RRR=0.55, 95% CI: 0.37–0.82).

Baseline menstrual disorders were significantly associated with the receipt of endometrial ablation compared to myomectomy (RRR=4.99, 95% CI: 4.36–5.71).

Discussion

Using a large commercial claims database, our study quantified the association between numerous patient characteristics and alternatives to hysterectomy for uterine leiomyomas. Strengths of this study include the large number of procedures performed in a

geographically and racially diverse population-based cohort with substantial information on comorbidities and patient characteristics.

While the association of age and race independently with uterine leiomyoma has been well-documented (12–16), our study highlights this age-race interaction in a more nuanced manner. We found that, within each age category, the odds of undergoing any USP over hysterectomy increase monotonically with higher proportion of black residents by the patient's geographic location. This age-race interaction was highest among the youngest women (25–34 years), where the odds of having a USP ranged from 20% to 50%. This is consistent with a synergy among younger women's desire to maintain fertility, the onset of symptomatic disease at an earlier age in black women who are also more likely to desire USPs over hysterectomy.(4, 14)

The majority of the remaining findings regarding the association between patient characteristics and the odds of a USP use over hysterectomy are consistent with prior studies: decreasing age, increasing income and education are all associated with decreased hysterectomy use. Similarly, our findings are consistent with clinical impressions; infertility is strongly associated with alternatives to hysterectomy, especially myomectomy, and concomitant endometriosis or genital prolapse are associated with increasing use of hysterectomy. (20, 21, 22) The fact that menstrual disorders were associated with higher odds of having USPs compared with hysterectomy is in line with the current understanding of the effectiveness of USPs for leiomyoma symptoms.(17–19)

The findings on the association between patient characteristics and the probability of undergoing a specific USP were more complex and nuanced. While increasing age was strongly associated with both embolization and ablation, for education and race, only the highest quintile was associated with decreased use of endometrial ablation compared to myomectomy. Endometriosis at baseline was an independent risk factor for undergoing myomectomy compared to both endometrial ablation and uterine artery embolization, while the opposite was true of menstrual disorders. Collectively, these findings appear to suggest that younger women (25–34 years) were more likely to optimize fertility.(24) There were also significant regional differences with increased use of embolization in the Midwest and endometrial ablation in the Midwest and South as compared to the Northeast. Patients from areas with highest proportion of black residents tend to undergo myomectomy more than endometrial ablation potentially because black women are more likely to develop leiomyoma-induced bulk symptoms and leiomyomas occur earlier in black women, perhaps before completing childbearing.(14, 25)

The modest association between HMO type health plans and the likelihood of undergoing a USP found in our study needs to be interpreted with caution as coverage restrictions for specific procedures might have been in place. However, it likely merits further study since this was the only insurance type significantly associated with increased utilization of USPs and understanding the facets of these plans or the people who elect these plans may give insight regarding how to decrease the hysterectomy rate for leiomyomas.

Potential limitations to generalizability of these findings include the possibility that patients could have a procedure prior to the start of the study, the requirement for continuous insurance coverage which excluded a large number of women who might be potentially different, and neither Medicaid nor uninsured women were included. Another potential limitation is the fact that ZIP-code level rather than individual-level socioeconomic characteristics were assessed. However, the use of ZIP-code level socioeconomic characteristics is widely prevalent health outcomes research and is known to detect differences in health outcomes as well (26). Finally, it is possible that some of observed differences were related to the availability of treatment options and practice pattern in different areas, rather than the socioeconomic characteristics alone. Further research is necessary to determine whether and to what extent the detected difference was from patients' preference or treatment availability reflecting health disparities in leiomyoma care.

While clinical factors including leiomyoma symptoms, size, number and location influence the selection of a treatment procedure, this study demonstrates that many additional factors can also play an influential role including income, education, insurance type and the presence of baseline comorbid conditions. The delineation of age-race interaction on the probability of undergoing a USP versus hysterectomy is a novel contribution of this study. Our study's methodologically rigorous quantification of the risk factors associated with the probability of undergoing different leiomyoma procedures may inform the delivery patient-centered care, thereby satisfying a key gap identified in the AHRQ report (4).

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Abbreviations

AHRQ	Agency for Healthcare Research and Quality
CCAE	Commercial Claims and Encounters
CCI	Charlson Comorbidity Index
CDHP	Consumer Directed Health Plan

CPT	Current Procedural Terminology
EPO	Exclusive Provider Organization
ER	Emergency Room
HDHP	High Deductible Health Plan
HMO	Health Maintenance Organization
IP	Inpatient
MNL	Multinomial Logistic
POS	Point of Service
PPO	Preferred Provider Organization
RRR	Relative Risk Ratio
USP	Uterine-Sparing Procedure

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Précis

In commercially insured women, besides clinical factors, nonclinical attributes including age, socioeconomic factors, geographic region, and health plan type are associated with uterine leiomyoma treatment.

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Figure 1. Marginal effects of age–race interactions (interactions between age groups and race quintiles). Q1 refers to quintile 1 of the distribution of proportion of blacks; similar interpretation for Q2–Q5. The covariates used as adjustors are shown in Table 2.

Table 1

Baseline Patient Characteristics by Study Cohorts

Patient Characteristics	UAE N=3,835 (1)	EA N=12,169 (2)	Myomectomy 7,039 (3)	Uterine-Sparing Procedure N=23,043 (4)=(1)+(2)+(3)	Hysterectomy N=73,809 (5)	P-value ^a
Age Group						
25–34	122 (3.18%)	457 (3.76%)	1916 (27.22%)	2495 (10.83%)	3378 (4.58%)	<0.001
35–44	1755 (45.76%)	5246 (43.11%)	4034 (57.31%)	11035 (47.89%)	31047 (42.06%)	
45–54	1958 (51.06%)	6466 (53.14%)	1089 (15.47%)	9513 (41.28%)	39384 (53.36%)	
Geographic Regions						
Northeast	543 (14.16%)	1464 (12.03%)	996 (14.15%)	3003 (13.03%)	6303 (8.54%)	<0.001
Midwest	709 (18.49%)	3143 (25.83%)	998 (14.18%)	4850 (21.05%)	17026(23.07%)	
South	2037 (53.12%)	5573 (45.8%)	3924 (55.75%)	11534 (50.05%)	37851 (51.28%)	
West	546 (14.24%)	1989 (16.34%)	1121 (15.93%)	3656 (15.87%)	12629 (17.11%)	
Comorbidity Status						
CCI=0	3221 (83.99%)	10020 (82.34%)	6080 (86.38%)	19321 (83.85%)	59778 (80.99%)	<0.001
CCI=1	457 (11.92%)	1568 (12.89%)	703 (9.99%)	2728 (11.84%)	9140 (12.38%)	
CCI>1	157 (4.09%)	581 (4.77%)	256 (3.64%)	994 (4.31%)	4891 (6.63%)	
Health Plan Type ^b						
Comprehensive	146 (3.81%)	553 (4.54%)	208 (2.95%)	907 (3.94%)	3411 (4.62%)	<0.001
EPO	30 (0.78%)	92 (0.76%)	72 (1.02%)	194 (0.84%)	507 (0.69%)	
HMO	1132 (29.52%)	2876 (23.63%)	1775 (25.22%)	5783 (25.10%)	15518 (21.02%)	
POS	572 (14.92%)	1605 (13.19%)	1097 (15.58%)	3274 (14.21%)	10079 (13.66%)	
PPO	1823 (47.54%)	6588 (54.14%)	3616 (51.37%)	12027 (52.19%)	41227 (55.86%)	
CDHP/HDHP	83 (2.16%)	314 (2.58%)	172 (2.44%)	569 (2.47%)	2037 (2.76%)	
Race Quintile ^c						
1	10 (0.26%)	113 (0.93%)	21 (0.3%)	144 (0.62%)	1001 (1.36%)	<0.001
2	89 (2.32%)	941 (7.73%)	180 (2.56%)	1210 (5.25%)	5737 (7.77%)	
3	492 (12.83%)	2435 (20.01%)	841 (11.95%)	3768 (16.35%)	13870 (18.79%)	
4	1149 (29.96%)	4378 (35.98%)	2105 (29.9%)	7632 (33.12%)	24238 (32.84%)	
5	2095 (54.63%)	4302 (35.35%)	3892 (55.29%)	10289 (44.65%)	28963 (39.24%)	

Income Quintile^d

Patient Characteristics	UAE N=3,835 (1)	EA N=12,169 (2)	Myomectomy 7,039 (3)	Uterine-Sparing Procedure N=23,043 (4)=(1)+(2)+(3)	Hysterectomy N=73,809 (5)	P-value ^d
1	317 (8.27%)	804 (6.61%)	679 (9.65%)	1800 (7.81%)	7017 (9.51%)	<0.001
2	323 (8.42%)	1272 (10.45%)	688 (9.77%)	2283 (9.91%)	9964 (13.5%)	
3	606 (15.8%)	1961 (16.11%)	1157 (16.44%)	3724 (16.16%)	13908 (18.84%)	
4	748 (19.5%)	2641 (21.7%)	1542 (21.91%)	4931 (21.4%)	16678 (22.6%)	
5	1841 (48.01%)	5491 (45.12%)	2973 (42.24%)	10305 (44.72%)	26242 (35.55%)	
Education Quintile ^e						
1	139 (3.62%)	453 (3.72%)	260 (3.69%)	852 (3.7%)	3439 (4.66%)	<0.001
2	285 (7.43%)	1243 (10.21%)	558 (7.93%)	2086 (9.05%)	9520 (12.9%)	
3	572 (14.92%)	2106 (17.31%)	1099 (15.61%)	3777 (16.39%)	14882 (20.16%)	
4	862 (22.48%)	3085 (25.35%)	1703 (24.19%)	5650 (24.52%)	18853 (25.54%)	
5	1977 (51.55%)	5282 (43.41%)	3419 (48.57%)	10678 (46.34%)	27115 (36.74%)	
Baseline uterine Leiomyoma-related Conditions						
Menstrual Disorders	2164 (56.43%)	9744 (80.07%)	3140 (44.61%)	15048 (65.3%)	40134 (54.38%)	<0.001
Pelvic Pain	910 (23.73%)	2768 (22.75%)	2281 (32.41%)	5959 (25.86%)	23062 (31.25%)	<0.001
Anemia	1093 (28.5%)	2801 (23.02%)	1395 (19.82%)	5289 (22.95%)	13188 (17.87%)	<0.001
Urinary Problems	128 (3.34%)	303 (2.49%)	281 (3.99%)	712 (3.09%)	2585 (3.5%)	<0.001
Constipation or Gas	106 (2.76%)	309 (2.54%)	224 (3.18%)	639 (2.77%)	2126 (2.88%)	0.061
Baseline Other Gynecologic Conditions						
Endometriosis	83 (2.16%)	264 (2.17%)	344 (4.89%)	691 (3%)	3367 (4.56%)	<0.001
Disorders of Uterus (unclassified)	753 (19.63%)	1860 (15.28%)	975 (13.85%)	3588 (15.57%)	11266 (15.26%)	<0.001
Genital Prolapse	19 (0.5%)	101 (0.83%)	49 (0.7%)	169 (0.73%)	2872 (3.89%)	<0.001
Benign Neoplasm of the Uterus or Ovary	3 (0.08%)	28 (0.23%)	38 (0.54%)	69 (0.3%)	354 (0.48%)	<0.001
Infertility	36 (0.94%)	54 (0.44%)	644 (9.15%)	734 (3.19%)	354 (0.48%)	<0.001
Baseline Non-gynecologic Conditions						
Inflammatory Disease	530 (13.82%)	1464 (12.03%)	1306 (18.55%)	3300(14.32%)	8552 (11.59%)	<0.001
Non-inflammatory Disease	533 (13.9%)	2139 (17.58%)	1238 (17.59%)	3910 (16.97%)	13916 (18.85%)	<0.001
Any Inpatient Admission	190 (4.95%)	555 (4.56%)	291 (4.13%)	1036 (4.5%)	4151 (5.62%)	<0.001
Any Emergency Room Admission	789 (20.57%)	2581 (21.21%)	1618 (22.99%)	4988 (21.65%)	16290 (22.07%)	0.004
Any NSAID Use	1056 (27.54%)	3336 (27.41%)	1757 (24.96%)	6149 (26.68%)	19889 (26.95%)	0.001
Any Hormone Use	1199 (31.26%)	4522 (37.16%)	2782 (39.52%)	8503 (36.9%)	23552 (31.91%)	<0.001

Note: UAE=Uterine Artery Embolization; EA=Endometrial Ablation.

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^dBased on Chi-squared tests comparing UAE, EA, myomectomy and hysterectomy.

^bPercentages do not add up to 100 because there are approximately 1% missing observations for this variable.

^cQuintile of % black in ZIP code, 2000 Census: 1=0% black; 2=0.1%–0.3%; 3=0.4%–1.3%; 4=1.4%–8.5% black, 5= 8.6%

^dQuintile of median income in ZIP code, 2000 Census: 1=\$0–\$28,280; 2 = 28,281–\$33,680, 3=\$33,681–\$39,204; 4=\$39,205–\$48,749 ; 5= \$48,750

^eQuintile of % with college degree in ZIP code, 2000 Census, Quintiles assigned so equal number of ZIP Codes in each quintile: 1=lowest values, 5=highest values: 1 = 0%–7% with college degree, 2 = 8%–11%, 3=12%–15%, 4=16%–24% and 5= 25%

Table 2

Logistic Regression of Uterine-Sparing Procedures versus Hysterectomy

Patient Characteristics	Odds Ratio	95% LCL ^a	95% UCL ^b	Adjusted P-Value ^c
Age Group (Ref: 25–34)				
35–44	0.794	0.219	2.873	1.000
45–54	0.623	0.174	2.236	1.000
Race Quintile (Ref: Quintile 1)				
2	1.111	0.305	4.054	1.000
3	2.298	0.670	7.884	1.000
4	3.175	0.939	10.729	0.090
5	4.380	1.304	14.708	0.003
Age Group & Race Quintile Interaction (Ref: Age Group=1, Race Quintile=1) ^d				
2#2	1.126	0.283	4.476	1.000
2#3	0.638	0.171	2.378	1.000
2#4	0.515	0.140	1.888	1.000
2#5	0.519	0.143	1.893	1.000
3#2	1.164	0.296	4.582	1.000
3#3	0.594	0.161	2.196	1.000
3#4	0.468	0.129	1.702	1.000
3#5	0.409	0.113	1.480	1.000
Health Plan Type (Ref: Comprehensive)				
EPO	1.158	0.842	1.592	1.000
HMO	1.213	1.054	1.396	<0.001
POS	1.047	0.904	1.213	1.000
PPO	1.024	0.896	1.170	1.000
CDHP/HDHP	0.936	0.761	1.151	1.000
Geographic Regions (Ref: Northeast)				
Midwest	0.643	0.584	0.709	<0.001
South	0.557	0.509	0.609	<0.001
West	0.601	0.543	0.666	<0.001
Comorbidity Status (Ref: CCI=0)				
CCI=1	0.957	0.882	1.038	1.000
CCI>1	0.770	0.672	0.882	<0.001
Income Quintile (Ref: Quintile 1)				
2	0.927	0.819	1.048	1.000
3	1.106	0.982	1.245	0.265
4	1.139	1.012	1.282	0.015
5	1.442	1.274	1.631	<0.001
Education Quintile (Ref: Quintile 1)				
2	0.887	0.758	1.038	0.607
3	1.013	0.870	1.180	1.000
4	1.064	0.913	1.239	1.000

Patient Characteristics	Odds Ratio	95% LCL ^a	95% UCL ^b	Adjusted P-Value ^c
5	1.292	1.104	1.511	<0.001
Baseline Uterine Leiomyoma-related Conditions				
Menstrual Disorders	1.506	1.425	1.592	<0.001
Pelvic Pain	0.772	0.726	0.820	<0.001
Anemia	1.267	1.188	1.352	<0.001
Constipation or Gas	1.054	0.899	1.235	1.000
Urinary Problems	0.975	0.839	1.133	1.000
Baseline Other Gynecologic Conditions				
Endometriosis	0.560	0.483	0.651	<0.001
Disorders of Uterus (unclassified)	1.002	0.932	1.078	1.000
Genital Prolapse	0.237	0.181	0.309	<0.001
Benign Neoplasm of the Uterus or Ovary	0.705	0.445	1.116	0.613
Infertility	5.657	4.516	7.085	<0.001
Baseline Non-gynecologic Conditions				
Inflammatory Disease	1.207	1.116	1.304	<0.001
Noninflammatory Disease	0.921	0.859	0.988	0.006
Any Inpatient Admission	0.779	0.686	0.885	<0.001
Any Emergency Room Admission	0.927	0.868	0.990	0.007
Any NSAID Use	0.982	0.925	1.043	1.000
Any Hormone Use	1.139	1.078	1.204	<0.001
Constant	0.229	0.067	0.778	0.004

Notes:

^a LCL=Bonferroni-corrected Lower Confidence Limit.

^b UCL= Bonferroni-corrected Upper Confidence Limit. Bold-faced numbers indicates statistical significance with p-value<0.05.

^c Adjusted p-values are based on Bonferroni correction.

^d Age Groups: 1:18–34; 2:35–44; 3:45–54; 2#2 means interaction of age group 2 and race quintile 2, and so on.

Table 3
Multinomial Logistic Regression of Uterine-Sparing Procedures (Reference: Myomectomy)

Patient Characteristics	UAE			Relative RR	EA		
	Relative RR	95% LCL ^a	95% UCL ^b		95% LCL ^a	95% UCL ^b	Adjusted P-Value ^c
Age Group (Ref: 25–34)							
35–44	6.663	4.722	9.400	5.186	4.196	6.410	<0.001
45–54	25.816	18.067	36.888	21.219	16.806	26.791	<0.001
Health Plan Type (Ref: Comprehensive)							
EPO	0.907	0.371	2.217	1.095	0.536	2.237	1.000
HMO	1.403	0.912	2.158	1.238	0.859	1.784	1.000
POS	1.147	0.733	1.794	1.139	0.780	1.662	1.000
PPO	1.035	0.683	1.570	1.182	0.832	1.679	1.000
CDHP/HDHP	0.931	0.496	1.747	1.066	0.645	1.763	1.000
Geographic Regions (Ref: Northeast)							
Midwest	1.421	1.077	1.875	2.076	1.649	2.614	<0.001
South	1.179	0.926	1.500	1.758	1.435	2.154	<0.001
West	0.856	0.643	1.141	1.123	0.889	1.419	1.000
Comorbidity Status (Ref: CCI=0)							
CCI=1	1.075	0.844	1.370	1.217	0.997	1.485	0.073
CCI>1	0.952	0.616	1.473	1.257	0.876	1.802	1.000
^d Race Quintile (Ref: Quintile 1)							
2	0.975	0.228	4.161	0.930	0.342	2.530	1.000
3	1.175	0.293	4.718	0.664	0.255	1.729	1.000
4	1.144	0.287	4.552	0.496	0.192	1.284	1.000
5	1.273	0.321	5.055	0.268	0.104	0.692	<0.001
^e Income Quintile (Ref: Quintile 1)							
2	1.019	0.703	1.479	1.316	0.968	1.788	0.162
3	1.174	0.829	1.662	1.130	0.839	1.522	1.000
4	1.070	0.752	1.521	1.293	0.962	1.738	0.199
5	1.319	0.918	1.894	1.384	1.019	1.882	0.017
^f Education Quintile (Ref: Quintile 1)							

Patient Characteristics	UAE				EA			
	Relative RR	95% LCL ^a	95% UCL ^b	Adjusted P-Value ^c	Relative RR	95% LCL ^a	95% UCL ^b	Adjusted P-Value ^c
2	0.934	0.571	1.530	1.000	1.161	0.776	1.735	1.000
3	0.932	0.583	1.491	1.000	0.868	0.587	1.282	1.000
4	0.830	0.517	1.331	1.000	0.808	0.547	1.193	1.000
5	0.800	0.495	1.293	1.000	0.550	0.370	0.818	<0.001
Baseline uterine leiomyoma-related Conditions								
Menstrual Disorders	1.541	1.318	1.803	<0.001	4.987	4.358	5.706	<0.001
Pelvic Pain	0.786	0.659	0.938	<0.001	0.710	0.614	0.820	<0.001
Anemia	1.362	1.139	1.629	<0.001	0.926	0.793	1.082	1.000
Urinary Problems	0.887	0.539	1.342	1.000	0.680	0.593	1.269	1.000
Constipation or Gas	0.851	0.586	1.344	1.000	0.867	0.476	0.973	0.017
Baseline Other Gynecologic Conditions								
Endometriosis	0.596	0.376	0.946	0.012	0.604	0.422	0.864	<0.001
Disorders of Uterus (unclassified)	1.458	1.187	1.790	<0.001	0.908	0.760	1.084	1.000
Genital Prolapse	0.598	0.214	1.673	1.000	0.935	0.436	2.003	1.000
Benign Neoplasm of the Uterus or Ovary	0.158	0.019	1.280	0.239	0.374	0.125	1.117	0.118
Infertility	0.117	0.063	0.217	<0.001	0.051	0.030	0.085	<0.001
Baseline Non-gynecologic Conditions								
Inflammatory Disease	0.864	0.698	1.070	1.000	0.768	0.643	0.918	<0.001
Non-inflammatory Disease	0.787	0.634	0.976	0.010	0.987	0.832	1.172	1.000
Any Inpatient Admission	1.087	0.749	1.576	1.000	0.948	0.686	1.310	1.000
Any Emergency Room Admission	0.921	0.758	1.119	1.000	1.000	0.852	1.173	1.000
Any NSAID Use	1.250	1.049	1.488	0.001	1.266	1.092	1.467	<0.001
Any Hormone Use	0.765	0.651	0.900	<0.001	0.869	0.763	0.990	0.021
Constant	0.040	0.009	0.181	<0.001	0.176	0.061	0.510	<0.001

Notes:

^a LCL= Bonferroni-corrected Lower Confidence Limit.

^b UCL= Bonferroni-corrected Upper Confidence Limit.

^c Adjusted p-values are based on Bonferroni correction. Bold-faced numbers indicates statistical significance with p-value <0.05.

^d Quintile of % black in ZIP code, 2000 Census: 1=0% black; 2=0.1%–0.3%; 3=0.4%–1.3%; 4=1.4%–8.5% black, 5= 8.6%

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^e Quintile of median income in ZIP code, 2000 Census: 1=\$0-\$28,280; 2 = 28,281-\$33,680; 3=\$33,681-\$39,204; 4=\$39,205-\$48,749; 5= \$48,750 values

^f Quintile of percentage with college degree in ZIP code, 2000 Census: 1=lowest values, 5=highest values; 1 = 0%–7% with college degree, 2 = 8%–11%, 3=12%–15%, 4=16%–24% and 5= 25%