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Trends in hysterectomy in hospital and ambulatory settings in Kentucky 2017-2020.

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TRENDS IN HYSTERECTOMY IN HOSPITAL AND AMBULATORY SETTINGS IN
KENTUCKY 2017-2020

by
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ABSTRACT

TRENDS IN HYSTERECTOMY IN HOSPITAL AND AMBULATORY SETTINGS

IN KENTUCKY 2017-2020

Felicia Pugh

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Hysterectomy is the most common treatment for benign uterine conditions in the United States. Data suggest that one in nine women will have the procedure in their lifetime (1). Previous studies indicate that abdominal hysterectomy rates for non-malignancies are declining as alternative methods are increasing for decades; however, those trends do not apply for all women in the country (2-5). In this cross-sectional study, hysterectomy procedures completed between 2017-2020 are described in Kentucky Cabinet for Health and Family Services data. Multivariable logistic regression is used to assess the odds of abdominal hysterectomy for benign indications in Kentucky.

Conclusion: Rates of abdominal hysterectomy in Kentucky are declining; however, the odds of an abdominal hysterectomy among women diagnosed with uterine fibroids are 2.42 times higher (95% CI, 2.01-2.88) among black women compared to white women over the study period. Further research is suggested to investigate the factors contributing to the disparity of treatment for uterine fibroids between black and white women in Kentucky.

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INTRODUCTION

The hysterectomy procedure, which is the surgical removal of part or all of the uterus, is one of the most common gynecological procedures performed on women in the United States for benign uterine conditions (1). Women may be prescribed hysterectomy for malignancies and benign conditions like leiomyomas (e.g., uterine fibroids), endometriosis, and other reproductive conditions. The uterus can be removed through an open abdominal procedure, vaginal incision or more through aid of a laparoscope in either inpatient or outpatient settings; the type of surgical procedure may affect patient levels of complications and recovery time (6). Trends in the usage of invasive approaches are declining, as less invasive methods are used more; however, those changes are not evenly reflected across subpopulations of women in the United States (3, 7, 8).

Conditions and indications related to hysterectomy may be categorized into sterilizations, neoplastic disease, emergencies, and benign conditions. Diagnoses classified as benign include dysfunctional uterine bleeding, prolapse, and fibroids (9). Fibroids are one of the most common indications for hysterectomy, and black women have a higher prevalence of fibroids and experience more severe symptoms compared to non-black women (10, 11). While there are non-surgical interventions for benign uterine conditions (pharmaceutical regulation of conditions, radiological interventions, and ultrasonic procedures) (12-14), hysterectomy is the most common approach to treatment of these conditions. Hysterectomies are mainly abdominal (AH),

laparoscopic (LH), and vaginal (VH) (15). Laparoscopic and vaginal approaches are considered less invasive; therefore, they are preferable to abdominal surgeries. In addition, they may be performed in outpatient settings, using smaller incisions, with few wound complications, less potential for blood loss, and lower mortality (16-18).

Significance

The advantages of less invasive procedures for treatment for which partial to total removal of the uterus is appropriate would suggest that the trend of declining abdominal hysterectomy should be equally represented across all groups within a population. However, women of some groups who are candidates for a minimally invasive hysterectomy (MIH), are more likely to have abdominal hysterectomy than white women. Even when controlling for conditions like fibroids, black women have a higher prevalence of AH (2, 5, 19, 20). For example, a recent study of hysterectomies performed for benign conditions between 2010-2014, indicates that black women were less likely to undergo VH as compared to white women (adjusted standardized prevalence ratios [aPR]:0.93; 95% CI, 0.90−0.96). The same relationship was observed for LH (aPR:0.90; 95% CI, 0.87−0.94) (7).

This research suggests that non-white women are not equally utilizing less invasive hysterectomy methods. In that case, they are at risk of more complications related to abdominal hysterectomy and longer recovery periods than white women.

This work aims to identify gaps in the delivery of uterine interventions within the Commonwealth of Kentucky's health systems. This study describes procedures performed in inpatient and outpatient settings across facilities in the whole of Kentucky, considering individual and hospital characteristics, to generate hypotheses relating to the status of uterine interventions in the Commonwealth.

SPECIFIC AIMS AND HYPOTHESIS

This research describes trends in hysterectomy procedure usage in Kentucky and determines differences between black women and white women in the Commonwealth. The specific aims of the study are as follows:

Specific Aim 1: Describe the rates of abdominal and minimally invasive hysterectomy surgical approaches over four years in Kentucky to investigate changes in procedure usage.

Hypothesis 1: The rates of abdominal hysterectomy shall decline from the beginning to end of the study (2017-2020) as minimally invasive procedures increase.

Specific Aim 2: Examine the association between race and type of hysterectomy (abdominal vs. minimally invasive) using multivariable logistic regression, controlling for important confounders.

Hypothesis 2: Black women will have higher odds of abdominal hysterectomy than white women, even after controlling for diagnosis and hospital setting.

BACKGROUND

Hysterectomy Definitions

Vaginal Hysterectomy (VH) – The oldest and most direct approach to uterine surgery is through the vagina. As the name suggests, a medical practitioner removes tumors and portions of the uterus through the vagina. References to a trans-vaginal entry to surgery are found as early as the 16th century, with the first recorded successful removal of the uterus noted in 1813 (21). This surgical approach often requires removing the cervix to access the uterus and may be aided by laparoscopy to visualize the surgical area; however, the size and location of a uterine growth may prevent this surgical route (22, 23). Nevertheless, this method is the preferred approach to hysterectomy compared to an AH as the vaginal approach does not open a woman's abdomen to expose her viscera or leave an external wound to heal in addition to recovery associated with her primary ailment.

Abdominal Hysterectomy (AH) – Laparotomy, or a surgical incision into the abdomen, is one of the most common approaches to performing uterine procedures. Dr. Ephraim McDowell completed the first planned laparotomy in 1809 in the United States. Between 1809 and 1817 in Danville, Kentucky, the surgeon removed ovaries from three unanesthetized black women through incisions into their abdominal cavities. Each had a benign tumor excised while blood flow was halted, and then the opening was closed (24). Opening up a woman's abdomen to address reproductive disorders is not the only surgical nor

oldest approach to uterine surgery but is the most common. After the open (abdominal) approach was adopted in the 1800s, it became the most popular method among surgeons; in fact, by 1940, 60-80% of all hysterectomies in North America and Britain for benign uterine conditions were performed through abdominal entry (25, 26).

Laparoscopic Hysterectomy (LH) – By the end of the 20th century, less invasive techniques than either abdominal or vaginal surgeries were added to the methods used to treat uterine disorders. A laparoscope is used to aid in removing all or parts of female reproductive organs through an incision in either the abdomen or vagina. The first laparoscopic hysterectomy procedures were developed in the 1980s (3). Compared with abdominal and vaginal approaches, LH requires more time, training, and resources (21). Even considering the more significant expense of LH, using a smaller incision and advancing technology is a preferred route. A 2016 study tracked an increase in LH procedures from 3.3% in 2000 to 43% in 2010 (as a percentage of all hysterectomy types –AH, LH, and VH-- each year)(3), which demonstrates the adoption of laparoscopy in hysterectomy-related surgeries.

Indications for Hysterectomy

Leiomyomas, abnormal bleeding, endometriosis, and pelvic prolapse are the leading indications for hysterectomy based on a review of Healthcare Cost and Utilizations Project (HCUP) data (8). These conditions are defined below:

- *Leiomyomas (uterine fibroids)* are common and affect at least 70% of all women during their reproductive years. These growths of

muscle and connective tissue are typically asymptomatic, but when they are symptomatic (about 30% of occurrences), they cause pain, anemia, and infertility, among other issues. In addition, because fibroids occur during reproductive years, the risk of a hysterectomy related to fibroids declines as women approach menopause (27).

- *Abnormal uterine bleeding (UAB)* is dysfunctional bleeding of the uterus in the absence of infection (9). UAB affects the quality of life for women and may occur during reproductive age and post menarche (28). The prevalence of UAB ranges from 3% to 35% of women (29).

- *Endometriosis* is an inflammatory disease in which the inner lining of the uterus grows on the outside. The chronic disease, which causes pelvic pain and infertility, affects 11% of women between the ages of 15 and 44, although it may occur throughout life (30, 31).

- *Uterine prolapse*, displacement of the uterus from its normal position, may be severe enough to warrant its removal (9). While the prevalence of the conditions is unknown, 14% of women enrolled in the Woman's Health Initiative in the US had the condition (32). Older women and those that have experienced childbirth are at risk of prolapse (33).

Impact of Hysterectomy Surgical Approach

This study considers that depending on symptom presentation, there is a preferred hierarchy to hysterectomy surgical routes; vaginal and laparoscope assisted surgeries should be considered before the abdominal approach. Abdominal hysterectomy should only be considered when other surgical methods have been eliminated or deemed inappropriate for a patient's diagnosis. An intervention review comparing surgical approaches found that vaginal hysterectomy is preferable to AH because it offers shorter hospital stays, a quicker return to regular activity, and fewer postoperative complications (16). Another review recommends that LH be considered over AH even though it has a longer operating time because LH offers faster postoperative recovery time, shorter hospital stays, lower blood loss, decreased risk of postoperative complications, and a quicker return to regular activity (17). Therefore, vaginal and laparoscopic approaches are both preferable to abdominal.

Surgical approaches are specific to each patient's symptoms and presentations; however, medical advisory boards offer guidelines suggesting that abdominal hysterectomy is considered a last resort. For example, a Canadian clinical practice guideline recommends that if a vaginal approach is possible, it should be provided based on reported lower rates of complications compared to other methods (34). Robert L. Barbieri, MD, a gynecological researcher, asks physicians to champion vaginal and laparoscopic approaches. To improve outcomes for women, he suggests setting a goal for the United States to lower

the proportion of AH procedures from 56% of hysterectomies observed in 2010, to under 40% (35).

Disparities in Hysterectomy Delivery

Differences between black and white women

An administrative brief of inpatient and outpatient data from five states (Connecticut, Indiana, Kansas, Ohio, and South Carolina) published in 2016 recognizes the trend of declining abdominal (typically, inpatient procedures) hysterectomy rates. Inpatient stays for hysterectomies decreased by 58% (172.1 per 100,000 adult women in 2005 to 72.1 per 100,000 adult women in 2013) (5). The same brief suggests a disparity in surgical approaches between groups of women in the selected states. For example, black women experienced inpatient hysterectomy at more that two times the rate for white women in a study (black: 143.7 per 100,000 compared to white: 58.0 per 100,000) (5).

There are differences and inequality in the delivery of reproductive health care to women in the United States that can be observed by self-identified race. This regional study confirms differences by race in hysterectomy surgical routes in hospital settings for all indications.

Differences by race are also evident when examining specific indications for hysterectomy. Studies of racial disparity in fibroid treatment found black women were more likely to have invasive procedures such as AH than white women (36-44). A series of studies investigating interventions within Veteran Administration data highlight differences in care comparing white female veterans to other races. One study comparing fibroid treatment approaches between

female veterans found that black veterans were less likely than white veterans to have a minimally invasive laparoscopic procedure than an abdominal hysterectomy (RR: 0.52 (95% CI, 0.38–0.72) (37). Similar results were observed in two more studies evaluating minimally invasive procedure differences between veterans of different races; one found that 61% of black women eligible for hysterectomy had abdominal hysterectomy compared to 39% of eligible white women, and the other reported that black women had lower odds of any MIH compared to abdominal hysterectomy (OR 0.80; 95% CI, 0.65, 0.97) (38, 43). It is understood from these studies that black women undergo more invasive procedures or those that would require an inpatient setting; these differences can result in differences in recovery time, complications, and impact of care in black women's lives.

Differences by Hospital Characteristics

The type of hysterectomy a woman receives can be influenced by where she resides, and the variety of services offered within her reach. Hospitals serving more black women are more likely to conduct abdominal hysterectomies. A 2019 study sought to examine factors that contribute to the apparent race differences in MIH usage. Two factors they examined were hospital service area and volume. To investigate differences in hospital service, the authors categorized hospitals in the study area into quintiles of based on proportions of service to black patients and compared the usage of AH, VH, and LH by racial and ethnic groups. They found that hospitals serving higher proportions of black

women used more AH and less MIH across hospital groupings of race and ethnicity compared to white women (7).

Subsequently, the same study considered the volume of hospitals. The annual volume of hysterectomy procedures was categorized into low, medium, and high. Comparisons between low- and high-volume hospitals were made to see if that characteristic indicated differences in the type of hysterectomy performed. The researchers found that women of all race/ethnic groups had more AH and fewer LH at low-volume hospitals compared to high-volume hospitals and that 38% of low-volume facilities performed no LH. (7).

It may also be prudent to examine if a surgical facility is in an urban or rural location. Abdominal hysterectomy is a common procedure; laparoscopic and other technology-aided surgery methods may not be equally available across the country and may suggest other differences in surgical approaches. For example, a 2017 Canadian study examining social and geographic determinants in hysterectomy delivery found that while there was slight variation in the delivery of MIH by income and education across neighborhoods in the province of Ontario, the proportion of MIH was higher in rural areas compared to urban (RR 1.10 95% CI 1.03-1.19) (45). So, in addition to evaluating race and SEP, a study of disparity in hysterectomy delivery should also consider the characteristics of the facility in which hysterectomies are delivered.

METHODS

Kentucky Family Services Data Collection

The datasets used in this thesis were acquired from the Kentucky Cabinet for Health and Family Services (CHFS) under agreement from the Commonwealth Scholars of Kentucky (46). CHFS has the authority to collect hospital discharge information in Kentucky which is reported quarterly through a subcontract with the Kentucky Hospital Association. Of 42,036,869 administrative records available from 2017-2020, records of black and white women over age 18 are included in this study (n= 22,524,629). Each record describes an encounter in either a Kentucky hospital (inpatient or outpatient) or an ambulatory facility (specialized medical technology outpatient provider). Patient encounters are assigned unique record identifiers so that individuals within the databases cannot be identified; therefore, the Institutional Review Board at the University of Louisville has deemed this research exempt under Category 4 of 45 CFR 46.101(b).

Outcome Data Collection

Records of women over the age of 18 with a primary diagnosis code for a benign gynecological disorder and a primary procedure code for an applicable intervention are included in the study sample. Diagnoses are either described as uterine leiomyomas (fibroids) or other benign gynecological conditions. Diagnoses are recorded within inpatient and outpatient datasets using the International Classifications of Diseases, Tenth Revision, Clinical Modification

(ICD-10) (47). Indications for hysterectomy considered in this study are listed in
[Supplemental Table 1](#).

Procedures are either described as abdominal hysterectomy or minimally invasive hysterectomy. Minimally invasive procedures include vaginal hysterectomy as well as any laparoscopy-assisted procedures. Inpatient procedures codes are recorded using ICD-10 (47). Outpatient procedure codes are recorded using Current Procedural Terminology (CPT) (48). Procedures for hysterectomy considered in this study are listed in [Supplemental Table 2](#).

Exposure Data Collection

The exposure of interest is race. Self-identified race categories in CHFS datasets are American Indian or Alaska Native, Asian, black or African American, Native Hawaiian or Pacific Islander, white, and others. Comparisons in this study will be between black and white women as other categories each represent less than 1% of the collected datasets, and were excluded from this study. Race is considered with the exclusion of ethnicity as less than 3% of the population self-identified as Hispanic, and 0.27% declined to identify ethnicity.

Patient Variable Data Collection

Patient-level variables of age and surgery year used in this work are defined by the CHFS. Age is recorded in 19 categories, of which four representing ages under 18 have been excluded. The remaining 15 age categories have been consolidated to 6. Thirty-two payer codes are defined in 5 categories: commercial insurance, Medicaid, Medicare, self-pay or charity, and

13

missing/other. The four calendar years of procedures considered are from 2017 through 2020.

Hospital Variable Data Collection

Hospital setting information follows the categories found within CHFS data sets. The outpatient category describes ambulatory facilities. Hospitals are identified by hospital classes: urban prospective payment system (PPS), critical access hospital (CAH), or rural payment system (rural PPS). The CAH and urban PPS designations are given to hospitals that meet Centers for Medicare and Medicaid Services criteria (49). The hospital hysterectomy volume variable is derived by summarizing the number of procedures selected into the study by facility identification number; volume is then grouped into three categories; 1-50, 51-200, and >200 procedures.

Descriptive Statistics

The analysis of this research was performed using SAS (Version 9.4, SAS Institute, Cary, NC).

The characteristics of the study population were generated by cross-tabulation in SAS using PROC FREQ for the patient and hospital variables by race categories of black and white women. Patient and hospital variables are recorded by the total number and percentage of women in each respective category.

Aim 1: To characterize the rates of hysterectomies over four years in Kentucky, the total number of AH and MIH was calculated by race categories for each study year. Hysterectomy totals by year are then used as the numerator

with population by race as the denominator to calculate AH and MIH rates by race for each study year. Thus, rates of hysterectomy are expressed as the number of procedures per 10,000 women per year.

Logistic Regression Modeling

Aim 2: Multivariable logistic regression models were used to calculate odds ratios and 95% confidence intervals, examining the association between race and type of hysterectomy (abdominal vs. minimally invasive) (15). Patient and hospital characteristic variables were first checked for relationships to both exposure and outcome through a literature review; of those variables, diagnosis and hospital location were found to be associated with both the exposure (race) and outcome (hysterectomy type).

Next, Chi-square tests of independence were used to examine possible associations between the variables representing diagnosis and hospital setting, with race. Race, diagnosis, and hospital setting were also assessed to account for the possibility of multicollinearity using a SAS macro; all condition indexes were less than 30. Therefore, all variables can included to create a hierarachically well formulated logistic regression model. Finally, variable interaction was assessed by including product terms in the multivariable models; interactions between race and diagnosis as well as race and hospital setting were tested. A significant interaction was indicated between the race and diagnosis categories. Therefore, this interaction term and its lower-order terms were included in the model.

A multivariable logistic regression model with the procedure variable (1= abdominal hysterectomy, 0= minimally invasive hysterectomy) as the dichotomous outcome of interest was fitted for the exposure of race (1=black, 0= white) adjusting for diagnosis (1= uterine leiomyomas, 0= other benign gynecological conditions), hospital setting (1= urban pps, 2= CAH or rural pps, 3= outpatient) variables and an interaction between diagnosis and race variables. Confounding for diagnosis and hospital setting variables was assessed by removing covariates from the model one at a time and determining whether the parameter estimates for the exposure changed by >10%; if so, the variable was deemed a confounder and retained in the model. If removal of a variable did not change the estimate by more than 10%, then precision was evaluated to determine if the variable should be kept in the model. Precision of each model was assessed to confirm that the most parsimonious and precise model included race, diagnosis, hospital setting and the interaction between race and diagnosis (Figure 1). Results were reported as odds ratios with 95% confidence intervals.

Figure 1: Final logistic regression model for the effect of race on the outcome of abdominal hysterectomy

$$Log\ (odds\ of\ abdominal\ hysterectomy) = \beta_0 + \beta_1 * race + \beta_2 * diagnosis + \beta_3 * setting + \beta_4 * race * diagnosis$$

RESULTS

Descriptive Statistics

Patient and hospital characteristics are summarized in Table 1. Of

22,524,629 black and white women over 18 admitted into medical facilities

tracked by the CHFS, 195,296 were eligible for minimally invasive

hysterectomies between 2017 and 2020. Of the women who make up this study's

cohort, black women represent 13.19% (n=25,751) of the sample, and white

women account for 86.81% (n=169,545). Women in the 18-34 years age are the

largest groups for black and white women (47.88% compared to 42.17%). For

black women 57.25% (n= 632) of all hysterectomies are performed by abdominal

route, and minimally invasive procedures are performed in 42.75% (n=472) of

the encounters over the study period. For white women 37.47% (n= 2,279) of all

procedures were performed by abdominal route and 62.53% (n= 3,804) are

performed through mininmally invasive manners. Of indications for hysterectomy,

black women were diagnosed with uterine fibroids over twice as often as white

women (18.64% versus 7.38%). Over 50% of white women used commercial

(50.32%) for payment for procedures, whereas less than half of black women

used it (35.73%).

Comparing characteristics of hospitals settings, both black and white

women received hysterectomy procedures in mostly urban inpatient settings

(Urban PPS); however, black women did so at a higher percentage (75.91%)

compared to white women (52.46%). Regarding hospital volume, both black and

white women were more likely to have their hysterectomies at high volume

facilities, with the least number of procedures performed at low volume locations.

*Table 1: Characteristics of women eligible for hysterectomy from Kentucky Health and Family Services Databases (2017-2020), by race (n = 195,296)**				
***Data are n (%). All % are column percentages. All % are column percentages.**				
	Black		**White**	
	(n = 25 751)		(n = 169 545)	
Age Groups (Years)				
18-34	12 329	(47.9)	71 489	(42.2)
35-44	7 349	(28.5)	46 915	(27.7)
45-54	4 194	(16.3)	32 317	(19.1)
55-64	1 243	(4.8)	9 288	(5.5)
65-74	469	(1.8)	6 065	(3.6)
75-85+	167	(0.7)	3 471	(2.1)
Insurance Status (Payer)				
Commercial	9 201	(35.7)	85 323	(50.3)
Medicaid	13 144	(51.0)	62 596	(36.9)
Medicare	1 637	(6.4)	14 518	(8.6)
Self-Care & Charity	1 049	(4.1)	4 240	(2.5)
Other or Missing	720	(2.8)	2 868	(1.7)
Surgical Indication				
Fibroid	4 799	(18.6)	12 510	(7.4)
Other Benign Disorders and Conditions	20 952	(81.4)	157 035	(92.6)
Surgical Route				
Abdominal Hysterectomy	632	(57.3)	2 279	(37.5)
Minimally Invasive Hysterectomy	472	(42.8)	3 804	(62.5)
Surgery Year				
2017	6 313	(24.5)	43 227	(25.5)
2018	6 590	(25.6)	43 791	(25.8)

2019	6 809	(26.44)	44 280	(26.12)
2020	6 039	(23.45)	38 247	(22.56)
Hospital Setting				
Urban Prospective Payment System (PPS)	19 537	(75.91)	88 884	(52.46)
Critical Access Hospital (CAH) or Rural PPS	3 331	(12.94)	59 724	(35.25)
Outpatient (OP)	2 870	(11.15)	20 820	(12.29)
Hospital Hysterectomy Volume				
1-50	2 282	(10.15)	13 181	(9.15)
51-200	5 120	(22.77)	48 107	(33.39)
>200	15 088	(67.09)	82 799	(57.46)

Specific Aim 1 Results

Specific Aim 1: Describe the rates of abdominal and minimally invasive hysterectomy surgical approaches interventions over four years in Kentucky to investigate changes in procedure usage.

The rates of abdominal and minimally invasive hysterectomy surgical approaches interventions over four years in Kentucky declined from 2017 to 2020 for both black and white women (Figure 2). At the beginning of the study period, there were 6.51 AH procedures per 10,000 among black women and 2.44 per 10,000 among white women. The rate of AH decreased for both groups of women by 2020 to 3.78/10,000 (black) and 1.58/10,000 (white). The rate of MIH also decreased from 2017 to 2020; black women had MIH at a rate of 8.55 per 10,000 in 2017, but the rate dropped to as low as 2.13/10,000 in 2019 and rose to 2.86/10,000 in 2020. The rate of MIH among white women also dropped over the study period; from 2017, the rate of 6.12/10,000 fell to 1.91/10,000 in 2020.

Figure 2: Abdominal and minimally invasive hysterectomy rates in Kentucky by race and year (2017-2020)

Hysterectomy Rates (per 10,000) by Race and Year
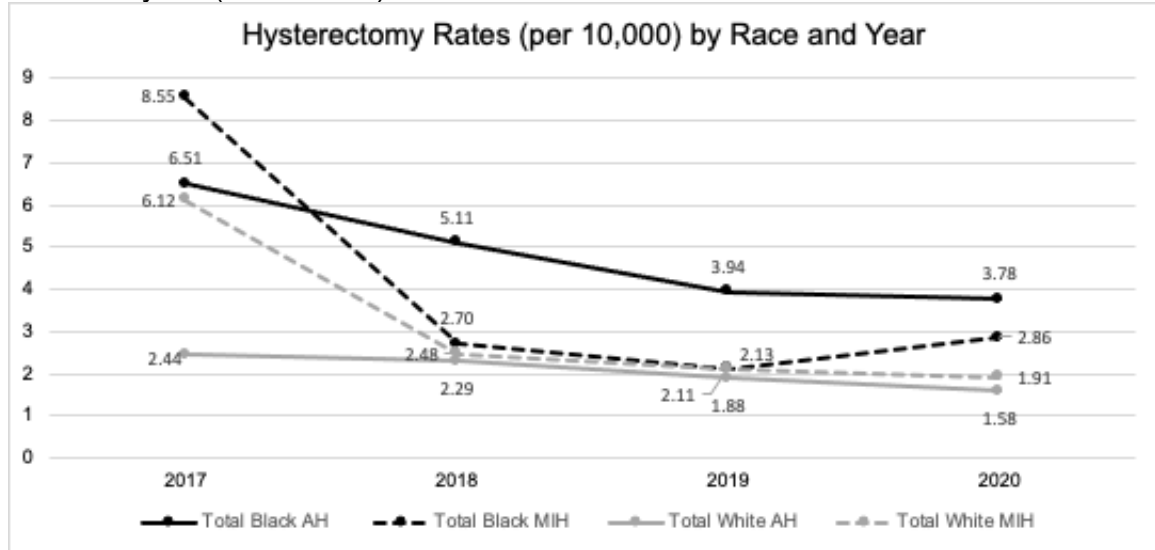
Specific Aim 2 Results

Specific Aim 2: Evaluate the association between race and type of hysterectomy (abdominal vs. minimally invasive).

The odds of abdominal hysterectomy for black and white women vary depending on the indication for the invasive approach (Table 2). For benign diagnoses such as endometriosis or uterine prolapse, the odds of an abdominal approach are roughly the same (OR: 1.03; 95% CI, 0.75-1.25). However, among women with an indication of uterine fibroids, the odds of a black woman receiving an abdominal hysterectomy was more than two-times that of a white woman for the same indication (OR: 2.42; 95% CI, 2.02-2.88). This model adjusts for diagnosis and interaction between race and diagnosis as well as hospital settings.

Table 2: Odds ratios of abdominal hysterectomy comparing black and white women with benign gynecological conditions in Kentucky*.		
Odds ratios by diagnosis category	OR	95% CI
Diagnosis = Uterine fibroids	2.42	(2.01-2.88)
Diagnosis = Other benign uterine conditions	1.03	(0.75-1.25)
*Adjusted for hospital setting		

DISCUSSION

Hysterectomy Trends in Kentucky

This research compared abdominal and minimally invasive hysterectomy rates over four years using inpatient and outpatient datasets to obtain a comprehensive view of surgical routes used to deliver the procedure. The first aim was to examine the rates of abdominal hysterectomy from 2017-2020. It was anticipated that abdominal hysterectomy rates would drop for all women; and this was observed, with a 41.95% drop for black women (from 6.51 to 3.78 per 10,000) and a 35.32% drop for white women (from 2.44 to 1.58 per 10,000). However, it was not hypothesized that rates of minimally invasive hysterectomy would also decrease. MIH rates decreased at similar rates of 66.58% (from 8.55 to 2.86 per 10,000) and 68.78% (from 6.12 to 1.91 per 10,000) for black and white women, respectively, with the biggest drop between 2017 and 2018 for both races (black: 68.44%, white: 59.40%). There was an uptick of 34.33% for MIH for black women from 2019 to 2020, but the overall trend was downward for both races.

The finding regarding decreased rates of MIH in this thesis is contrary to similar research of regional administrative data. A statistical brief of the Health Cost and Utilization Project (HCUP) describing trends of hysterectomies from

2005-2013 found that MIH increased over 400% in outpatient settings, with an annual increase of 22.70% (from 31.40 per 100,000 adult women in 2005 to 161.60 per 100,000 adult women in 2013) during the study period. (5)

The rates of uterine fibroids declined at similar rates of 14.34% for black women (from 30.66 per 10,000 in 2017 to 26.26 per 10,000 in 2020) and 14.95% for white women (from 6.27 per 10,000 in 2017 to 5.33 per 10,000 in 2020). For other benign conditions there was a less than 10% change in diagnoses for either group of women; black women were diagnosed at an increase of 2.35% throughout the study, and white women were diagnosed at an increase of 8.00%. So, the drop in hysterectomy rates does not appear to be related to a decrease in indications for the procedures.

Figure 3: Benign uterine indication rates in Kentucky by race and year (2017-2020)
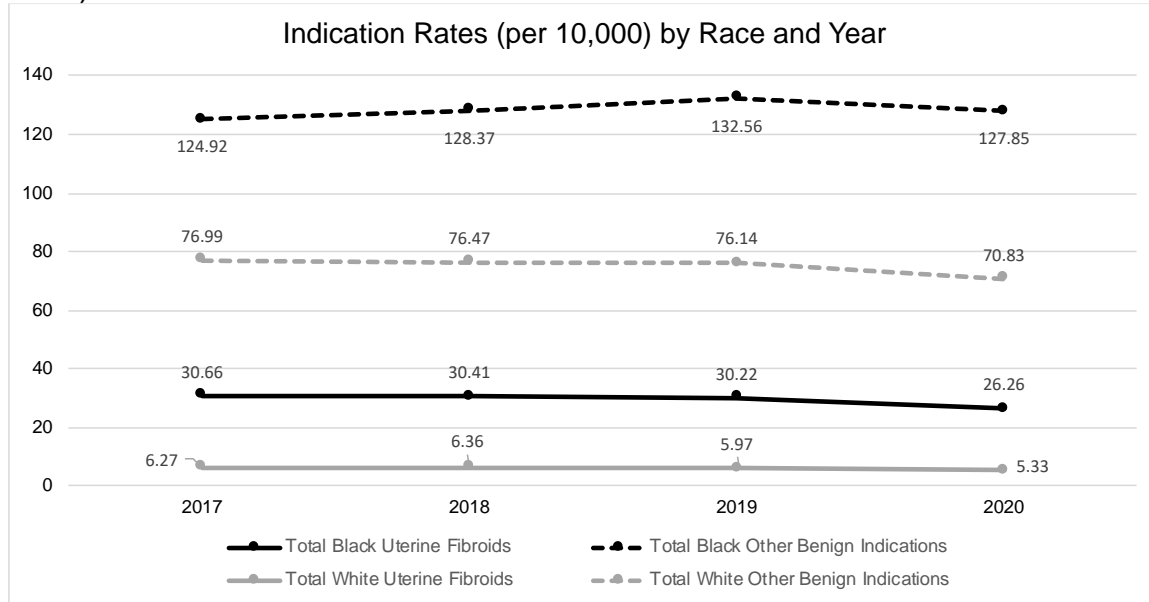
Other treatments for fibroids, which occur at higher rates in the CHFS population of women in this study, may account for the changes in hysterectomy trends. In a study that examined treatments for fibroids, a cohort of 871 women

surveyed about their fibroid treatments, 71% of the respondents chose a type of pharmacologic treatment. Thus, fewer than 30% of survey respondents pursued a surgical route to address their fibroids (50). Discharge records do not capture all non-surgical treatment approaches for fibroids or other benign indications. Alternatively, not all fibroids or benign gynecological conditions diagnosed result in treatment; women may choose to live with symptoms or delay treatment (50, 51). Utilization of other therapies for benign conditions may account for the changes in hysterectomies over the study period.

The decline in the use of MIH in Kentucky may be due to the lack of availability. HCUP categorizes Kentucky as Division 6 (East South Central) in regional analysis (52). As such, in research related to hysterectomy trends derived from administrative datasets, Kentucky may be considered a southern region. The highest incidence of AH is found in the southern region of the United States (63% of all cases), according to a hysterectomy surveillance report published in 2014 (53). The same study confirms that vaginal and robot-assisted hysterectomy routes (not accessed in this work) are lowest in the Southern region of the United States (53). These findings may imply that the resources such as trained staff and necessary equipment required for alternative methods may not be available throughout the Commonwealth.

The hypothesis for Aim 2 anticipated that *black women will have higher odds of abdominal hysterectomy than white women.* This statement is partially correct when considering diagnosis as an effect modifier in comparing outcomes by race; there are different results, depending on the diagnosis. For benign

gynecological indications excluding uterine fibroids, the odds of abdominal or minimally invasive surgery as a response were roughly the same for both black or white women (OR: 1.03; 95% CI, 0.75-1.25). However, for women with a diagnosis of uterine fibroids the odds of AH for black women is over two time that of white women (OR: 2.42; 95% CI, 2.01-2.88).

When considering the diagnosis of uterine fibroids in the delivery of abdominal hysterectomy between black and white women, there is a two-fold difference in the receipt of AH for black women. The literature review revealed that causes of racial disparity in the usage of AH compared to MIH are complex and not fully explored. The fact that rates of AH differed comparing black vs. white women, even among women who all have the same diagnosis, indicates that race is not a biological marker but may represent exposure to discrimination. However, there may be residual confounding related to the etiology of fibroids (a biological consideration) related to race that could account for some disparity in the delivery of hysterectomy types. The prevalence of uterine fibroids is adjusted for in this study; however, the presentation and size of the growths for an individual level are not assessed. The dimensions of fibroids affect the suitability of MIH for an individual (23). A quantitative examination of administrative data may be able to detect the effects of discrimination; because healthcare provider input regarding clinical presentation of symptoms was not available, this analysis was not able to interrogate this important line of research.

Strengths and Limitations

The analysis in this thesis is based on data collected from admission and discharge records. Because this work is extracted from administrative records, it is subject to information bias due to record-keeping errors and misclassification of diagnosis (ICD-10) and procedure codes (CPT, ICD-10). However, the use of CHFS data sets is a strength of this work because it includes women seen in both inpatient and outpatient settings using multiple payers and allows for placement of people and services in urban and rural locations. Research referenced in and outside this study often focuses on either inpatient or outpatient data or is specific to healthcare systems like the Veteran's Administration; our analysis offers a broad view of the status of hysterectomy in Kentucky. However, this report does not include procedures performed in private practices that may not report to the Cabinet of Family Services and Health collection process.

This study's primary aim is to examine black-white differences in hysterectomy surgery routes. Still, this research does not control for confounding related to the presentation of symptoms such as the size and position of uterine fibroids. Nor does this work account for the health status of individuals; obesity, for example, may prevent the use of some laparoscopic techniques to intervene upon conditions (54). More individual-level data, for example from medical records, would be required to control for additional individual-level confounding factors.

This thesis offers a cross-sectional view of the distribution of abdominal and minimally invasive hysterectomy in Kentucky but lacks comparison to a similar environment. This research would be improved by comparison to neighboring states such as Indiana and Ohio; these states have similar access to care, black-white, urban-rural differences by which researchers may establish standards of expected usage of approaches. A broader understanding of changes in the use of hysterectomy for benign conditions could include alternative treatments; radiological, lifestyle, and pharmaceutical methods are not considered in this work.

Suggestions for Further Research

Work in this thesis suggests important differences in the delivery of minimally invasive hysterectomy between the most populous groups in Kentucky. Understanding the cause of these differences prompts an essential research question: *What factors contribute to the difference in hysterectomy procedures in Kentucky between black and white women?* Addressing this question will require different levels of investigation. For example, to answer the question of disparity in MIH use, researchers may consider individual factors (e.g., choice, symptoms) and access (what facilities perform MIH in Kentucky). Potential research could also examine how a woman's partner, age and parity affect MIH use. Researchers may also investigate the use of alternatives to hysterectomy and explore the influence healthcare providers have upon a chosen treatments.

Because answers to the questions above cannot be gleaned from this research, a mixed-methods approach to research that evaluates attitudes

towards the type of intervention chosen, and one that considers factors

contributing to health outcomes beyond the scope of an individual woman's

control, is suggested.

SUMMARY AND CONCLUSION

The use of minimally invasive hysterectomy approaches benefits women experiencing uterine-related health issues through reduced risk of pain, shorter hospital visits, and quicker returns to everyday life. It is essential these interventions be available equally to all groups of women to improve health status in Kentucky. This project acknowledges that individual healthcare decisions are made amid complex circumstances. Further exploration is warranted to identify the multiple interrelated factors that may inhibit or encourage the use of MIH to produce tangible ideas that can support strategies that deliver equitable uterine interventions to women in Kentucky.

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*Supplemental Table 1: International Classifications of Diseases, Tenth Revision (ICD-10)
Diagnosis Codes*

Study Classification	ICD-10 CM	Description
Fibroid	D250	Submucous leiomyoma
	D251	Intramural leiomyoma of uterus
	D252	Subserous leiomyoma of uterus
	D259	Leiomyoma of uterus, unspecified
	D269	Benign neoplasm of uterus, part unspecified
Benign Uterine Conditions	N800	Endometriosis of uterus
	N803	Endometriosis of pelvic peritoneum
	N804	Endometriosis of rectovaginal septum and vagina
	N920	Excessive or frequent menstruation
	N926	Irregular menstrual cycle
	N925	Other specified irregular menstruation
	N921	Metrorrhagia
	N930	Postcoital bleeding
	N938	Other specified abnormal uterine and vaginal bleeding
	N939	Abnormal uterine and vaginal bleeding, unspecified
	N840	Polyp of corpus uteri
	N841	Polyp of cervix uteri
	N852	Hypertrophy of uterus
	N857	Hematometra
	N858	Other specified disorders of uterus, not elsewhere classified
	N8500	Endometrial hyperplasia, unspecified
	N8501	Simple endometrial hyperplasia without atypia or benign endometrial hyperplasia
	N8502	Endometrial hyperplasia with atypia
	N8502	Endometrial intraepithelial neoplasia [EIN]
	D282	Benign neoplasm of fallopian tube and uterine ligaments
	D287	Benign neoplasm of other specified sites of female genital organs
	N898	Other specified noninflammatory disorders of vagina
	N812	Uterine prolapse without mention of vaginal wall prolapse
	N813	Uterovaginal prolapse, complete
	N814	Uterovaginal prolapse, unspecified
	N815	Vaginal enterocele, congenital or acquired
	N819	Unspecified genital prolapse

Supplemental Table 2: Current Procedural Terminology (CPT) and International Classifications of Diseases, Tenth Revision (ICD-10) Procedure Codes

Study Classification	Procedure Category	ICD-10	CPT	Description
	Abdominal	0UT90ZL		Resection of Uterus, Supracervical, Open Approach
	Abdominal		58150	Total abdominal hysterectomy (corpus and cervix), with or without removal of tube(s), with or without removal of ovary(s)
	Abdominal		58152	Total abdominal hysterectomy (corpus and cervix), with or without removal of tube(s), with or without removal of ovary(s)
	Abdominal		58180	Supracervical abdominal hysterectomy (subtotal hysterectomy), with or without removal of tube(s), with or without removal of ovary(s)
Abdominal Hysterectomy	Abdominal		58200	Total abdominal hysterectomy, including partial vaginectomy, with para-aortic and pelvic lymph node sampling, with or without removal of tube(s), with or without removal of ovary(s)
	Abdominal	0UT90ZZ		Resection of Uterus, Open Approach
	Abdominal	0UTC0ZZ		Resection of Cervix, Open Approach
	Abdominal	0UT40ZZ		Resection of Uterine Supporting Structure, Open Approach
	Laparoscopic	0UT94ZL		Resection of Uterus, Supracervical, Percutaneous Endoscopic Approach
	Laparoscopic	0UT94ZZ		Resection of Uterus, Percutaneous Endoscopic Approach
	Laparoscopic	0UTC4ZZ		Resection of Cervix, Percutaneous Endoscopic Approach
	Laparoscopic	0UT44ZZ		Resection of Uterine Supporting Structure, Percutaneous Endoscopic Approach
	Laparoscopic	0UT48ZZ		Resection of Uterine Supporting Structure, Via Natural or Artificial Opening Endoscopic
	Laparoscopic	0UTC8ZZ		Resection of Cervix, Via Natural or Artificial Opening Endoscopic
	Laparoscopic	0UT98ZZ		Resection of Uterus, Via Natural or Artificial Opening Endoscopic
	Laparoscopic	0UT98ZL		Resection of Uterus, Supracervical, Via Natural or Artificial Opening Endoscopic
	Laparoscopic		58541	Laparoscopy, surgical, supracervical hysterectomy, for uterus 250 g or less
	Laparoscopic		58542	Laparoscopy, surgical, supracervical hysterectomy, for uterus 250 g or less
	Laparoscopic		58570	Laparoscopy, surgical, with total hysterectomy, for uterus 250 g or less
	Laparoscopic		58571	Laparoscopy, surgical, with total hysterectomy, for uterus 250 g or less
	Laparoscopic		58543	Laparoscopy, surgical, supracervical hysterectomy, for uterus greater than 250 g
	Laparoscopic		58544	Laparoscopy, surgical, supracervical hysterectomy, for uterus greater than 250 g
	Laparoscopic		58572	Laparoscopy, surgical, with total hysterectomy, for uterus greater than 250 g
	Laparoscopic		58573	Laparoscopy, surgical, with total hysterectomy, for uterus greater than 250 g
	Vaginal	0UT9FZZ		Resection of Uterus, Via Natural or Artificial Opening With Percutaneous Endoscopic Assistance
	Vaginal		58260	Vaginal hysterectomy, for uterus 250 g or less
	Vaginal		58262	Vaginal hysterectomy, for uterus 250 g or less; with removal of tube(s), and/or ovary(s)
	Vaginal		58263	Vaginal hysterectomy, for uterus 250 g or less; with removal of tube(s), and/or ovary(s), with repair of enterocele
Minimally Invasive Hysterectomy	Vaginal		58267	Vaginal hysterectomy, for uterus 250 g or less; with colpo-urethrocystopexy (MarshallMarchetti-Krantz type, Pereyra type) with or without endoscopic control
	Vaginal		58270	Vaginal hysterectomy, for uterus 250 g or less; with repair of enterocele
	Vaginal		58275	Vaginal hysterectomy, with total or partial vaginectomy
	Vaginal		58280	Vaginal hysterectomy, with total or partial vaginectomy; with repair of enterocele
	Vaginal		58550	Laparoscopy, surgical, with vaginal hysterectomy, for uterus 250 g or less
	Vaginal		58552	Laparoscopy, surgical, with vaginal hysterectomy, for uterus 250 g or less
	Vaginal		58290	Vaginal hysterectomy, for uterus greater than 250 g
	Vaginal		58291	Vaginal hysterectomy, for uterus greater than 250 g; with removal of tube(s) and/or ovary(s)
	Vaginal		58292	Vaginal hysterectomy, for uterus greater than 250 g; with removal of tube(s) and/or ovary(s), with repair of enterocele
	Vaginal		58293	Vaginal undefined, deleted 12/31/2020 Vaginal hysterectomy, for uterus greater than 250 g; with colpo-urethrocystopexy (Marshall-Marchetti-Krantz type, Pereyra type) with or without endoscopic control
	Vaginal		58294	Vaginal hysterectomy, for uterus greater than 250 g; with repair of enterocele
	Vaginal		58553	Laparoscopy, surgical, with vaginal hysterectomy, for uterus greater than 250 g;
	Vaginal		58554	Laparoscopy, surgical, with vaginal hysterectomy, for uterus greater than 250 g; with removal of tube(s) and/or ovary(
	Vaginal	0UT47ZZ		Resection of Uterine Supporting Structure, Via Natural or Artificial Opening
	Vaginal	0UT97ZL		Resection of Uterus, Supracervical, Via Natural or Artificial Opening
	Vaginal	0UT97ZZ		Resection of Uterus, Via Natural or Artificial Opening
	Vaginal	0UTC7ZZ		Resection of Cervix, Via Natural or Artificial Opening

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<u>EDUCATION</u>
Master of Science Epidemiology, University of Louisville, 2019- present
Relevant classes: Advanced Epidemiology Methods, Introduction to
Epidemiology, Introduction to Public Health & Administration, Introduction Health
Behavior and Promotion, Biostatistics for Health Sciences.
Thesis: Trends in hysterectomy in hospital and ambulatory settings in Kentucky
2015-2020.
Chair: Anne Baber Wallis, MHS, Ph.D., Associate Professor, Epidemiology and
Population Health

Post Baccalaureate Coursework, Jefferson Community and Technical College,
2018-2019
Relevant classes: Human Anatomy & Physiology I and II.

Master of Museum Studies & Administration, Macquarie University (Sydney,
Australia), 2007
Relevant classes: Museum Studies and Information Management, Field Studies,
Heritage: Identification, Conservation, and Sustainable Management.
Special Projects: Created searchable databases for Jim Rose Earth Sciences
Garden and commercial projects Established accession, acquisition processes
related to collection.
Thesis: Digitization of Jim Rose Earth Sciences Garden
Chair: Ruth Mawson, Ph.D. Associate Professor, Earth and Planetary Sciences
Internship: Fernbank Museum of Natural History, Atlanta, GA, 2006
- Authored papers and compiled data that contributed to the museum's
  American Alliance of Museums accreditation review. Conducted research
  within the Library of Congress related to museum establishment; developed
  marketing materials based on that work.

Bachelor of Arts in Anthropology, University of Georgia (Athens, GA), 1999
Relevant Classes: General Biology I and II, Zoo archeology, Ecology, Vertebrate
Zoology, Environmental Archeology, Special topic in Anthropology: Human
Osteology.
Notable projects: Under supervision of Georgia Museum of Natural History
curators Elizabeth Reitz and Liz McGhee; student collections manager of
herpetology, ichthyology, and zoo archeology ranges.

Continuing Education:
- Publishing Academy, University of Louisville, Graduate School (2021)
- Artifact Collection Care Certification, University of Chicago, Graham School (2015)
  Coursework included: Protecting the Collection: Environmental Factors; Collections Policy and Procedure; Display Storage and Use I and II; Digitizing Collections; and Exhibitions Development and Design.
- Diversity Practitioner of the 21st Century, Society for Human Resource Management.
- Targeted Selection Interview Skills Trainer, Development Dimensions International.

GRANTS
- Graduate Student Council Travel Grant, University of Louisville. Award of $350 toward the Society for Epidemiologic Research Annual Meeting (2021).
- Department of Earth and Planetary Science, Macquarie University. Award of $500 towards a trip to Mahidol University for fieldwork and research (2005).
- Department of Earth and Planetary Science, Macquarie University. Award of $500 towards a trip to Mexico City for museum conference attendance (2006).

PUBLICATIONS
- Newton J, Pugh F, Tomlinson M, Ruther M, DuPré NC, Ellis T. Socioeconomic Patterns and Environmental Greenness in Relation to Census Tract-Level Colorectal Cancer Rates in Kentucky. The University of Louisville Society for Epidemiologic Research. June 22-25, 2021. Virtual.
- Newton J, Tomlinson M, Pugh F, Ruther M, DuPré NC, Ellis T. Greenness and Colorectal Cancer Case Rates in Kentucky from 2006-2014. University of Louisville Graduate Student Regional Research Conference. March 11-12, 2021. Virtual.

  Contributed to articles and thought-leadership papers on Human Resources policies and best practices:

- Gearin, Christopher. "Diversify Your Workforce: Leveraging the Employer-College Connection." U.S. News & World Report. May 17, 2016.
- Gellman, Lindsay. "The Workers Who Say 'Thanks, but No Thanks' to Jobs." Wall Street Journal. July 14, 2015.

TEACHING EXPERIENCE
Guest Lecturer – Babes-Bolyai University, Cluj-Napoca, Romania, 2021
Department of Public Health – Spring MPH Level Global Health

- Presented an overview of fibroid epidemiology, public health impact, and research topics.
- Overview of a current research project: Trends in Hysterectomy in Hospital and Ambulatory Settings
in Kentucky 2008-2018

Guest Lecturer – University of California, Santa Barbara, CA, 2021
Cheadle Center for Biodiversity & Ecological Restoration – Spring NVS: EEMB 96 - Collections Curation
- Presented an overview of epidemiology, vector-borne and zoonotic diseases, public health impact, and select research topics.

Guest Lecturer – School of Public Health and Information Science, University of Louisville, KY, 2020
Department of Epidemiology and Population Health – Fall PHEP 301, Global Public Health.
- Presented an overview of fibroid epidemiology, public health impact, and research topics.
- Participant in a companion fibroid panel discussion.

Summer Program Educator – Heron Island Research Station, QLD, AUS, 2005
Department of Earth and Planetary Sciences hosts one-week summer sessions for middle school-aged girls for reef ecology instruction.
- Instructed students in best practices for specimen collection.
- Conducted field workshops on population estimation and reef management.
- Introduced students to topics related to indigenous and traditional uses of marine resources.

PROFESSIONAL EXPERIENCE

Graduate Research Assistant – Louisville, KY, 2020 - Present
The University of Louisville, School of Public Health and Information Science
Assist in pilot project program identifying geographic clusters and environmental correlates of colorectal and breast cancers in Kentucky.
Responsibilities include:
- Conduct literature reviews
- Collect and analyze data
- Prepare manuscripts and materials for submission to granting agency and publications

COVID-19 Communicable Disease Investigator, Center Lead, KY, 2020
Brooksource Staffing for Bullitt County Health Department
Lacuna Health for Louisville Metro Public Health & Wellness Department
Assist transition from local health department disease tracking to centralized state tracking
Counsel team disease investigators and contact tracers regarding appropriate practice, including:

- Document symptoms and hospitalization records of patients (if applicable)
- Assess patient and household needs
- Obtain a list of people with whom they've been in contact
- Inform employer and consul employer response

Corporate Archivist – Robert Half International, Louisville, KY, 2017 – 2019
Legal Service: Expert witness for high-profile lawsuit discovery collection, content, and method review.
- Provided independent party review of discovery documents of plaintiffs and defendants. Compiled searchable structure and verified content and accuracy of presented analysis.
- Authored comprehensive summary of findings that were utilized as evidence.
- May provide independent testimony as required by court orders.

Two-year placement with an international real estate investment company (REIT).
- Migrate and digitize corporate and legal documents, photographs, and site plans going back over 100 years.
- Created metadata and data collection structure.
- At the end of the contract, the company took over the management of its collection documents. In addition, a body of policy and procedures was created that could be amended easily as new laws and compliance guidelines are updated.

Talent Acquisition & Development – ArcelorMittal, Chicago, IL, 2007 – 2016
Division Manager (Promoted, 2014)
Consistently viewed as a Change Agent and Leader – especially regarding process improvement. Honored to serve on ArcelorMittal Leadership Development Council, a global leadership strategy team.
- Provided leadership and oversight for Talent Acquisition; Salaried Recruitment Process, Campus Partnership Program, and College Recruiting, Immigration, Relocation, and Learning & Development units.
- Managed multi-million-dollar budget, directed 9-person staff, and collaborated with HR teams from 13 plants/offices to ensure that hiring goals (quantity and quality) were met and processes aligned with company strategies.
- Prioritized myriad challenges in talent management in a heavily unionized workforce for a company operating in many countries. Implemented recruiting tactics that increased the diversity of the workforce.
- Oversaw learning and development programs for 4,000 employees. Managed policy updates and continuous education calendar.
- Ensured the company's reputation as a top employer through effective marketing and visibility at college and professional-level career fairs.
- Coordinated the organization's annual 'Case Competition' with Indiana University. Worked closely with competing student teams who developed real-world solutions to common recruiting challenges. This initiative provided another conduit between education and business to future leaders.

Process Manager (Promoted, 2012)

- Earned a broader role of directing college recruiting for four divisions (150 college graduates and 200 interns at 18 colleges). Led process improvement efforts which improved efficiencies and the company's brand. Shared best practices with other divisions. Oversaw marketing for college recruiting.

Representative (Promoted, 2009)
- Managed recruiting program for Flat Carbon division. Developed hiring and onboarding processes and tracked data. Improved interviewing capabilities by implementing new training plans, policies, and recruiting roles. Coordinated temporary relocation of 200 managers to five other sites.

- Developed and managed recruiting at 18 colleges. Recruited 300+ people annually while reducing redundancies and cutting yearly costs by $500K. Administrative Support (2007-2008).

VOLUNTEER EXPERIENCE

Bullitt County Cooperative Extension – Master Gardener and Horticulture Club**:** Assist in planning and staffing annual plant sale (2015-2019).

Kentucky Refugee Ministries - Adult Cultural Exchange and Escort for Social Services: Welcomed and oriented clients to their new community. Assisted with language skills and provided avenues to resources that would lead to self-sufficiency (2016-2018).

Bernheim Arboretum and Research Forest – Teamed with novice gardeners and horticulture experts to cultivate and maintain beautification initiatives in public spaces (2016-2017).

Elder Serve – Human Resources Volunteer: Contributed expertise in records and document management. Purged outdated/duplicate records; established documentation management to ensure compliance with HR laws and guidelines (2016).

YMCA (Newcomer Academy) – ESL Tutor: Guided middle and high school students with learning activities focused on English and Maths while helping them to integrate into American culture (2016).

Chicago Academy of Sciences (Peggy Notebaert Nature Museum) – Biological Collection Public Educator: Maintained the ornithology collection in a demonstration lab. Addressed questions on procedures and purpose of conservation and research collections (2007-2008).

Australian Museum – Biological Collection Volunteer: Species identification and preservation of small mammals and reptiles from field collection for the Australian Centre for Wildlife Genomics. Sydney, Australia (2006).

Hurstville Council Regional Museum – Exhibitions Volunteer: Researched the history/uses for objects in a medical instrument exhibition; created display descriptions and archive metadata. Hurstville, Australia (2005).

COUNCILS AND MEMBERSHIPS

Society for Epidemiologic Research 2021-Present

Graduate Student Council Representative – Department of Epidemiology and Population Health 2021-Present

American Alliance of Museums 2005-Present ICD