



Colonoscopy utilization in rural areas by general surgeons: An analysis of the National Ambulatory Medical Care Survey

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ABSTRACT

Background: One in three adults above 50 years old have not been screened for colorectal cancer as of 2013.¹ Rural areas have even lower screening and have more general surgeons compared to gastroenterologists,² offering surgeons as a reservoir for necessary services.

Methods: Public data from the 2006–2015 CDC National Ambulatory Medical Care Survey was analyzed using SAS. Number of colonoscopies performed by rural general surgeons, family medicine practitioners, and other specialties were compared to their urban counterparts.

Results: 21.91% of rural colonoscopies were performed by general surgeons, whereas 32.87% were performed by family medicine practitioners and 45.22% by other specialties including gastroenterologists. Rural general surgeons performed a greater percentage of annual rural colonoscopies than urban general surgeons ($p < 0.05$).

Conclusion: General surgeons are fulfilling the need for colonoscopy in rural areas. Improvements to current colonoscopy training guidelines are imperative, especially for physicians who practice in rural areas.

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Introduction

Colorectal cancer is currently the second leading cause of cancer-related death in the United States.³ The advantages of colorectal cancer screening have been extensively investigated. Colonoscopies currently have the highest sensitivity and specificity for screening for colorectal cancer.⁴ A case-control study performed by Baxter et al. (2012) demonstrated that colonoscopy is associated with a reduced risk for colorectal cancer.⁵ U.S. Preventative Task Force (USPTF) guidelines recommend that adults from age 50–75 years should receive a colonoscopy.⁴ However, 41.8 million people over the recommended age of 50 were not screened in 2004 for colorectal cancer.⁶ This disparity disproportionately affects people in rural areas. While 54% of urban residents reported colorectal cancer screening from 1998 to 2005, only 45% of rural patients reported screening.⁷ Studying the availability of health services in rural compared to urban areas demonstrates that a key explanation for this disparity is lack of geographical access to care, leading to

more patients with unstaged cancer in rural regions.⁸ There is a clear unmet need for colorectal screening in rural areas.^{1,2}

The lack of preventative care provided in rural areas is associated with a paucity of providers. Rural residency is related to a decrease in density of colonoscopy providers such as gastroenterologists and general surgeons, leading to longer wait time and increased travel distances.⁸ While there are only 0.39 gastroenterologists per 100,000 people in rural counties, there are 4.8 general surgeons per 100,000 people.² This increased density, and the capability of general surgeons to offer colonoscopies, creates a supply for the demand of rural colonoscopy screening. As gastroenterologists decrease in number, the proportion of general surgery practice comprised of colonoscopies rises.⁹ Due to the decreased physician availability in rural settings, endoscopic procedures make up much of surgical practice in rural hospitals.^{10–13} This is particularly striking in comparison to their urban counterparts; rural surgeons perform five times more colonoscopies than those in urban areas.¹⁴ In communities where rural surgeons are more available than other practitioners, these surgeons are meeting the burden of unmet need for colon cancer screening.

While it is generally believed that general surgeons pick up a large burden of screening colonoscopies in rural areas of the United States, there has not been any national level data to support this

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conclusion. This is mainly due to the lack of reliable, nationally representative databases dedicated to endoscopic procedures that have geographic, specialty, and procedural information. However, there are national level databases of outpatient care and procedures that can be used for this data.

In this study we used data from one such database, the National Ambulatory Medical Care Survey (NAMCS) collected by the Centers for Disease Control and Prevention (CDC), to compare 1) the proportion of colonoscopies performed by general surgeons, family medicine practitioners and other specialties in rural areas and 2) the percentage of colonoscopies performed by general surgeons in rural and urban areas. We hypothesize that general surgeons will conduct a significantly higher proportion of colonoscopies than other specialties in rural areas as well as compared to their urban counterparts.

Methods

To identify outpatient data regarding colonoscopy administration, we used the NAMCS data made available by the CDC for the years 2006–2015. Since reporting methods were not consistent throughout the annual datasets, isolation of colonoscopies was adapted accordingly. From 2006 to 2012, colonoscopies were identified using the CPT and ICD-9 procedure codes outlined in [Table 1](#).

For 2012–2015, the codes from [Table 1](#) were still used, however, a colonoscopy indicator made available in the data (only 2012 onwards) was also utilized to identify colonoscopies. A breakdown of the colonoscopies identified by year and either CPT code, ICD-9 code, or the colonoscopy indicator variable is outlined in [Table 2](#). Observations containing both a CPT or ICD-9 code from [Table 1](#) and a positive colonoscopy indicator were counted as a single colonoscopy. Starting in 2012, the majority of the colonoscopy data was restructured into the aforementioned colonoscopy variable, and CPT and ICD-9 codes were not as prominent in identifying colonoscopies.

Next, we explored the various specialty types for the identified colonoscopies. Physician specialties were encoded in the original data into one of the following categories: general/family medicine, internal medicine, pediatrics, general surgery, obstetrics and gynecology, orthopedic surgery, cardiovascular, dermatology, urology, psychiatry, neurology, oncology, ophthalmology, otolaryngology, and other specialties. Gastroenterology was not available as a separate category. Therefore, we chose to separate out general surgery and general/family medicine into their own categories and combined the rest into a third category called “all other specialties”.

To identify urban and rural areas, metropolitan statistical areas (MSA) status was used to identify practices as belonging to either a metropolitan statistical area (urban) or a non-MSA (rural). MSAs are geographical regions defined by high population density. Insurance

Table 2
Breakdown of colonoscopies identified by year and code type.

Year	ICD-9	CPT	COLON
2006	271		
2007	212		
2008	253		
2009	341		
2010	251		
2011	260	1	
2012	21	5	849
2013	24	2	834
2014	4	3	770
2015	4	1	226

coverage for the colonoscopies was also analyzed using the payment type variables in the data. Each colonoscopy was grouped into one of the following categories: Medicare, Medicaid, commercial, self-pay, or unknown. Since Medicare and Medicaid enrollees also purchase supplemental insurance plans to reduce out-of-pocket expenses, colonoscopies that were listed as covered under multiple plan types were counted only under the Medicare or the Medicaid group.

The data were then analyzed on a bi-annual and an aggregate basis from 2006 to 2015 using the three physician specialty categories and the urban/rural status. The data were grouped bi-annually to comply with the data recommendations provided by the CDC to ensure a sample size of greater than 30 colonoscopies for each urban and rural sample. The data were also weighted using patient weights provided in the dataset and all weighted estimates analyzed had relative standard errors <30%, a benchmark set by the CDC to consider the data reliable. Patient demographics, differences in proportions of colonoscopies performed by general surgeons in urban versus rural areas, and the likelihood of colonoscopies performed by general surgeons in rural areas were all computed using weighted estimates and standard errors in SAS. Graphs were generated using Microsoft Excel. All results with p-value < 0.05 were considered statistically significant.

Results

The demographic characteristics of the urban and rural population samples identified as having undergone colonoscopies are not statistically different in terms of average age, distribution of age groups, gender, and insurance coverage ([Table 3](#)). In order to ensure that the average age was not skewed due to age distribution differences between urban and rural areas, identified colonoscopies were also categorized into different age brackets and the relative proportions by age groups were compared among the urban and rural samples, as shown in [Table 3](#).

Table 1
CPT and ICD-9 codes used to identify colonoscopies in the NAMCS data.

Code	Type	Description
45378	CPT	Colonoscopy
45380	CPT	Colonoscopy
45381	CPT	Colonoscopy
45382	CPT	Colonoscopy
45383	CPT	Colonoscopy
45384	CPT	Colonoscopy
45385	CPT	Colonoscopy
4522	ICD-9	Endoscopy of large intestine through artificial stoma
4523	ICD-9	Colonoscopy
4542	ICD-9	Endoscopic polypectomy of large intestine
4543	ICD-9	Endoscopic destruction of other lesion or tissue of large intestine

Table 3
Demographic comparison of patients identified as having undergone a colonoscopy in urban and rural populations.

	Rural	Urban	Difference (Rural - Urban)	95% Confidence Interval		P-Value
				Lower CL	Upper CL	
Average Age (years)	58.1	58.8	-0.7	-3.6	2.3	0.6493
Distribution of Age Groups						
Under 15 Years	0.60%	0.29%	0.31%	-0.35%	0.97%	0.3509
15–24 Years	2.82%	1.02%	1.79%	-0.73%	4.32%	0.1634
25–44 Years	8.99%	9.84%	-0.85%	-4.13%	2.42%	0.6097
45–64 Years	53.21%	55.80%	-2.59%	-11.94%	6.76%	0.5867
65–74 Years	22.16%	21.93%	0.23%	-4.59%	5.04%	0.9259
75 Years and Over	12.23%	11.12%	1.11%	-6.06%	8.28%	0.7616
Gender						
Female	53.99%	56.65%	-2.66%	-12.17%	6.84%	0.5829
Male	46.01%	43.35%	2.66%	-6.84%	12.17%	0.5829
Payment Type						
Commercial	56.04%	57.28%	-1.25%	-11.62%	9.12%	0.8137
Medicaid	4.57%	6.32%	-1.75%	-5.15%	1.66%	0.3149
Medicare	34.05%	30.51%	3.54%	-6.46%	13.53%	0.4881
Other/Unknown	4.15%	4.44%	-0.29%	-3.20%	2.62%	0.8464
Self-Pay	1.19%	1.44%	-0.25%	-1.79%	1.28%	0.7455

Weighted frequencies of colonoscopies by specialty type, bi-annual year grouping, and urban/rural status is presented in Table 4. Our sample represented a total of 115,262,467 weighted urban colonoscopies and 11,590,768 weighted rural colonoscopies between 2006 and 2015. Of the 115,262,467 urban colonoscopies, only 3,568,083 (3.10%) were performed by general surgeons, whereas 2,540,014 (21.91%) of the 11,590,768 rural colonoscopies were performed by general surgeons. The bi-annual absolute and percentage trends for the aggregate proportions are shown in Fig. 1 and Fig. 2. As seen in Fig. 1, even on a bi-annual basis, colonoscopies performed by general surgeons comprised of a significant proportion of total colonoscopies in rural areas (17.42%–30.54%) relative to urban areas (2.21%–3.81%). The difference in proportions of colonoscopies performed by general surgeons in rural and urban areas is statistically significant over the 10-year analysis period (18.82%, 95%CI: 9.65–27.98, P = 0.0001) and two of the five bi-annual periods (2010–11 – 17.38%, 95%CI: 3.14–31.62, P < 0.02,

2012–13 – 27.92%, 95%CI: 13.62–42.22, P = 0.0001) (Table 5). Table 6 shows odds ratio representing the likelihood of a colonoscopy being performed by a general surgeon in a rural area relative to an urban area. According to our 10-year analysis period, a colonoscopy performed by a general surgeon is 5.99 times more likely to be performed in a rural area than in an urban area (95%CI: 3.61–9.92, P < 0.0001). The bi-annual estimates of the odds ratio range from 2.83 to 9.95 and all odds ratio estimates were statistically significant, except for the estimate for 2014–2015 (Table 6).

Lastly, Fig. 3. A and B show the stark contrast in the aggregate distributions of colonoscopies performed by specialty types in rural and urban areas between for the 10-year analysis period.

Discussion

This study is the first analysis of the NAMCS database's information on colonoscopy procedures. The results of our study show

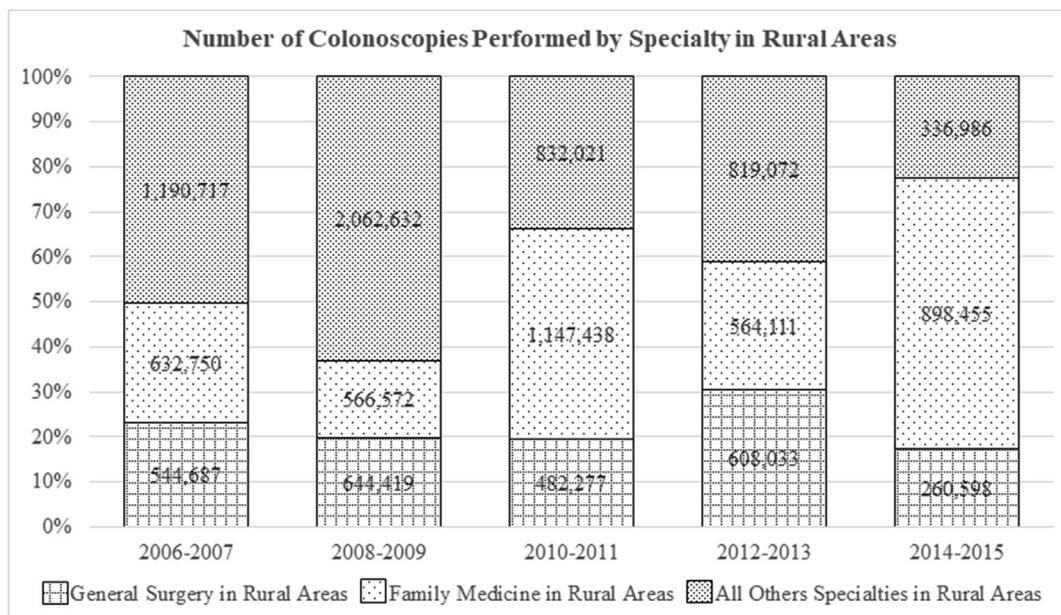


Fig. 1. Absolute number of colonoscopies performed by each specialty in rural areas on a bi-annual basis from 2006 to 2015, grouped on recommendation from the CDC. N = Total number of colonoscopies performed by all rural specialties.

Table 4
Weighted frequency of colonoscopies performed by each specialty in rural and non-rural areas per year from 2006 to 2015.

Years	Urban			Rural		
	General Surgery	Family Practice	All Others	General Surgery	Family Practice	All Others
2006–2007	607,881	3,026,182	12,324,397	544,687	632,750	1,190,717
2008–2009	769,105	4,994,048	19,215,686	644,419	566,572	2,062,632
2010–2011	488,053	2,433,569	19,173,116	482,277	1,147,438	832,021
2012–2013	585,006	2,255,017	19,543,689	608,033	564,111	819,072
2014–2015	1,118,038	4,858,135	23,870,545	260,598	898,455	336,986
Total	3,568,083	17,566,951	94,127,433	2,540,014	3,809,326	5,241,427

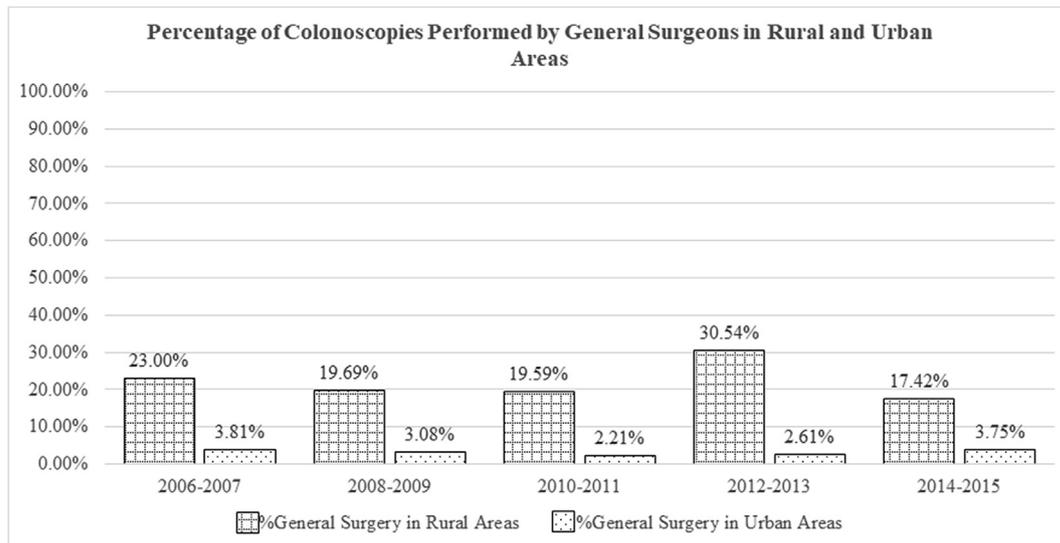


Fig. 2. Bi-annual trend of colonoscopies performed by surgeons in rural and urban areas.

that there is a greater burden for general surgeons performing colonoscopies in rural areas compared to other specialties in those areas. Of all rural colonoscopies conducted from 2006 to 2015, 41% were performed by general surgeons compared to 22% by family medicine practitioners and 37% by all other specialties (Fig. 3, A). In the years 2006, 2008, 2011, and 2015 specifically, more than 50% of colonoscopies recorded were performed by general surgeons.

We have also found that rural general surgeons conduct more colonoscopies compared to urban general surgeons. From 2006 to 2015, only 9% of total colonoscopies in urban areas were administered by general surgeons (Fig. 3, B). Annual trends showed that general surgeons consistently performed a significantly greater percentage of total rural colonoscopies than urban colonoscopies ($p < 0.05$) (Fig. 2). Furthermore, a general surgeon is 5.99 times more likely to perform a colonoscopy in a rural area compared to an urban area (Table 6).

One explanation for this data is an ongoing decline in rural gastroenterologist density. For instance, rural counties in South Carolina lost 10 gastroenterologists over a ten-year period whereas urban counties gained 17. The same study that discovered this also noted urban colonoscopy centers were 1.5 times more likely to have **gastroenterologists than rural centers**.¹⁵ The lack of gastroenterologists available in rural areas to perform colonoscopies transfers the burden to available general surgeons in the area. Mean density of gastroenterologists is 0.39 per 100,000 people in rural counties whereas mean density of general surgeons is 4.82 per 100,000 people in rural counties,² creating a workforce of available colonoscopy providers.

Other studies support our results. In a national survey of general surgeons, 42% of rural surgeons reported performing more than

200 procedures annually, compared to 12% of nonrural surgeons.¹⁶ Studies similar in method have been performed using patient databases on state levels and have discovered the same pattern; analyzing patient discharge records in South Carolina from 2001 to 2010 demonstrated rural surgeons have higher annual colonoscopy volumes than urban surgeons.¹⁷ This conclusion has been seen in West Virginia¹¹ and the Dakotas.¹² However, our study took a different approach by 1) focusing on an outpatient national database rather than physician surveys and 2) comparing the numbers of colonoscopies performed by other providers in rural and urban areas. Choosing a publicly available outpatient database rather than data from single or multiple institutions provides a more nationally representative view of everyday non-emergent preventative and diagnostic practice.

Our analysis also yielded that family medicine practitioners provide more colonoscopies in urban areas (17%) than general surgeons (9%), but this finding was not replicated in rural locales where family medicine performed 22% of colonoscopies compared to general surgery's 41% (Fig. 3A and B). The rural data seems reflective of nationwide trends; 10.8% of national colonoscopies were performed by general surgeons while 0.8% were performed by family practitioners.¹⁸ The American Academy of Family Physicians reports that 6.7% of rural family physicians perform colonoscopies as of 2012.¹⁹ No other data exists outside of our study on how many colonoscopies are performed by family physicians in rural areas, and it remains to be seen why rural general surgeons appear to be conducting more than family practitioners.

Interestingly, colonoscopies are not the only procedures rural surgeons pick up from other practitioners. Specialty procedures such as obstetric, gynecologic, and orthopedic account for >20% of

Table 5

Difference in relative proportions of colonoscopies performed by general surgeons in urban and rural areas from 2006 to 2015.

Years	Rural	Urban	Difference (Rural - Urban)	95% Confidence Interval		P-Value
				Lower CL	Upper CL	
2006–2007	23.00%	3.81%	19.19%	–0.17%	38.55%	0.0520
2008–2009	19.69%	3.08%	16.61%	–3.19%	36.40%	0.1002
2010–2011	19.59%	2.21%	17.38%	3.14%	31.62%	0.0168
2012–2013	30.54%	2.61%	27.92%	13.62%	42.22%	0.0001
2014–2015	17.42%	3.75%	13.67%	–1.98%	29.32%	0.0868
Total	21.91%	3.10%	18.82%	9.65%	27.98%	0.0001

rural surgical procedures excluding endoscopies.²⁰ Another study following surgeons practicing in rural cities found that 28.3% of cases were endoscopies and 20.6% were gynecological procedures.²¹ These findings harken to the study by Aboagye et al. (2014); with the reduced density of many specialty providers in rural areas, there is an increase in reliance on general surgeons to provide certain services. The question remains whether general surgeons are trained appropriately for the volume of the different procedures they must perform.

In a national survey, 63% of rural surgeons felt they needed more training in endoscopy before beginning practice, whereas 46% of non-rural surgeons agreed.¹⁵ When asked what skill they would most like to improve, rural surgeons expressed interest in acquiring more skills in colonoscopy and advanced techniques.²² 87% of rural surgeons report that current residency programs do not adequately prepare them for rural surgical practice.²³ In comparison with their urban colleagues, rural surgeons feel they need more training in endoscopy; one study reports that rural surgeons have a 16.2% greater perceived need for endoscopic training and performed 2.87 as many colonoscopies as urban surgeons.²⁴ This inequity is concerning. If rural surgeons do not feel prepared for the evident demand for colonoscopies present in rural communities, it is imperative to train them to improve their comfort and confidence. Increasing and improving training requirements for general surgeons may be key to increasing colonoscopy coverage in underserved rural areas.

With further developed skills and confidence, general surgeons can effectively take on the burden through screening initiatives as demonstrated by Goldenberg (2005).²⁵ According to their colorectal cancer screening initiative, only 46% of new patients who met screening criteria reported appropriate prior screening. Screening of these patients showed that 18% were candidates for treatment. Further, they saw a 95% compliance rate. Not only did they demonstrate need but also feasibility and compliance of such screening initiatives. Though the paper does not comment on the effect of screening on mortality, other literature that focus on population-based ecological studies have concluded that colonoscopy screening reduces disease-specific mortality.^{26,27} Evidence of such a significant relationship between proper screening and decline in mortality even within small populations confirm the need to strengthen the task force in rural communities. Considering

Table 6

Odds of a colonoscopy being performed in a rural area given that a colonoscopy was performed by a general surgeon for 2006–2015.

Years	Odds Ratio (Ref = Urban)	95% Confidence Interval		P-Value
		Lower CL	Upper CL	
2006–2007	5.54	2.16	14.22	0.0004
2008–2009	7.05	2.48	20.02	0.0002
2010–2011	7.66	3.36	17.44	0.0000
2012–2013	9.95	4.91	20.17	0.0000
2014–2015	2.83	0.94	8.51	0.0640
Total	5.99	3.61	9.92	0.0000

our findings, rural general surgeons can play a vital role in capturing the unscreened population and be better equipped with a life-saving screening modality for such a deadly yet preventable disease with further colonoscopy training.

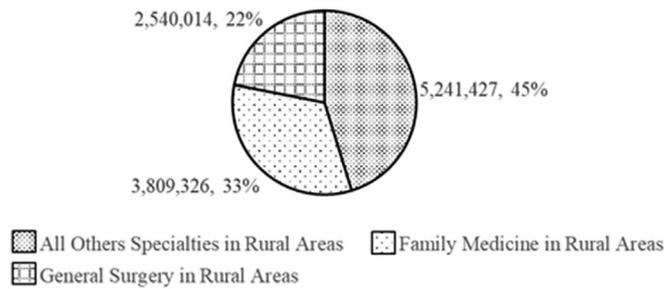
Limitations

As in any national discharge database study, our methodology has certain limitations. First is the lack of granularity in the “Other” category of specialties. Without consistent annual data, we could not differentiate gastroenterologists from “Other” or internal medicine specialists. No further conclusions can be made comparing colonoscopies performed by gastroenterologists and general surgeons. Additionally, there is the possibility that colorectal surgical procedures are included in the “Other” category, which could confound the results. Colorectal surgeons could also be included in the general surgeon category. These limitations do not question the validity of our data concerning general surgery – the aggregate distribution of colonoscopies performed in rural areas from 2006 to 2015 remained higher for general surgeons compared to other specialties (Fig. 3, A), including the “other” category, whether this contains colorectal surgeons or not. Furthermore, even if colorectal surgeons were distinct in the dataset, it is likely that the numbers would be too low to be statistically significant. Regardless of the breakdown of “other specialties”, it is clear that general surgeons are performing the most colonoscopies in rural areas between 2006 and 2015.

Another limitation of our study is the small sample size of colonoscopies recorded in the database in comparison to total number of colonoscopies performed nationwide. This is especially seen in rural data. Conclusions can be drawn from the data as a whole, but not from individual years due to small sample size. This limited our ability to perform a major logistic regression to determine the additional risk factors for people undergoing colonoscopies. We addressed this limitation by performing a weighting analysis of the raw data (Table 2) to make the data more nationally representative (Table 4). It would be interesting to repeat this study on any available larger national outpatient database to see if our conclusions still hold.

Due to the nature of the data, evaluation of state and county needs also could not be taken into account. While we were able to classify procedures as rural and non-rural, we could not assess how individual geographic areas may have different colonoscopy burden distributions within a more microcosmic scale. Utilizing state-level data could offer more insight into whether certain states and counties rely more on general surgeons for colonoscopies than others, particularly in vastly rural areas with fewer providers. Additionally, the NAMCS data does not provide any details on the pathology or the severity of the disease that was treated by the identified colonoscopies. Therefore, the limited capacity of the data does not allow us to distinguish whether only the more complicated cases are transferred to urban areas with a higher density of specialists.

A) Number and Percentage of Colonoscopies by Specialty from 2006 - 2015 in Rural Areas



B) Number and Percentage of Colonoscopies by Specialty from 2006 - 2015 in Urban Areas

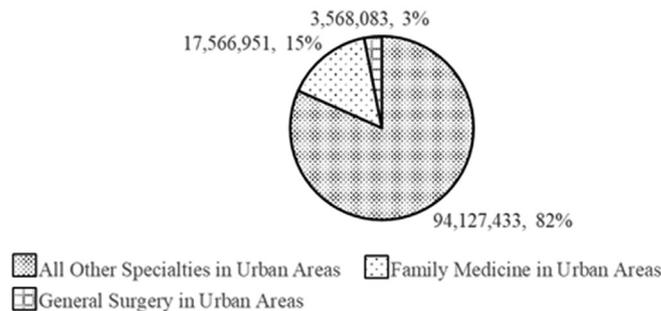


Fig. 3. Number and percentage of colonoscopies by specialty from 2006 to 2015 in (A) rural areas and (B) urban areas.

The NAMCS is a database of self-reported survey responses from physicians and hospital staff. The number of participating physicians varies each year. The lack of defined categories such as physician specialties and parameters such as performed colonoscopy setting specifying hospital, office, or operating room procedures prevented further evaluation. These limitations could also result in reporting errors and sampling bias. Further, the NAMCS does not provide longitudinal records for individual patients. Thus, the data may include multiple colonoscopies performed on the same patient. This, along with the small sample sizes in certain years, may contribute to selection bias due to not being representative of the general population.

In this study, we were most interested in identifying the burden of colonoscopy screening in various specialties in urban and rural settings. Therefore, the event of patient repeat should not affect the results of our study. We also show that the demographic characteristics are not statistically different between urban and rural patients in terms of average age, distribution of age groups, gender, and payment used. Further socioeconomic granularity was not available, and such factors like insurance status have been investigated as explanations for nationwide disparity in colonoscopy administration.²⁸ Does our study reflect differences in geographic access to care, or socioeconomics? Regardless of socioeconomic disparity, providers serve areas, therefore rural medicine and surgery differ in practice from their urban counterparts. Rural medicine is not only about geography or socioeconomic status, but both. This is what our investigation supports, and the reason that it is essential to study the needs of rural communities separate from urban communities, to question if they are receiving the targeted care they require.

Conclusions

Despite the availability and clear benefit to colonoscopy

screening, a substantial number of patients within the recommended age group have not been screened for colorectal cancer. This need is even greater in rural areas. As the first analysis of the NAMCS database's information on colonoscopy procedures, this study shows that general surgeons are fulfilling the need for colonoscopy in rural areas. Further, compared to their urban counterparts, rural general surgeons are performing a greater percentage of annual colonoscopies. General surgery programs currently require fewer colonoscopies compared to other procedures. Improving current colonoscopy training guidelines, especially for physicians who go on to practice in rural areas, may be key to closing the unmet need in colorectal cancer screening in underserved rural areas.

Conflicts of interest declaration

The authors of this manuscript have no conflicts of interest, or financial and personal relationships with other people or organizations that may influence our research.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.amjsurg.2019.02.009>.

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