



Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Elsevier hereby grants permission to make all its COVID-19-related research that is available on the COVID-19 resource centre - including this research content - immediately available in PubMed Central and other publicly funded repositories, such as the WHO COVID database with rights for unrestricted research re-use and analyses in any form or by any means with acknowledgement of the original source. These permissions are granted for free by Elsevier for as long as the COVID-19 resource centre remains active.

Original Article

Patient Characteristics Associated with Access to Minimally Invasive Gynecologic Surgery: Changes during the COVID-19 Pandemic

R. Gina Silverstein, MD, Asha B. McClurg, MD, Kristin J. Moore, PhD, MPH, Mike D. Fliss, PhD, MPS, MSW, and Michelle Louie, MD, MSCR

From the Department of Obstetrics and Gynecology, University of North Carolina, Chapel Hill, North Carolina

ABSTRACT **Study Objective:** To evaluate patient characteristics that affect access to minimally invasive gynecologic surgery (MIGS) subspecialty care and identify changes during the coronavirus disease 2019 pandemic.

Design: Retrospective cohort study of patients referred to MIGS from 2014 to 2016 (historic cohort) compared with those referred to MIGS in 2020 (pandemic cohort). Primary outcome was the interval between referral and first appointment.

Setting: Single-institution academic MIGS division.

Patients: Historic cohort (n = 1082) and pandemic cohort (n = 770).

Interventions: Not applicable.

Measurements and Main Results: Demographics and socioeconomic variables (race, ethnicity, language, insurance, employment, and socioeconomic factors by census tract) and distance from hospital were compared between historic and pandemic cohorts with respect to referral interval using the chi-square, Fisher exact tests, and logistic regression. After adjusting for referral indication, being unemployed and living in an area with less population density, less education, and higher percentage of poverty were associated with a referral interval >30 days in the historic cohort. In the pandemic cohort, only unemployment persisted as a covariate associated with prolonged referral interval and new associated variables were primary language other than English (odds ratio, 3.20; 95% confidence interval [CI], 1.60–6.40) and “other” race (odds ratio, 2.22; 95% CI, 1.34–3.68). The odds of waiting >30 days increased by 6% with the addition of 1 demographic risk factor (95% CI, 1.01–1.10) and by 17% for 3 risk factors (95% CI, 1.03–1.34) in the historic cohort whereas no significant intersectionality was identified in the pandemic cohort. Average referral intervals were significantly shorter during the pandemic (31 vs 50 days, $p < .01$). Telemedicine appointments had a significantly shorter referral interval than in-person appointments (27 vs 47 days, $p < .01$). Of patients using telemedicine, a greater proportion were non-Hispanic, English speaking, employed, privately insured, and lived further from the hospital ($p < .05$).

Conclusion: Time from referral to first appointment at a tertiary-care MIGS practice during the coronavirus disease 2019 pandemic was shorter than that before the pandemic, likely owing to the adoption of telemedicine. Differences in socioeconomic and demographic factors suggest that telemedicine improved access to care and decreased access disparities for many populations, but not for non-English-speaking patients. *Journal of Minimally Invasive Gynecology* (2022) 29, 1110–1118. © 2022 AAGL. All rights reserved.

Keywords: Coronavirus; Disparity; Laparoscopic surgery; Social determinants of health; Telemedicine

Background

Social determinants of health (SDOH) are demographic factors that underlie development of illness, access to

medical care, adherence to treatment plans, and outcomes [1]. SDOH have been shown to affect health outcomes and are a driving factor of health disparities [2]. There is a

Michelle Louie is a consultant for Hologic Inc. and Applied Medical. The other authors declare that they have no conflict of interest.

This study was funded by the Department of Obstetrics and Gynecology, University of North Carolina.

This research was previously presented as a poster at American Association of Gynecologic Laparoscopists Global Congress in Austin Texas, November 14, 2021.

The study protocol was approved by the University of North Carolina Institutional Review Board number 20-2851.

Corresponding author: R. Gina Silverstein, MD, Department of Obstetrics and Gynecology, University of North Carolina, 460 Waterstone Dr, Third Floor, Hillsborough, NC 27278.

E-mail: gina.silverstein@unchealth.unc.edu

Submitted February 25, 2022, Revised June 14, 2022, Accepted for publication June 16, 2022.

Available at www.sciencedirect.com and www.jmig.org

paucity of data describing how SDOH affect access to gynecologic subspecialists.

Within gynecology, minimally invasive surgery is associated with significantly fewer complications and faster recovery than laparotomy [3,4]. In addition, patients have improved outcomes with high-volume [5–7] and fellowship-trained surgeons [8]. Previous work within gynecology has shown SDOH such as race, ethnicity, income, and insurance affect the likelihood of undergoing minimally invasive surgery [6,9,10]. Therefore, equitable access to high-volume gynecologists specializing in minimally invasive techniques has the potential to improve outcomes and decrease health disparities. Fellowship-trained MIGS physicians also have additional expertise in the medical management of complex gynecologic disorders including chronic pelvic pain (CPP).

The coronavirus disease 2019 (COVID-19) global pandemic has affected access to medical care throughout all specialties, causing an initial decrease in available appointments, later partially alleviated by telemedicine [11]. Although telemedicine removes some barriers to care, such as transportation or distance from the provider, there are inequities in access to technology, digital literacy, and reliable internet coverage [12].

Identifying differences in access to care can improve health equity in gynecology. The objective of our study was to evaluate access to minimally invasive gynecologic surgery (MIGS) subspecialty care and how this changed during the COVID-19 pandemic by determining which socioeconomic and demographic factors are associated with a prolonged interval between referral and first appointment in a historic cohort and a pandemic cohort. We hypothesized that access to MIGS care would be negatively affected by the COVID-19 pandemic and previously identified SDOH [6,9,10].

Materials and Methods

We performed a retrospective cohort study of patients who were referred, for any indication, to the MIGS Division of the University of North Carolina Department of Obstetrics and Gynecology, an academic, tertiary-care center with a referral network across the southeastern United States. Any patient referred to MIGS subspecialty care and seen by an MIGS provider either in person or virtually from 2014 to 2016 (“historic” cohort) and 2020 (“pandemic” cohort) was included for analysis. Patients were excluded if their referral interval was >180 days because these patients required a new referral order to be scheduled. Our primary outcome was the time between referral and first visit (referral interval).

The time period from 2014 to 2016 was chosen as the comparison cohort because the practice size was the same as that in 2020. During both study periods, there were 4 fellowship-trained MIGS physicians and 2 MIGS fellows seeing new consults. New consults are triaged by an

experienced nurse or MIGS physician evaluating referral records and categorizing as either a CPP referral including vulvodynia (“CPP”) or a surgical referral, including any diagnoses that may require operative intervention such as endometriosis, myomas, or abnormal uterine bleeding (“OP”) and then scheduled by administrative staff according to medical necessity based on the physician or nurse judgment. Referral indication (CPP or OP) was controlled for in the logistic regression models to control for confounding by the triage process.

Telemedicine, defined in our practice as an audiovisual visit using an online platform, was universally offered to all patients at the start of the pandemic in January 2020. As our office remained open during the COVID-19 pandemic, all patients were offered an in-person visit if they had a medical indication to be physically examined, did not have the means to engage in telemedicine, or preferred to be seen in the office. Telemedicine was not formally offered and was available with audio only during the historic study period. Patients who had their first appointment remotely (either by audio or video) were coded as telemedicine. Interpreters (audio, audiovisual, or in-person) were offered to all non-English-speaking patients during all points of contact, both for in-person and telemedicine visits. When the provider fluently spoke the patient’s primary language, patients were given the option to defer the hospital-provided translator (there was a Spanish-speaking and an Arabic-speaking provider during the study periods).

Patients were identified via internal referral database, and demographic and appointment information were abstracted. Electronic medical records were used to collect additional variables including patient-reported race, ethnicity, primary language, employment status, and insurance information. Race was categorized as Black/African American, White/Caucasian, and “other” (American Indian/Alaskan Native, Asian, Native Hawaiian/Pacific Islander, and other were analyzed together given the low number of patients in these individual racial groups). Ethnicity was categorized as Hispanic/Latino and not Hispanic/Latino. Language was categorized as English and non-English given the low frequency of patients in individual language groups other than Spanish. Employment status was categorized into employed (full time, part time, contract, self-employed, active military, or student) and unemployed/other (unemployed, retired, disabled, leave of absence, temporary unemployment, unknown, or other). Insurance was categorized into Medicare/Medicaid, private/other (including military and health plan for state employees), and none. Sex, gender identity, and marital status were collected but not included in the analysis because of the extent of missing data. Patient’s addresses were used to collect socioeconomic data about their census tract using IPUMS GeoMarker based on the 2018 American Community Survey estimates [13], and these variables were analyzed as

quartiles. Euclidean (straight-line) distance in miles from the patient's geocoded home address to the hospital was calculated on the North Carolina state plane coordinate reference system and analyzed as quartiles and median differences with Wilcoxon rank sum test.

Demographic and socioeconomic variables were compared between the historic cohort and the pandemic cohort with respect to the interval between the date the referral was received and first appointment with an MIGS provider using the chi-square, Fisher exact tests, and Wilcoxon rank sum tests, as appropriate. $p < .05$ was considered statistically significant. Multivariable logistic regression, adjusting for referral indication (CPP or OP), was used to estimate the association between demographic characteristics in each cohort and waiting >30 days for an appointment, which was selected as a clinically relevant wait time. A risk score was calculated to summarize the estimated effect that individuals may experience as a result of the intersectionality of multiple identities. Each demographic characteristic was reviewed, and the minority category was given the value of 1 point and then all points were summated per participant. Minority value assignments were based on existing literature about SDOH [2,6,9,10]: nonwhite race, Hispanic ethnicity, primary language non-English, male sex, gender identified as transgender, unemployed, no insurance or public insurance, marital status of single, living in an area with a lower proportion of housing owned, a greater proportion of poverty, a higher proportion of African Americans, a lower portion of adults who completed high school, a lower number of housing units per square kilometer, a higher income inequality, and living in an area with a lower number of persons per square kilometer were given the value of 1. Scores in this study population ranged from 0 to 14. Logistic regression was used to calculate the odds of waiting >30 days associated with higher risk scores (1-point and 3-point differences), after adjusting for referral indication.

Data analysis was performed using SAS 9.4 software (SAS Institute Inc., Cary, NC) and distance calculations between addresses and the hospital were performed in R (R Foundation for Statistical Computing, Vienna, Austria) [14] using the sf (Simple Features for R, Muenster, Germany) [15] package. The study protocol was approved by the University of North Carolina Institutional Review Board number 20-2851.

Results

A total of 1823 patients met study criteria for analysis. A total of 1070 patients were referred and seen from 2014 to 2016 ("historic" cohort), and 753 patients were included in 2020 ("pandemic" cohort). The pandemic cohort had a larger proportion of patients who identified as Hispanic/Latino ($p = .02$), Spanish-speaking ($p = .04$), without insurance ($p < .01$), and lived closer to the hospital ($p < .01$) than the historic cohort (Table 1). Of patients who did not have a

primary language of English, the majority spoke Spanish (92%). There were no differences between the 2 cohorts in race, employment status, or census tract housing density and proportion in poverty.

The mean referral interval during the pandemic was significantly shorter than in the historic cohort (31 vs 50 days, $p < .01$). In the historic cohort, 429 patients (40%) were seen in ≤ 30 days from the time of referral and 641 patients (60%) waited >30 days for their first appointment (Table 2). Employment status, proportion of census tract in poverty, population density, and high school completion rate (all $p < .05$) were associated with a prolonged referral interval. Patients who waited >30 days also lived further from the hospital (median 44 vs 38 miles, $p = .04$).

In the pandemic cohort, substantially more patients, 529 patients (70%) were seen in ≤ 30 days and only 224 patients (30%) waited >30 days for their first appointment. Employment was still associated with a prolonged referral interval; however, the other variables from the historic cohort were no longer significantly associated with a delay in the first appointment, including distance from the hospital and census tract data such as proportion of people living in poverty, population density, and percentage of high school completion. Primary language and race were associated with a referral interval >30 days in the pandemic cohort ($p < .05$), whereas they were not significant in the historic cohort. Ethnicity and insurance status were not associated with referral interval in either cohort.

In total, 889 patients were referred for CPP with a mean referral interval of 46 days and 929 were referred for potential operative management (OP) and had a mean referral interval of 37 days ($p < .01$). Multivariable logistic regression was performed to further determine the association between demographic characteristics and referral interval >30 days, by cohort, after adjusting for referral indication (CPP or OP) (Table 3). In the historic cohort, being unemployed was associated with 44% greater odds of having a long referral interval than being employed (95% confidence interval [CI], 1.04–2.01). Living in an area with a higher proportion of people living in poverty (odds ratio [OR], 1.71; 95% CI, 1.21–2.43), less population density (rural) (OR, 1.55; 95% CI, 1.09–2.20), and lower percent of high school completion (OR, 1.70; 95% CI, 1.18–2.44) were also associated with increased odds of a prolonged referral interval in the historic cohort. Race, ethnicity, language, and insurance status were not associated with time to first MIGS appointment in the historic cohort.

During the pandemic, being unemployed was associated with 68% greater odds of a long referral time (95% CI, 1.15–2.47); however, the other variables previously identified within the historic cohort were no longer significantly associated with referral time. Patients with a primary language other than English had more than 3 times the odds of a prolonged referral interval (95% CI, 1.60–6.36), and race of "other" compared with White was associated with 2 times

Table 1

Study demographics by cohort			
Characteristic	Pandemic cohort, n = 753 (41%)	Historic cohort, n = 1070 (59%)	p-value
Race			
Black/African American	224 (33)	316 (33)	.92
White/Caucasian	380 (56)	545 (57)	.84
Other	80 (12)	88 (9)	.08
Ethnicity			
Hispanic/Latino	61 (9)	57 (6)	.02*
Not Hispanic/Latino	611 (91)	882 (94)	
Primary language			
English	700 (95)	1026 (97)	<.01*
Spanish	33 (4)	28 (3)	.04*
Other	2 (0)	3 (0)	>.99
Employment status			
Employed	328 (62)	381 (60)	.62
Unemployed/other	202 (38)	249 (40)	
Insurance status			
Medicare/Medicaid	145 (19)	211 (20)	.81
Private/other	460 (61)	730 (68)	<.01*
None	148 (20)	129 (12)	<.01*
Housing units per square km			
<35.1	189 (25)	267 (25)	.95
35.1–139.5	192 (26)	266 (25)	
139.6–400.5	189 (25)	264 (25)	
≥400.6	182 (24)	271 (25)	
Proportion of adults who completed high school			
<0.83	179 (24)	259 (24)	.08
0.83–0.89	159 (21)	278 (26)	
0.90–0.94	235 (31)	297 (28)	
≥0.95	180 (24)	236 (22)	
Proportion in poverty			
<0.07	206 (27)	248 (23)	.05
0.07–0.11	196 (26)	264 (25)	
0.12–0.19	171 (23)	296 (28)	
≥0.20	180 (24)	262 (24)	
Distance to hospital—quartiles			
<24 miles	232 (31)	229 (21)	<.01*
24–38 miles	202 (27)	275 (26)	
39–70 miles	168 (22)	256 (24)	
≥71 miles	151 (20)	310 (29)	
Distance to hospital—median and interquartile range (miles)			
	34 (19–60)	42 (26–77)	<.01*

* statistically significant; p < .05.

the odds of a prolonged referral (95% CI, 1.34–3.68)—differences that were not present in the historic cohort. Patients identifying as Black did not have increased odds of a prolonged referral compared with patients identifying as White (OR, 1.19; 95% CI, 0.81–1.76).

In the historic cohort, the odds of waiting >30 days between referral and first appointment increased by 6% with the addition of 1 demographic risk factor (95% CI, 1.01–1.10) and by 17% for 3 risk factors (95% CI, 1.03–1.34), whereas there was no significant intersectionality identified in the pandemic cohort for 1 (OR, 1.03; 95% CI, 0.98–1.09) or 3 risk factors (OR, 1.19; 95% CI, 0.94–1.29) (Table 3).

In the pandemic cohort, 64% of appointments were telemedicine whereas only 2 telemedicine visits (0.4%) occurred in the historic cohort. Patients whose first visit was telemedicine had significantly a shorter mean referral interval than those who had first in-office visits (27 vs 47 days, p <.01) (Table 4). Of patients seen in person, as opposed to via telemedicine, a greater proportion were Hispanic, non-English speaking, unemployed, and publicly insured/uninsured (all p <.05). A greater proportion of patients who had telemedicine appointments lived further away from the hospital (p <.01), although median distance to the hospital was not statistically different between those seen in the office or

Table 2

Demographic and socioeconomic characteristics associated with referral interval						
Characteristic	Pandemic cohort (n = 753; 41%)			Historic cohort (n = 1070; 59%)		
	≤30 d, (n = 529; 70%)	>30 d, (n = 224; 30%)	p-value	≤30 d, (n = 429; 40%)	>30 d, (n = 641; 60%)	p-value
<i>Referral interval</i>						
Race						
Black/African American	162 (33)	62 (31)	.02*	134 (35)	182 (32)	.39
White/Caucasian	279 (57)	101 (51)		210 (55)	335 (59)	
Other	46 (9)	34 (17)		39 (10)	49 (9)	
Ethnicity						
Hispanic/Latino	38 (8)	23 (12)	.10	22 (6)	35 (6)	.73
Not Hispanic/Latino	441 (92)	170 (88)		361 (94)	521 (94)	
Primary language						
English	501 (97)	199 (91)	<.01*	416 (97)	610 (97)	.84
Non-English	16 (3)	19 (9)		12 (3)	19 (3)	
Employment status						
Working	248 (66)	80 (53)	<.01*	168 (66)	213 (57)	.03*
Other or not working	130 (34)	72 (47)		88 (34)	161 (43)	
Insurance status						
Medicare/Medicaid	93 (18)	52 (23)	.17	79 (18)	132 (21)	.53
Private/other	333 (63)	127 (57)		301 (70)	429 (67)	
None	103 (19)	45 (20)		49 (11)	80 (12)	
Housing units per square km						
<35.1	131 (25)	58 (26)	.38	92 (22)	175 (27)	.03*
35.1–139.5	144 (27)	48 (22)		99 (23)	167 (26)	
139.6–400.5	132 (25)	57 (26)		114 (27)	150 (23)	
≥400.6	122 (23)	60 (27)		123 (29)	148 (23)	
Proportion of adults who completed high school						
<0.83	129 (24)	50 (22)	.85	90 (21)	169 (26)	.03*
0.83–0.89	108 (20)	51 (23)		119 (28)	159 (25)	
0.90–0.94	164 (31)	71 (32)		110 (26)	187 (29)	
≥0.95	128 (24)	52 (23)		110 (26)	126 (20)	
Proportion in poverty						
<0.07	139 (26)	67 (30)	.15	115 (27)	133 (21)	.02*
0.07–0.11	145 (27)	51 (23)		112 (26)	152 (24)	
0.12–0.19	127 (24)	44 (20)		99 (23)	197 (31)	
≥0.20	118 (22)	62 (28)		103 (24)	159 (25)	
Distance to hospital—quartiles						
<24 miles	168 (32)	64 (29)	.70	98 (23)	131 (20)	.12
24–38 miles	144 (27)	58 (26)		123 (29)	152 (24)	
39–70 miles	115 (22)	53 (24)		95 (22)	161 (25)	
≥71 miles	102 (19)	49 (22)		113 (26)	197 (31)	
Distance to hospital—median and interquartile range (miles)						
	34 (19–56)	37 (19–63)	.33	38 (25–72)	44 (26–80)	.04*

* statistically significant; $p < .05$.

via telemedicine (39 vs 37 miles, $p = .06$). Census tract data, including population density, educational attainment, and proportion in poverty, were not significantly different between patients seen in the office vs telemedicine.

Discussion

We evaluated the interval between referral and first appointment at a single-institution tertiary-care MIGS practice as a measure of accessing MIGS in the southeastern United States during the COVID-19 pandemic. Before the pandemic, being unemployed and living in an area with

more poverty, less population density (rural), less educational attainment, and further from the hospital were associated with a referral time >30 days, and having multiple risk factors increased the odds of a long referral time. During the pandemic, only being unemployed persisted as a risk factor for a referral time >30 days, and having multiple risk factors was not associated with delayed care. Referral wait times significantly decreased during the pandemic, and having a primary language other than English emerged as a new risk factor for decreased access.

Consistent with the findings of previous research, we found that unemployment and more impoverished and

Table 3

Logistic regression for associations between demographic characteristics and waiting >30 days for an appointment, adjusted for type of appointment

Characteristic	Pandemic cohort	Historic cohort
Race		
White/Caucasian	1	1
Black/African American	1.19 (0.81–1.76)	0.94 (0.70–1.27)
Other	2.22 (1.34–3.68)*	0.83 (0.53–1.32)
Ethnicity		
Not Hispanic/Latino	1	1
Hispanic/Latino	1.63 (0.94–2.82)	1.14 (0.66–1.98)
Language		
English	1	1
Non-English	3.20 (1.60–6.40)*	1.16 (0.55–2.41)
Employment		
Employed	1	1
Unemployed/other	1.68 (1.15–2.47)*	1.44 (1.04–2.01)*
Insurance status		
Private/other	1	1
Medicare/Medicaid	1.39 (0.93–2.08)	1.19 (0.89–1.63)
None	1.16 (0.77–1.74)	1.18 (0.80–1.73)
Housing units per square km		
<91.4	0.89 (0.58–1.39)	1.55 (1.09–2.20)*
91.4–327.3	0.71 (0.45–1.11)	1.39 (0.98–1.96)
327.4–939.1	0.91 (0.59–1.41)	1.09 (0.78–1.54)
≥939.2	1	1
Proportion in poverty		
<0.07	1	1
0.07–0.11	0.73 (0.47–1.13)	1.17 (0.82–1.66)
0.12–0.19	0.72 (0.46–1.14)	1.71 (1.21–2.43)*
≥0.20	1.10 (0.72–1.68)	1.27 (0.96–1.95)
Proportion of adults who completed high school		
<0.83	0.99 (0.62–1.56)	1.70 (1.18–2.44)*
0.83–0.89	1.18 (0.74–1.87)	1.18 (0.83–1.67)
0.90–0.94	1.09 (0.71–1.67)	1.52 (1.07–2.15)*
≥0.95	1	1
Distance to hospital		
<24 miles	0.81 (0.52–1.27)	0.79 (0.55–1.12)
24–38 miles	0.86 (0.54–1.36)	0.73 (0.53–1.02)
39–70 miles	1.02 (0.64–1.64)	1.00 (0.71–1.41)
≥71 miles	1	1
Risk score		
1-unit increase	1.03 (0.98–1.09)	1.06 (1.01–1.10)*
3-unit increase	1.10 (0.94–1.29)	1.17 (1.03–1.34)*

* statistically significant.

more rural census tracts were associated with delays in MIGS subspecialty access [16–18]. Other SDOH identified in previous research, such as Black race, Hispanic/Latino ethnicity, and uninsured status [6,9,10,16–18], were not associated with prolonged referral time either before or during the pandemic, which may be because our practice triages appointments by medical necessity alone. No demographic information is used during scheduling, which may decrease implicit and explicit bias. Our institution has no restrictions on who may receive care (e.g., uninsured or undocumented patients), so our study could underestimate disparities and may not be generalizable to other institutions [2].

Contrary to the findings of a previous study [11], time to first appointment decreased during the pandemic in our study, likely secondary to the rapid adoption of telemedicine. Telemedicine appointments had a significantly shorter referral interval than in-person appointments and accounted for two-thirds of visits during the pandemic. This may be in part because telemedicine removes some barriers to attending appointments, such as transportation and childcare, although our data do not include patient's reason for rescheduling or canceling appointments or patients who could not be contacted to schedule an appointment. Telemedicine was used more by patients who lived further from the office, and living in a rural census tract was no longer

Table 4

Study demographics by visit type			
Characteristic	Office visit, (n = 269; 36%)	Telemedicine, (n = 484; 64%)	p-values
Referral time			
≤30 d	164 (61)	365 (75)	<.01*
>30 d	105 (39)	119 (25)	
Race			
Black/African American	83 (34)	141 (32)	.04*
White/Caucasian	125 (51)	255 (58)	
Other	38 (15)	42 (10)	
Ethnicity			
Hispanic/Latino	32 (13)	29 (7)	<.01*
Non-Hispanic	210 (87)	401 (93)	
Language			
English	243 (92)	457 (97)	<.01*
Non-English	20 (8)	15 (3)	
Employment			
Employed	101 (53)	227 (67)	<.01*
Unemployed/other	91 (47)	111 (33)	
Insurance status			
Medicare/Medicaid	62 (23)	83 (17)	.03*
Private/other	148 (55)	312 (64)	
None	59 (22)	89 (18)	
Housing units per square km			
<35.1	69 (26)	120 (25)	.71
35.1–139.5	67 (25)	125 (26)	
139.6–400.5	73 (27)	116 (24)	
≥400.6	60 (22)	122 (25)	
Proportion of adults who completed high school			
<0.83	65 (24)	114 (24)	.21
0.83–0.89	48 (18)	111 (23)	
0.90–0.94	82 (30)	153 (32)	
≥0.95	74 (28)	106 (22)	
Proportion in poverty			
<0.07	74 (28)	132 (27)	.28
0.07–0.11	77 (29)	119 (25)	
0.12–0.19	64 (24)	107 (22)	
≥0.20	54 (20)	126 (26)	
Distance to hospital			
<24 miles	102 (38)	130 (27)	<.01*
24–38 miles	71 (26)	131 (27)	
39–70 miles	55 (20)	113 (23)	
≥71 miles	41 (15)	110 (23)	
Distance to hospital—median and interquartile range (miles)	39 (24–72)	37 (23–67)	.06

* statistically significant; p < .05.

associated with prolonged referral intervals during the pandemic, suggesting telemedicine may be a way to improve access to MIGS subspecialty care.

Before the pandemic, having multiple risk factors compounded the odds of having a prolonged referral interval. Given that the risk score was no longer a significant covariate during the pandemic, it is possible that telemedicine helped to improve access for patients with multiple socioeconomic risk factors. A similar risk score could be used by hospitals to proactively identify and assist patients who might have difficulty with healthcare access, possibly

with patient navigators, care managers, and support for telemedicine.

Information from our study may be used to support continuing telemedicine insurance coverage beyond the current pandemic as a means of improving access to subspecialty care. However, our study also shows that additional functionality may be needed for telemedicine so that patients with limited technological literacy or non-English-speaking patients still benefit from this option. Given our results, institution-wide changes such as making interpreters more readily available, having technology support staff, and

having more diverse office staff may help to decrease disparities.

The results of our study should be interpreted within the context of limitations relevant to all single-institution retrospective studies. Our results may not be generalizable to other institutions that are not large tertiary-care, university-based safety net hospitals or practices that have fixed limits on payer mix. Our patient population may not be representative of all geographic areas; although >40% of our cohort were racial minorities, <10% were Hispanic/Latino and 5% were non-English speaking, making conclusions for these smaller groups imprecise. Our study cannot provide an insight into the patient experience without qualitative data about personal reasons for rescheduling or canceling appointments or system issues they encountered. Similarly, our study uses time from referral to first visit as a proxy for access to subspecialty gynecologic care, but additional studies are warranted to determine whether clinical outcomes or patient satisfaction is improved, especially with respect to telemedicine. Given that our practice has been well established for more than 20 years, the referral network has remained stable over both study periods, but the number of new consults has been steadily increasing with the expansion of the University of North Carolina Hospitals across the state over the past several years, which may have changed referral patterns and appointment availability over the study periods. In addition, although census tract data are a common and generally well-correlated proxy for individual socioeconomic status (SES) data [19], the region around our practice has been changing over the last decade, which may make census tracts less reliable measures for individuals in the 2020 sample. Some areas have been dramatically gentrifying. Around the hospital, the median residential sale price has nearly doubled and there has been a dramatic increase in White residents and median income [20–23]. Statewide, there has been an increase in Hispanic/Latinx residents, which was reflected in the demographic differences between our 2 cohorts [20–23].

Although census tract data were used as a proxy for individual SES data, we used geocoded patient home addresses for straight-line distance calculations, which reduces the spatial bias and misclassification compared with area-level proxies. Using straight-line distance instead of network driving distance is easier to calculate (making it more repeatable in practice settings) and does not require road-network dynamic calculations. Given the wide distribution of distances in our study (dissimilar to the nuances of a smaller-scale, neighborhood-level walking or driving study) and percentile/rank variable construct in our model, we expected straight-line distance calculations to be largely rank collinear and effective for this setting [24].

The strengths of this study include its large size, use of multiple variables to define SES, and long follow-up time. We selected SDOH that have previously been associated with poor access to nonspecialty [25,26] and

subspecialty care [16] and decreased likelihood of having minimally invasive surgery vs laparotomy [3,6,9,10]. Our primary outcome, time to care, is a well-documented proxy for healthcare access [18]. We chose 30 days as a clinically relevant cutoff for a long wait time. A sensitivity analysis showed that findings were generally similar when referral intervals were more extreme (<30 days vs >90 days and <20 days vs >90 days), with only minor differences emerging (data not shown).

In conclusion, access to MIGS subspecialty care in our southeastern referral network improved during the pandemic for most patients, and multiple historic differences in referral times by SDOH resolved. Although telemedicine has improved MIGS access for most, our results may be used to develop specific strategies to assist the potentially marginalized groups identified in this study, such as those whose primary language is not English. As we continue to explore the ongoing role of telemedicine within the healthcare system, we must be thoughtful about those that may be left behind.

References

1. Braveman PA, Kumanyika S, Fielding J, et al. Health disparities and health equity: the issue is justice. *Am J Public Health.* 2011;101 Suppl 1:S149–S155.
2. Haider AH, Scott VK, Rehman KA, et al. Racial disparities in surgical care and outcomes in the United States: a comprehensive review of patient, provider, and systemic factors. *J Am Coll Surg.* 2013;216:482–492. e12.
3. Fader AN, Weise RM, Sinno AK, et al. Utilization of minimally invasive surgery in endometrial cancer care: a quality and cost disparity. *Obstet Gynecol.* 2016;127:91–100.
4. Jin C, Hu Y, Chen XC, et al. Laparoscopic versus open myomectomy – a meta-analysis of randomized controlled trials. *Eur J Obstet Gynecol Reprod Biol.* 2009;145:14–21.
5. Mowat A, Maher C, Ballard E. Surgical outcomes for low-volume vs high-volume surgeons in gynecology surgery: a systematic review and meta-analysis. *Am J Obstet Gynecol.* 2016;215:21–33.
6. Mehta A, Xu T, Hutfless S, et al. Patient, surgeon, and hospital disparities associated with benign hysterectomy approach and perioperative complications. *Am J Obstet Gynecol.* 2017;216:497.. e1–497.e10.
7. Boyd LR, Novetsky AP, Curtin JP. Effect of surgical volume on route of hysterectomy and short-term morbidity. *Obstet Gynecol.* 2010;116:909–915.
8. Clark NV, Gujral HS, Wright KN. Impact of a fellowship-trained minimally invasive gynecologic surgeon on patient outcomes. *JSL.* 2017;21. e2017.00037.
9. McClurg A, Wong J, Louie M. The impact of race on hysterectomy for benign indications. *Curr Opin Obstet Gynecol.* 2020;32:263–268.
10. Abenhaim HA, Azziz R, Hu J, Bartolucci A, Tulandi T. Socioeconomic and racial predictors of undergoing laparoscopic hysterectomy for selected benign diseases: analysis of 341487 hysterectomies. *J Minim Invasive Gynecol.* 2008;15:11–15.
11. Mehrotra A, Chernew M, Linetsky D, Hatch H, Cutler D. The Impact of the COVID-19 pandemic on outpatient visits: a rebound emerges. Available at: <https://www.commonwealthfund.org/publications/2020/apr/impact-covid-19-outpatient-visits>. Accessed January 19, 2022.
12. Velasquez D, Mehrotra A. Ensuring the growth of telehealth during COVID-19 does not exacerbate disparities in care. *Health Affairs*

- Blog*. 2020. Available at <https://www.healthaffairs.org/doi/10.1377/hblog20200505.591306/full/> Accessed January 19, 2022.
13. Oakes JM, Van Riper D, Kugler TA, Goldberg D. IPUMS GeoMarker. Minneapolis: IPUMS; 2019 Version 1.0. [Database].
 14. Wickham H, Averick M, Bryan J, et al. Welcome to the tidyverse. *J Open Source Softw*. 2019;4:1686.
 15. Pebesma E. Simple features for R: standardized support for spatial vector data. *R J*. 2018;10:439–446.
 16. Mellinger JL, Moser S, Welsh DE, et al. Access to subspecialty care and survival among patients with liver disease. *Am J Gastroenterol*. 2016;111:838–844.
 17. Weissman JS, Stern R, Fielding SL, Epstein AM. Delayed access to health care: risk factors, reasons, and consequences. *Ann Intern Med*. 1991;114:325–331.
 18. de Jager E, Levine AA, Udyavar NR, et al. Disparities in surgical access: a systematic literature review, conceptual model, and evidence map. *J Am Coll Surg*. 2019;228:276–298.
 19. Moss JL, Johnson NJ, Yu M, Altekruze SF, Cronin KA. Comparisons of individual- and area-level socioeconomic status as proxies for individual-level measures: evidence from the mortality disparities in American communities study. *Popul Health Metr*. 2021;19:1.
 20. Baumgartner Vaughn D, Eanes Z. ‘Story of My Street’: gentrification and neighborhood change in Durham. The Herald Sun [online]. Available at: <https://www.heraldsun.com/news/local/counties/durham-county/article204694739.html>. Accessed December 31, 2021.
 21. De Marco A, Hunt H. Racial inequality, poverty and gentrification in Durham, North Carolina. *North Carolina Poverty Research Fund*. 2018 Available at: https://fpg.unc.edu/sites/fpg.unc.edu/files/resource-files/durham_final_web.pdf. Accessed July 12, 2022.
 22. DataWorks NC. “Race. *Ethnicity (Adult Population)*. 2010–2020.” Durham Neighborhood Compass. Available at: <https://compass.durhamnc.gov/en/compass/PTLAT/tract>. Accessed January 19, 2022.
 23. Place Explorer: North Carolina. Available at: <https://datacommons.org>. Accessed April 20, 2022.
 24. Apparicio P, Gelb J, Dubé AS, Kingham S, Gauvin L, Robitaille É. The approaches to measuring the potential spatial access to urban health services revisited: distance types and aggregation-error issues. *Int J Health Geogr*. 2017;16:32.
 25. Andrulis DP. Access to care is the centerpiece in the elimination of socioeconomic disparities in health. *Ann Intern Med*. 1998;129:412–416.
 26. Cheung PT, Wiler JL, Lowe RA, Ginde AA. National study of barriers to timely primary care and emergency department utilization among Medicaid beneficiaries. *Ann Emerg Med*. 2012;60:4–10. e2.