Declining Colectomy Rates for Nonmalignant Colorectal Polyps in a Large, Ethnically Diverse, Community-Based Population

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INTRODUCTION: **Despite studies showing improved safety, efficacy, and cost-effectiveness of endoscopic resection for nonmalignant colorectal polyps, colectomy rates for nonmalignant colorectal polyps have been increasing in the United States and Europe. Given this alarming trend, we aimed to investigate whether colectomy rates for nonmalignant colorectal polyps are increasing or declining in a large, integrated, community-based healthcare system with access to advanced endoscopic resection procedures.**

METHODS: **We identified all individuals aged 50–85 years who underwent a colonoscopy between 2008 and 2018 and were diagnosed with a nonmalignant colorectal polyp(s) at the Kaiser Permanente Northern California integrated healthcare system. Among these individuals, we identified those who underwent a colectomy for nonmalignant colorectal polyps within 12 months after the colonoscopy. We calculated annual colectomy rates for nonmalignant colorectal polyps and stratified rates by age, sex, and race and ethnicity. Changes in rates over time were tested by the Cochran-Armitage test for a linear trend.**

RESULTS: **Among 229,730 patients who were diagnosed with nonmalignant colorectal polyps between 2008 and 2018, 1,611 patients underwent a colectomy. Colectomy rates for nonmalignant colorectal polyps decreased significantly from 125 per 10,000 patients with nonmalignant polyps in 2008 to 12 per 10,000 patients with nonmalignant polyps in 2018 ($P < 0.001$ for trend). When stratified by age, sex, and race and ethnicity, colectomy rates for nonmalignant colorectal polyps also significantly declined from 2008 to 2018.**

DISCUSSION: **In a large, ethnically diverse, community-based population in the United States, we found that colectomy rates for nonmalignant colorectal polyps declined significantly over the past decade likely because of the establishment of advanced endoscopy centers, improved care coordination, and an organized colorectal cancer screening program.**

SUPPLEMENTARY MATERIAL accompanies this paper at http://links.lww.com/CTG/A792

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INTRODUCTION

Colorectal cancer (CRC) is the second leading cause of cancer death in the United States (US) (1). Randomized controlled trials have shown that screening reduces CRC incidence and mortality, primarily through the detection and removal of precancerous colorectal polyps (2–6). Nearly all polyps can be removed during routine colonoscopy; however, about 2%–15% of polyps detected on screening are complex (e.g., large, challenging location, or flat

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morphology) and may not be amenable to conventional polypectomy techniques (7). Although surgery has historically been a common option for complex colorectal polyps, recent advances in endoscopic resection techniques, such as endoscopic mucosal resection (EMR) and endoscopic submucosal dissection (ESD), have provided patients with alternative, less invasive, and more cost-effective options (8,9). Several studies have reported the safety and efficacy of EMR and ESD for complex colorectal polyps (9–14). In addition, repeat colonoscopy for patients directly referred for the surgical management of complex colorectal polyps has been shown to decrease the need for surgery, suggesting that many surgeries for these lesions can be avoided (15).

Despite growing evidence supporting endoscopic resection over surgical therapy, a recent US-based study using the National Inpatient Sample (NIS) database showed that colectomy rates for nonmalignant polyps actually *increased* significantly from 2000 through 2014 (16). This trend is particularly alarming, given the potential for avoidable surgery-associated morbidity, mortality, and costs associated with colectomies for these lesions (17–19). Although the NIS study provided important insights into national trends for the management of nonmalignant colorectal polyps, it was limited by reporting colectomy rates per 100,000 US adults, many of whom may not have undergone a colonoscopy. Thus, it remains unclear whether colectomy rates are indeed increasing over time among patients with nonmalignant colorectal polyps and whether interventions are needed to mitigate this concerning trend. The aim of this study was to examine annual colectomy rates for nonmalignant colorectal polyps between 2008 and 2018 in a large, ethnically diverse, integrated, community-based healthcare system with full access to advanced endoscopic resection techniques.

METHODS

Study design, setting, and oversight

This retrospective cohort study was conducted among members of Kaiser Permanente Northern California (KPNC), an integrated healthcare organization that serves approximately 4.5 million members across 22 medical centers in urban, suburban, and semirural regions throughout Northern California, representing roughly 25% of the surrounding population. Its membership demographics closely approximate the diverse underlying population in Northern California, as compared with the census demographics, including members with Medicare, Medicaid, and commercial insurance (20).

KPNC started a regional advanced endoscopic resection referral center in 2010 for complex lesions in the gastrointestinal tract (including the colon and rectum). This referral center was started in San Francisco (California) in 2010 and expanded to the greater Sacramento region (California) in 2012. Like other advanced endoscopy centers in the United States, these 2 centers absorbed referrals from gastroenterologists and surgeons across the 22 medical centers and provided advanced resection services such as EMR and ESD. This study was approved by the KPNC institutional review board.

Study eligibility criteria

Individuals were eligible for the study if they were KPNC health plan members, aged 50–85 years, underwent a colonoscopy between January 1, 2008, and December 31, 2018, were diagnosed with ≥1 nonmalignant colorectal polyp using a systematized nomenclature of medicine codes (see Supplementary Tables 1 and 2, http://links.lww.com/CTG/A792), and had ≥1 year of membership enrollment before the colonoscopy. We excluded individuals who had a prior total colectomy. Among eligible individuals, we identified those who underwent a colectomy using International Classification of Disease ninth and tenth edition procedure codes and Current Procedural Terminology codes (see Supplementary Table 3, http://links.lww.com/CTG/A792) within 12 months after the colonoscopy. To ensure that the colectomy was for a nonmalignant colorectal polyp rather than for another indication, we excluded those who had intestinal perforation, inflammatory bowel disease, diverticulitis, or CRC before or at the time of the colectomy (see Supplemental Tables 4 and 5, http://links.lww.com/CTG/A792). Given that a CRC diagnosis can be delayed at the time of colectomy or at discharge, we ascertained any CRC diagnosis 6 months after the colectomy date using KPNC's Cancer Registry. To confirm the accuracy of our approach in assigning colectomy indication (i.e., nonmalignant colorectal polyp), we manually reviewed a random subset of 100 colectomies and found a positive predictive value of 98.0% and a misclassification rate of 2.0%.

Outcomes measured

The primary outcome was colectomy among patients who underwent a colonoscopy and were diagnosed with a nonmalignant colorectal polyp; we determined colectomy rates annually. As some patients had multiple colonoscopies in a calendar year, we used the first colonoscopy with a nonmalignant colorectal polyp diagnosis in each year as the anchoring date and identified any subsequent colectomies within 12 months after the diagnosis date. If a colectomy was performed in a subsequent calendar year (e.g., 2012) but within 12 months of the polyp diagnosis (e.g., 2011), we assigned the colectomy to the year of the polyp diagnosis (e.g., 2011).

Statistical analysis

Descriptive statistics were used to describe demographic and clinical characteristics of the cohort overall and by colectomy status. We tested statistical significance with the χ^2 test for categorical variables and the t test or Wilcoxon signed-rank test for continuous variables. We calculated annual colectomy rates by dividing the number of colectomies performed for a nonmalignant colorectal polyp by the number of distinct patients with a nonmalignant colorectal polyp diagnosis each year. We also calculated colectomy rates stratified by age groups (i.e., 50–59, 60–69, and ≥70 years), sex, and race and ethnicity. Changes in rates over time were tested by the Cochran-Armitage test for a linear trend. All analyses were performed using SAS software, version 9.4 (SAS institute, Cary, NC), and a 2-sided *P* value of less than 0.05 was considered significant.

RESULTS

We identified 229,730 patients with nonmalignant colorectal polyps diagnosed by colonoscopy during the study period, of whom 1,611 (0.7%) underwent a colectomy. Demographic and clinical characteristics of the cohort overall and by colectomy status are summarized in Table 1. Compared with patients who did not undergo a colectomy for a nonmalignant colorectal polyp,

Table 1. Demographic characteristics of adult patients diagnosed with nonmalignant colorectal polyps (2008–2018)

Characteristic	Total patients with a nonmalignant colorectal polyp diagnosis	No colectomy after nonmalignant colorectal polyp diagnosis	Colectomy after nonmalignant colorectal polyp diagnosis	*P* Value
N	229,730	228,119	1,611	
Age, yr				
Mean (SD)	63.49 (8.4)	63.5 (8.4)	66.7 (8.6)	<0.0001[a]
Median (IQR)	63.0 (57.0–70.0)	63.0 (57.0–70.0)	67.0 (61.0–73.0)	<0.0001[b]
Sex, n (%)				<0.0001[c]
Female	101,745 (44.3)	100,922 (43.9)	823 (51.1)	
Male	127,985 (55.7)	127,197 (55.4)	788 (48.9)	
Race and ethnicity (%)				<0.0001[c]
White	136,873 (59.6)	135,824 (59.5)	1,049 (65.1)	
Black	15,285 (6.7)	15,107 (6.6)	178 (11.1)	
Hispanic	29,563 (12.9)	29,395 (12.9)	168 (10.4)	
Asian	34,256 (14.9)	34,129 (15.0)	127 (7.9)	
Others	13,753 (6.0)	13,664 (6.0)	89 (5.5)	
Charlson comorbidity score				<0.0001[c]
0	123,177 (53.6)	122,385 (53.7)	792 (49.2)	
1	44,456 (19.4)	44,159 (19.4)	297 (18.4)	
≥2	62,097 (27.0)	61,575 (27.0)	522 (32.4)	

IQR, interquartile range.
[a]Student *t* test.
[b]Wilcoxon test.
[c]χ^2 test.

patients who underwent colectomy were more likely to be older (median age 67.0 vs 63.0 years, $P < 0.0001$), female in sex (51.1% vs 43.9%, $P < 0.0001$), White (65.1% vs 59.5%, $P < 0.0001$), and Black (11.1% vs 6.6%, $P < 0.0001$). In addition, patients who underwent colectomy for a nonmalignant colorectal polyp had a higher Charlson comorbidity score of 2 or higher (32.4% vs 27.0%, $P < 0.0001$) compared with patients who did not undergo a colectomy.

As summarized in Table 2, the number of patients with a nonmalignant colorectal polyp diagnosis steadily increased between 2008 and 2018, whereas annual colectomy rates steadily declined (Table 2 and Figure 1). Specifically, the colectomy rate was 125 per 10,000 individuals (1.25%) in 2008 and declined to 12 per 10,000 (0.12%) in 2018 ($P < 0.001$ for trend).

Stratified by age (Figure 2a), colectomy rates were 0.92%, 1.26%, and 1.61% in 2008 among those aged 50–59, 60–60, and ≥70 years, respectively, and declined to 0.15%, 0.12%, and 0.11%, respectively, in 2018 ($P < 0.001$ for trend). Stratified by sex (Figure 2b), colectomy rates in 2008 were 1.58% and 1.02% in women and men, respectively, and declined to 0.19% and 0.08%, respectively, in 2018 ($P < 0.001$ for trend). Stratified by race and ethnicity (Figure 2c), in 2008, colectomy rates were 1.89%, 1.38%, 1.10%, and 0.67% for Blacks, Whites, Asians, and Hispanics, respectively, and declined to 0.19%, 0.16%, 0.08%, and 0.02%, respectively, in 2018 ($P < 0.001$ for trend).

To assess the impact of establishing an advanced endoscopy referral center in 2010 on colectomy rates, we re-evaluated colectomy rates starting in 2010–2018. Like the main analyses, colectomy rates significantly declined since the establishment of an advanced endoscopy referral center. The colectomy rate was 115 per 10,000 individuals (1.15%) in 2010 and declined to 12 per 10,000 (0.12%) in 2018 ($P < 0.001$ for trend).

DISCUSSION

In a large, community-based population, we found a steady increase in the number of patients with nonmalignant colorectal polyps diagnosed by colonoscopy during the study interval, whereas colectomy rates for these lesions declined significantly. This decline over time was seen across age groups, among men and women, and across racial and ethnic groups.

Our results contrast with 2 recent studies from the United States and the Netherlands reporting rising or stable colectomy rates for nonmalignant colorectal polyps over time. Using the NIS database, Peery et al. (16) found that colectomy rates for nonmalignant colorectal polyps increased substantially (approximately 50%) from 5.9 per 100,000 adults in 2000 to 9.4 per 100,000 in 2014. In a Dutch study, Bronzwaer et al. (21) reported a 25% decline in colectomy rates for benign colorectal polyps, from 370 per 100,000 colonoscopies in 2005 to 260 per 100,000 in 2015. Although these studies provide important insights into the global trends for colectomy rates after a nonmalignant colorectal polyp diagnosis, comparing rates across studies is hampered by differences in denominator populations. In this study, we calculated rates per 10,000 individuals diagnosed with a nonmalignant colorectal polyp, whereas the NIS study reported rates per 100,000

Table 2. Colectomy rates after a nonmalignant colorectal polyp diagnosis by year (2008–2018)

Year	No. of patients with a nonmalignant colorectal polyp diagnosis	No. of colectomies after a nonmalignant colorectal polyp diagnosis	Colectomy rate among patients with a nonmalignant colorectal polyp diagnosis (%)
2008	18,130	227	1.25
2009	19,393	215	1.11
2010	20,174	232	1.15
2011	21,534	206	0.96
2012	22,840	197	0.86
2013	24,916	172	0.69
2014	26,892	122	0.45
2015	30,757	88	0.29
2016	33,076	62	0.19
2017	36,738	41	0.11
2018	39,582	49	0.12

adults; the latter may be a less useful denominator, given not every adult in the United States undergoes a colonoscopy. The Dutch study calculated rates per 100,000 colonoscopies but was unable to link their colonoscopy database with pathology findings, and therefore, it remains unclear how many of these individuals who underwent colonoscopy had polyps.

Interestingly, we found a steady rise in the number of patients diagnosed with a nonmalignant colorectal polyp during our study period. We suspect a few reasons for this finding. First, in 2008, we established an organized CRC screening program, which consisted of annual mailed FIT outreach and opportunistic screening colonoscopy, for all average-risk adults aged 50–75 years (6). As previously reported, we found a significant rise in the number of patients up to date with current screening recommendations because of this organized CRC screening program, from 45% in 2006 to over 80% by 2011 (6). This increase in screening rates over time likely contributed to the corresponding rise in the number of polyps detected per year. Second, colonoscopy rates for all indications (i.e., screening postpolypectomy surveillance and diagnostic) have increased in our population over the study period, as previously published (22), which creates more opportunities to diagnose nonmalignant polyps. Finally, like previous studies (23,24), we have found increasing adenoma detection rates over time in our population.

There are several factors that likely contributed to the decline in colectomy rates in our study. In 2010, KPNC established an advanced endoscopy referral center in San Francisco, California; this allowed gastroenterologists and surgeons across the Northern California region to refer complex colorectal polyps for evaluation and treatment by highly specialized endoscopists skilled in advanced imaging and endoscopic resection techniques (e.g., EMR and ESD). When we shifted our analyses to reflect the year (i.e., 2010), we established our advanced endoscopy referral center; we also found a significant decline in colectomy rates over time. Several studies have demonstrated that the referral of complex colorectal polyps to high-volume, advanced endoscopic resection centers is effective in improving EMR completion rates, reducing neoplasia recurrence rates and avoiding unnecessary surgical management of these benign lesions (25–27). Another important contributor to the declining colectomy rates in our cohort is the organized CRC screening program at KPNC, which was implemented in 2008 (6). With increased screening, prevalent polyps within the screening population, including complex ones, would be detected earlier (before becoming more complex) and removed. Thus, with succeeding years, there would be fewer prevalent polyps to detect and those being detected would largely

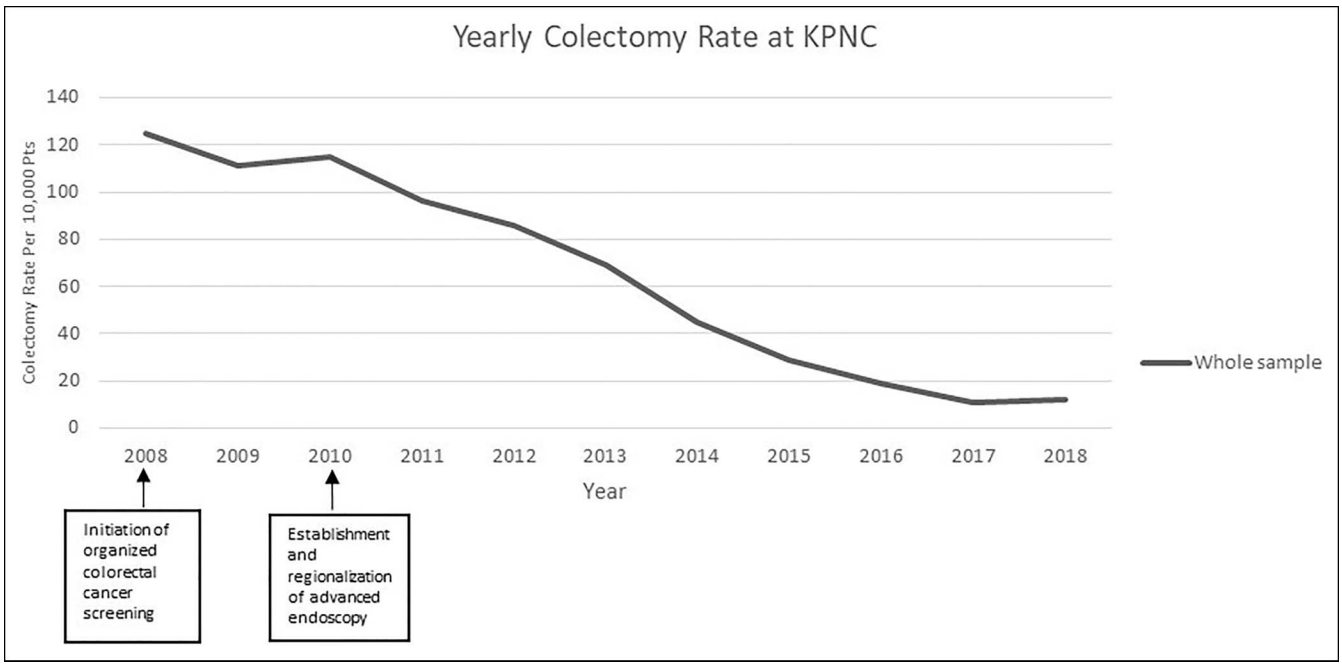

Figure 1. Annual colectomy rates after a nonmalignant colorectal polyp diagnosis between 2008 and 2018.

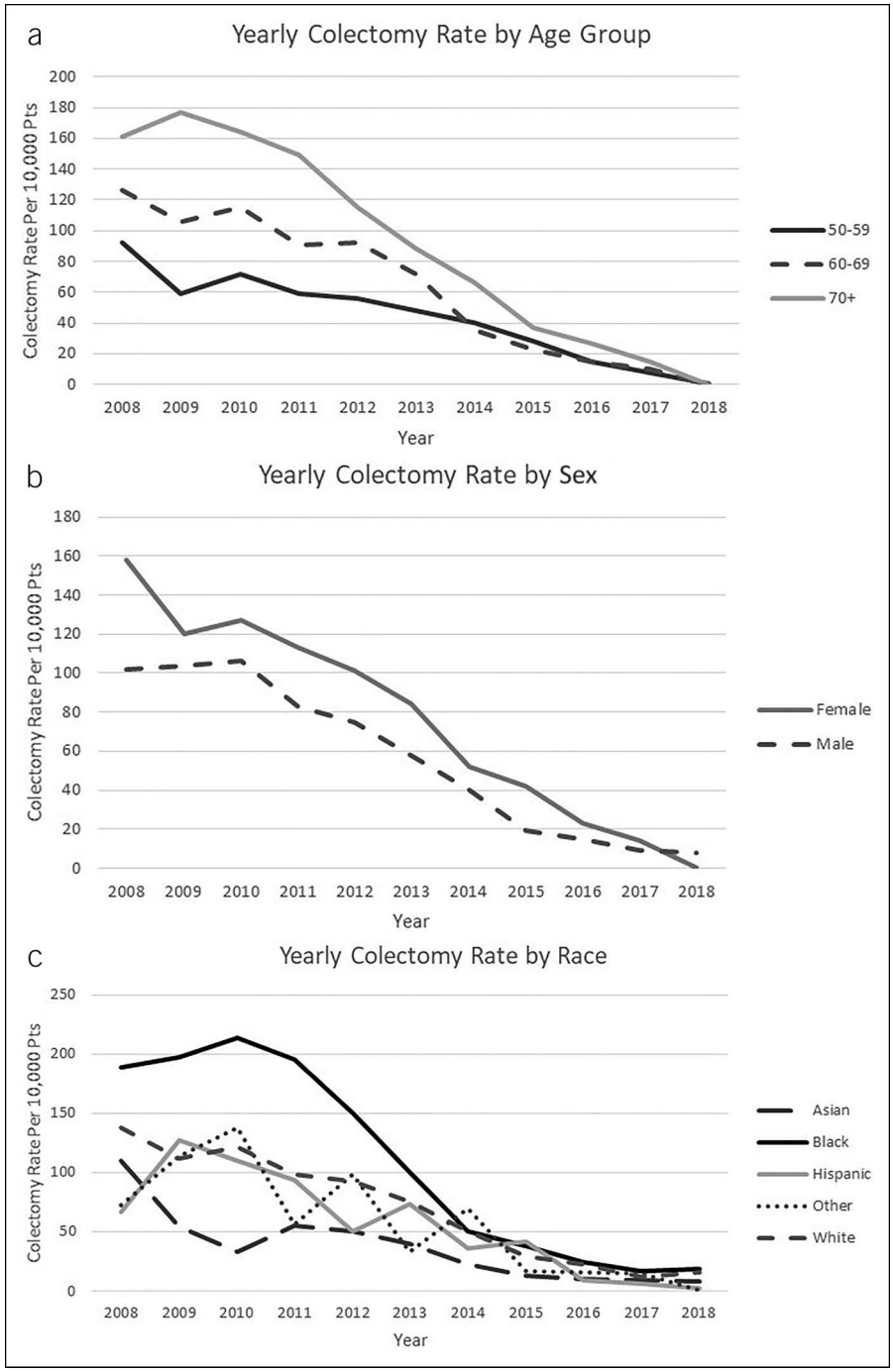

Figure 2. Annual colectomy rates after a nonmalignant colorectal polyp diagnosis between 2008 and 2018, stratified by age, sex, and race and ethnicity.

represent incident (new) cases. With fewer complex polyps over time, the need for surgical intervention would expect to be less. Finally, an integrated healthcare system also likely contributed to the decline in colectomy rates in our study population. In integrated healthcare systems, emphasis is placed on greater care coordination between primary care physicians, gastroenterologists, and surgeons to enhance the quality and cost-effectiveness of medical care. In addition, integrated healthcare systems (e.g., Veteran Affairs and Kaiser Permanente) can be financially structured to favor endoscopic approaches over surgical treatment for the same disease process.

There are several strengths to our study. Our study population was drawn from a diverse, broad geographic region in Northern California that is representative of the population in this region (20). We were able to accurately capture the total number of individuals diagnosed with colorectal polyps each year and ascertain colectomies performed for this indication. Our calculation of colectomy rates was based on the entire study population rather than a sample, as previously reported (16,21). We were also able to calculate precise colectomy rates based on the denominator of individuals with a polyp diagnosis rather than those who underwent a colonoscopy or the overall population.

There are also limitations worth noting. First, our cohort represents patients from a large, community-based integrated healthcare delivery system, which may limit the generalizability of our findings. Although the proportion of individuals in the United States covered in a Healthcare Maintenance Organization or integrated healthcare delivery system (e.g., Veteran Affairs, Geisinger Health System, Harvard Pilgrim, and Mount Sinai Health System) was traditionally small, this has changed dramatically over the past 2 decades. With changes in healthcare environment compelled by drivers such as the Affordable Care Act and industry consolidation, a majority of US citizens are now in broad health delivery systems similar to KPNC rather than the traditional fee-for-service and hospital-based health care. Thus, understanding the research question in this study is not only highly appropriate to today's environment but also likely to be more informative as time moves forward. In addition, this study highlights what is possible when a health system becomes more integrated and care coordination is the primary focus on delivering patient-centric care. Second, we were unable to review each colectomy case to determine exactly why the lesion was referred for a colectomy and/or not amenable to endoscopic resection. Third, we were unable to ascertain specific procedural codes to differentiate between advanced endoscopic resection procedures (such as EMR and ESD) and conventional polypectomy in our system; thus, we were unable to quantify EMR and ESD trends for nonmalignant colorectal polyps during our study period. Fourth, although we found evidence of misclassification during our chart review validation, it was small (i.e., 2%), and the true colectomy rates for nonmalignant colorectal polyps would likely be lower based on how they were misclassified. However, we believe any misclassification will be nondifferential across each year. Finally, we did not evaluate the sensitivity of our administrative codes for capturing colectomies; however, previous studies have used these codes to capture colectomies for various indications including adenomas and have reported high accuracy rates (16–19,21).

Our study shows that in a large, community-based population, colectomy rates after a nonmalignant colorectal polyp diagnosis declined over time, and the trend was seen across age, sex, and racial and ethnic groups. This study provides reassuring evidence that colectomy rates for nonmalignant colorectal polyps can decrease over time in healthcare delivery systems that become more integrated and care coordination is the focus in healthcare delivery. Further research is needed to evaluate whether this trend is seen in other integrated healthcare settings and understand why nonmalignant colorectal polyps are referred for colectomies in all types of healthcare settings.

CONFLICTS OF INTEREST

Guarantor of the article: Jeffrey K. Lee, MD, MPH.

Specific author contributions: Study concept and design: A.A., C.M., S.F.J., C.D.J., F.S.V., E.S.B., K.H.W., C.H.M,. D.A.C., and J.K.L. Acquisition of data: A.A. and S.F.J. Analysis and interpretation of data: all authors. Drafting of the manuscript: A.A., C.D.J., and J.K.L. Critical revision of the manuscript for important intellectual content: all authors. Approval of the final manuscript: all authors. Guarantor of Article: A.A. and J.K.L.

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Study Highlights

WHAT IS KNOWN

- ✓ A subset of nonmalignant colorectal polyps are not amenable for removal by conventional polypectomy.
- ✓ Endoscopic mucosal resection and endoscopic submucosal dissection have been shown to be effective, safe, and cost-effective compared with surgery for the management of complex nonmalignant colorectal polyps.
- ✓ However, recent reports have highlighted increasing colectomy rates for nonmalignant colorectal polyps.

WHAT IS NEW HERE

- ✓ We show a decline in colectomy rates for nonmalignant colorectal polyps in a large, ethnically diverse, community-based population from 2008 to 2018.
- ✓ When stratified by age, sex, and race and ethnicity, colectomy rates for nonmalignant colorectal polyps also declined from 2008 to 2018.

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