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Access to common laparoscopic general surgical procedures: do racial disparities exist?

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Abstract

Background Laparoscopy has become the standard of care for the majority of cases for inguinal hernia repair, cholecystectomy, appendectomy, and colectomy due to the shortened patient recovery time compared to open surgery. This study sought to determine if there exists racial disparity in access to a laparoscopic approach to these common surgeries.

Methods This was an IRB-approved retrospective study utilizing data from the American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP). Individuals who underwent inguinal hernia repair, cholecystectomy, appendectomy, and colectomy in 2016 were identified. Information on self-reported race and ethnicity and other demographic and pre-operative clinical covariates were recorded. Propensity matching was conducted to evaluate the association between race and a laparoscopic approach to surgery.

Results There were 44,522, 60,444, 50,523, and 58,012 cases of inguinal hernia repair, cholecystectomy, appendectomy, and colectomy identified, respectively. Of these patients, 8.38, 8.76, 6.69, and 9.02% self-identified as black, respectively. Confounding effects of variables other than race were balanced by propensity matching. After propensity matching, there were 7460, 10,574, 10,470, and 6758 cases of hernia repair, cholecystectomy, colectomy, and appendectomy, respectively. On univariate (Chi square) analysis with laparoscopic surgery as the primary outcome, black race was significantly associated with lower likelihood of undergoing a minimally-invasive surgical approach in all four surgical procedures under investigation (33.86% of white patients and 21.69% of black patients, $p < 0.0001$ for hernia repair; 97.98% of white patients and 94.29%, $p < 0.0001$ of black patients for cholecystectomy; 70.93% of white patients and 48.60% of black patients, $p < 0.0001$ for colectomy; and 98.85% of white patients and 92.81% of black patients, $p < 0.0001$ for appendectomy).

Conclusions There appears to be a significant racial disparity in the application of a laparoscopic approach to routine intra-abdominal surgery. This warrants further investigation into the barriers preventing access to laparoscopic general surgical procedures that certain populations face.

Keywords Inguinal hernia repair · Cholecystectomy · Appendectomy · Colectomy · Laparoscopy · Racial disparities

Laparoscopy has revolutionized the field of surgery and is increasingly becoming the standard of care for many routine intra-abdominal operations. Inguinal hernia repair, cholecystectomy, appendectomy, and colectomy are among the most common surgeries performed in a routine general surgical practice and are increasingly performed using minimally-invasive techniques. Recent meta-analyses and retrospective studies have shown that patients who receive a minimally-invasive approach to these four common surgeries have decreased post-operative pain, earlier return to normal activities, and reduced incidence of post-operative complications such as wound infection, when compared to patients who undergo similar open surgery [1–7]. Relative to an open approach, a laparoscopic approach requires additional surgical skill, training, and more expensive equipment. Despite the fact that an open approach to operations of the abdomen is typically performed by most surgeons and reduces operation length, laparoscopic procedures require additional skills and are less invasive, improving the patient's recovery experience.

Laparoscopic surgeries gain access to the abdomen via tiny, strategically placed ports to avoid important vessels and nerves [8, 9]. While this leads to reduced visibility and

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tactile feedback for the surgeon, the smaller incisions result in lower incidence of surgical site infection, bleeding, scarring, and post-operative pain. In turn, laparoscopic surgeries are met with improved patient satisfaction [10]. As such, an open approach to surgery is now reserved only for patients presenting more advanced or complicated cases (i.e., an unusually large hernia, severe cholecystitis) or a potentially compromising pre-existing condition (i.e., cancer, abnormal anatomy) or to convert intra-operatively to avoid or treat a complication from laparoscopic approach. Otherwise, the standard of care has shifted toward a laparoscopic procedure for many intra-abdominal operations [1–7].

Current literature has identified racial disparities in the quality of care received by patients in a variety of healthcare settings. While there is a lack of literature describing racial disparities in access to minimally-invasive surgery, racial disparities in clinical care is well-documented [11, 12]. Risk factors for decreased quality of care that are currently under investigation include patient race, ethnicity, gender, and weight. Previous investigation into disparities in access to basic laparoscopic surgery has been limited in that only non-profit academic medical centers were included for analysis [13]. The present study examines the influence of race on access to minimally-invasive surgery for patients in need of inguinal hernia repair, cholecystectomy, appendectomy, and colectomy utilizing a database with participation from governmental, municipal, academic, and community hospitals. We hypothesized that race may be significantly associated with access minimally-invasive general surgical procedures.

Materials and methods

Data collection

The American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) and the hospitals participating in the ACS-NSQIP are the source of the data used herein; they have not verified and are not responsible for the statistical validity of the data analysis or the conclusions derived by the authors.

This was an IRB-approved retrospective study utilizing data from the ACS-NSQIP database. ACS-NSQIP is a source of more than 150 prospectively recorded demographic, pre-operative, intra-operative, and 30-day post-operative variables. Data are collected on randomly-selected patients in a HIPAA-compliant manner by dedicated clinicians. In 2016, 680 hospitals participated in ACS-NSQIP, submitting data for more than 1 million cases. The database was queried to identify cases of individuals who underwent inguinal hernia repair, cholecystectomy, appendectomy, or colectomy in 2016. The following CPT codes corresponded to open approach to surgery: 44950, 47,612, 44,140, and 49,505. The following CPT codes corresponded to laparoscopic approach to surgery: 44,970, 47,562, 44,204, and 49,650.

Variables of interest

Variables recorded from ACS-NSQIP included demographic and pre-operative clinical covariates. Demographic variables included race and ethnicity (white, black, American Indian/Alaska Native, Asian Pacific Islander, Hispanic, and unknown), age, and sex. Pre-operative clinical variables that the attending surgeon would have access to were selected for analysis, including American Association of Anesthesiologists (ASA) class, current smoking status, chronic obstructive pulmonary disease (COPD), body mass index (BMI), diabetes, congestive heart failure (CHF), medicated hypertension, renal failure or dialysis, steroid use, and bleeding disorders. All subsequent statistical analyses were performed using SAS 9.4 (Cary, NC).

Univariate analyses

The primary outcome of interest was laparoscopic approach to surgery. Descriptive statistics were performed to characterize the patients included in this study (Table 1). Univariate analyses were then performed to identify demographic and pre-operative variables associated with the primary outcome. Chi squared tests and Student's t-tests were used for categorical and continuous variables, respectively, with p values < 0.05 being regarded as statistically significant. Chi squared tests were done on all procedures to elucidate the association between all races and ethnicities listed in ACS-NSQIP and laparoscopic approach to surgery (Table 2).

Propensity score matching

To eliminate undesired bias associated with racial differences in comorbidities and identify demographic and pre-operative variables independently associated with laparoscopic approach to the surgical procedures under investigation, a propensity score matching algorithm was utilized. The PSMATCH procedure was used to develop a 1:1 greedy-matching algorithm [14] that included variables that the attending surgeon would have access to pre-operatively and inguinal hernia repairs were matched for unilateral and bilateral (Table 1). Chi squared tests were then implemented to confirm group balancing and determine the association between race and access to minimally-invasive approach to surgery (Table 2). p values < 0.05 were regarded as statistically significant.

Table 1 Demographic and clinical characteristics of whole patient cohort from ACS-NSQIP

Variable	Unilateral inguinal hernia repair				Bilateral inguinal hernia repair				Cholecystectomy				Appendectomy				Colectomy			
	N	% Received laparo-scopic approach	% Received open approach	*p* value	*N*	% Received laparo-scopic approach	% Received open approach	*p* value	*N*	% Received laparo-scopic approach	% Received open approach	*p* value	*N*	% Received laparo-scopic approach	% Received open approach	*p* value	*N*	% Received laparo-scopic approach	% Received open approach	*p* value
Age				**< 0.0001**				**< 0.0001**				**< 0.0001**				**< 0.0001**				**< 0.001**
≤ 60 Years	21,953	26.73	73.27		1702	63.10	36.90		42,625	96.79	3.21		41,555	94.45	5.55		26,365	56.20	43.80	
> 60 Years	19,387	20.76	79.24		1480	52.97	47.03		17,819	90.75	9.25		8968	92.53	7.47		31,647	51.40	48.60	
Sex				**< 0.0001**				**< 0.0001**				**< 0.0001**				**< 0.0001**				**0.0044**
Male	34,168	26.57	73.43		2875	61.25	38.75		18,974	91.72	8.28		25,340	93.66	6.34		27,756	54.19	55.81	
Female	7172	11.35	88.65		307	31.60	68.40		41,470	96.51	3.49		25,183	94.56	5.44		30,256	53.01	56.99	
Race/ethnic-ity				**< 0.0001**				**< 0.0001**				**< 0.0001**				**< 0.0001**				**< 0.0001**
American Indian/ Alaska Native	182	16.48	83.52		18	66.67	33.33		411	95.38	4.62		291	95.88	4.12		249	55.02	54.98	
Asian/ Pacific Islander	901	29.41	70.59		57	59.65	40.35		2052	91.52	8.48		2275	91.25	8.75		1524	59.19	40.81	
Black	3553	20.10	79.90		178	53.37	46.63		5298	94.28	5.72		3381	92.81	7.19		5235	48.60	51.40	
Hispanic	3049	20.33	79.67		227	56.83	43.17		8167	96.40	3.60		6570	95.13	4.87		3137	53.36	46.64	
White	27,918	26.61	73.39		2238	62.02	37.98		36,454	94.90	5.10		30,092	94.88	5.12		40,794	54.47	55.53	
Unknown	5737	14.54	85.46		464	43.10	56.90		8062	95.44	4.56		7914	91.65	8.35		7073	50.97	49.03	
ASA class > 2	13,382	17.08	82.92	**< 0.0001**	894	47.09	52.91	**< 0.0001**	20,414	90.91	9.09	**< 0.0001**	10,618	91.92	8.08	**< 0.0001**	33,662	45.89	54.11	**< 0.0001**
Current smoker	7709	23.04	76.96	**0.0417**	585	55.56	44.44	0.1235	10,624	94.95	5.05	0.7792	8829	93.34	6.66	**0.0007**	10,362	47.41	52.59	**< 0.0001**
COPD	1511	15.55	84.45	**< 0.0001**	102	32.35	67.65	**< 0.0001**	1725	89.51	10.49	**< 0.0001**	794	88.79	11.21	**< 0.0001**	3395	38.70	61.30	**< 0.0001**
Morbidly obese	2416	13.91	86.09	**< 0.0001**	128	54.69	45.31	0.3856	11,010	94.31	5.69	**0.0002**	4068	92.99	7.11	**0.0016**	6899	51.92	48.08	**0.0033**
Diabetic:	3868	17.24	82.76	**< 0.0001**	269	46.10	53.90	**< 0.0001**	8068	91.61	8.39	**< 0.0001**	3120	91.79	8.21	**< 0.0001**	9140	51.40	48.60	**< 0.0001**
Conges-tive heart failure	257	8.95	91.05	**< 0.0001**	14	28.57	71.43	**0.0233**	374	85.03	4.97	**< 0.0002**	112	83.04	16.96	**< 0.0001**	812	29.19	70.81	**< 0.0001**
Medicated hyperten-sion:	16,204	19.95	80.05	**< 0.0001**	1143	52.49	47.51	**< 0.0001**	20,874	92.27	7.73	**< 0.0001**	10,013	92.47	7.53	**< 0.0001**	28,255	51.38	48.62	**< 0.0001**
Renal failure/ dialysis	342	12.57	87.43	**< 0.0001**	16	37.50	62.50	0.0892	409	79.71	20.29	**< 0.0001**	190	81.58	18.42	**< 0.0001**	923	19.39	80.61	**< 0.0001**
Steroid user	1046	12.62	87.38	**< 0.0001**	71	38.03	61.97	**0.0004**	1227	92.50	7.50	**< 0.0001**	1061	92.65	7.35	**0.0410**	5201	47.66	52.34	**< 0.0001**
Bleeding disorder	992	14.31	85.69	**< 0.0001**	69	44.93	55.07	**0.0218**	1716	86.54	3.46	**< 0.0001**	918	89.76	10.34	**< 0.0001**	2812	30.16	69.84	**< 0.0001**

Boldface indicates significance

Table 2 Demographic and clinical characteristics of propensity score matched groups

Variable	Unilateral inguinal hernia repair			Bilateral inguinal hernia repair			Cholecystectomy			Appendectomy			Colectomy		
	Percent		*p* value	Percent		*p* value	Percent		*p* value	Percent		*p* value	Percent		*p* value
	White patients (*N* = 3551)	Black patients (*N* = 3551)		White patients (*N* = 177)	Black patients (*N* = 177)		White patients (*N* = 5276)	Black patients (*N* = 5276)		White patients (*N* = 3379)	Black patients (*N* = 3379)		White patients (*N* = 5181)	Black patients (*N* = 5181)	
Laparoscopic	68.74	31.26	**< 0.0001**	74.58	53.11	**< 0.0001**	98.67	94.31	**< 0.0001**	98.96	92.81	**< 0.0001**	61.49	49.01	**< 0.0001**
> 60 Years old	35.17	35.29	0.9208	33.33	32.20	0.8208	22.63	22.59	0.9629	13.61	13.91	0.7240	49.43	49.33	0.9217
Female	20.59	20.39	0.8369	9.60	9.60	1.000	21.27	21.21	0.9431	50.04	50.01	0.9806	43.91	43.78	0.8898
ASA class > 2	35.03	35.00	0.9802	28.25	27.12	0.8122	42.00	42.04	0.9685	27.23	27.23	1.000	65.61	65.55	0.9505
Current smoker	28.50	28.25	0.8127	28.81	27.68	0.8133	20.92	21.25	0.6850	22.82	23.79	0.9772	22.18	22.22	0.9623
History of COPD	3.38	3.27	0.7912	1.69	3.39	0.3111	2.37	2.39	0.9491	1.54	1.51	0.9209	4.92	4.94	0.9638
Morbidly obese	8.19	8.34	0.8294	7.34	6.78	0.8357	31.80	31.52	0.7536	14.71	14.65	0.9452	17.99	18.05	0.9389
Diabetic	12.08	12.00	0.9129	10.17	11.30	0.7313	18.61	18.56	0.9402	9.91	9.88	0.9875	23.45	23.16	0.7274
History of congestive heart failure	1.24	1.24	1.000	1.13	1.13	1.000	0.64	0.83	0.2558	0.24	0.18	0.5926	1.81	1.95	0.6128
Medicated hypertension	47.56	47.54	0.981	46.33	45.20	0.831	45.28	45.26	0.9844	27.23	27.49	0.8060	62.42	62.19	0.8078
History of renal failure or dialysis	2.42	2.62	0.5962	0.56	0.56	1.000	1.72	1.78	0.8239	1.21	1.33	0.6642	3.65	3.82	0.6410
Taking steroids	2.34	2.39	0.8759	2.82	1.69	0.4745	1.97	1.93	0.8881	2.04	2.19	0.6726	7.62	7.86	0.6591
Bleeding disorder	2.08	2.20	0.7429	0.56	1.13	0.5620	2.41	2.62	0.4937	1.98	2.10	0.7308	4.59	4.59	1.000

Boldface indicates significance

Results

Patient characteristics

There were 41,340, 3182, 60,444, 50,523, and 58,012 cases of unilateral inguinal hernia repair, bilateral inguinal hernia repair, cholecystectomy, appendectomy, and colectomy identified, respectively. Of these patients, 67.53, 70.33, 60.31, 59.56, and 70.32% self-reported as white; 8.59, 5.59, 8.76, 6.69, and 9.02% self-reported as black; 0.44, 0.57, 0.68, 0.58, and 0.43% self-reported as American Indian/Alaska native; 2.18, 1.79, 3.39, 4.50, and 2.63% self-reported as Asian/Pacific Islander; 7.38, 7.13, 13.51, 13.00, and 5.41% self-reported as Hispanic; and 13.88, 14.58, 13.34, 15.66, and 12.19% patients were of unknown race/ethnicity, respectively (Table 1).

Overall, patients of non-white race/ethnicity had a lower incidence of minimally-invasive approach to surgery. With respect to unilateral inguinal hernia repair, bilateral inguinal hernia repair, cholecystectomy, appendectomy, and colectomy, 26.61, 62.02, 94.90, 94.88, and 54.47% of white patients; 20.10, 53.37, 94.28, 92.81, and 48.60% of black patients; 16.48, 66.67, 95.38, 95.88, and 55.02% of American Indian/Alaska native patients; 29.41, 59.65, 91.52, 91.25, and 59.19% of Asian/Pacific Islander patients; 20.33, 56.83, 96.40, 95.13, and 53.36% of Hispanic patients; and 14.54, 43.10, 95.44, 91.65, and 50.97% of patients of unknown race/ethnicity underwent a laparoscopic approach to their surgery (Table 1). On Chi squared tests conducted on the entire patient cohort and across all four surgeries, there was a significant association between self-reported race/ethnicity and access to laparoscopic approach to surgery (laparoscopic approach on 95.88% of American Indian/Alaska Native patients, 91.25% of Asian/Pacific Islander patients, 92.81% of black patients, 95.13% of Hispanic patients, 94.88% of white patients, and 91.65% of patients of unknown race/ethnicity, $p < 0.0001$).

Propensity score matching

After propensity matching, there were 7102, 354, 10,574, 6758, and 10,470 cases of unilateral inguinal hernia repair, bilateral hernia repair, cholecystectomy, appendectomy, and colectomy, respectively. Groups were balanced for all covariates with the exception of race; half of each patient cohort self-reported as white while the other half self-reported as black. On univariate analysis, black race was significantly associated with undergoing an open approach in all four surgical procedures under investigation, (Table 2) (41.13% of white people and 58.87% of black people, $p < 0.0001$ for unilateral inguinal hernia repair; 35.16% of white people and 64.84% of black people, $p < 0.0001$ for bilateral inguinal hernia repair; 97.98% of white people and 94.29%, $p < 0.0001$ of black people for cholecystectomy; 98.85% of white people and 92.81% of black people, $p < 0.0001$ for appendectomy; and 70.93% of white people and 48.60% of black people, $p < 0.0001$ for colectomy).

Discussion

The impact of racial disparities in access to minimally-invasive surgery

In this study, we found that black, Hispanic, and Asian patient populations requiring inguinal hernia repair, cholecystectomy, appendectomy, and colectomy were less likely to receive minimally-invasive surgery via laparoscopy compared to the white patient population. As previously mentioned, an open approach to these procedures is justified and safe for patients presenting with a complex case or a potentially compromising pre-existing condition or to intraoperatively save a patient from a laparoscopic complication. However, an open approach to surgery is avoided when possible because of higher rates of surgical site infection, longer hospital stays, increased bleeding and hemorrhaging, and more scarring [10]. But ultimately, the decision is made by the attending surgeon.

Decreased access to minimally-invasive general surgery for minority groups is one of many ways in which racial disparities in healthcare affect patient care. Racial disparity in healthcare quality is a complex, multi-faceted, and national problem. And of greatest relevance to the present study, it has been reported that racial disparities in general surgical outcomes exist, although the etiologies of these disparities have not been elucidated [15, 16]. In the pursuit of healthcare equity, elucidating the social, economic, and clinical factors that generate racial disparities is essential. There are several theories that may explain racial disparities in access to laparoscopic approach to inguinal hernia repair, cholecystectomy, appendectomy, and colectomy. Some of the theories suggested by researchers are: economic barriers in access to standard of care, geographic differences in standard of care, and the impact of implicit bias in clinical practice.

Economic barriers in access to standard of care

In the racial disparity identified herein, it may be that race is a proxy for socioeconomic and insurance status. The propensity score matching algorithm used in the present study did not balance for insurance coverage because the intent of the authors was to control only for clinical variables directly

related to the presentation of a patient's condition. Therefore, the racial disparity in access to minimally-invasive inguinal hernia repair, cholecystectomy, appendectomy, and colectomy identified in this study may be in part due to economic barriers related to insurance coverage.

Currently, reimbursement rates are determined via a complex system that takes resources, physician work, time commitment, and malpractice expense into account [17]. There exist significant differences in this system among the public and private health insurance infrastructures. Consequently, hospitals and physicians are reimbursed at different rates depending on patient insurance coverage. In this way, reimbursement policy may potentially play a role in clinical decision making, forcing a surgeon to make a clinical decision that is in lieu with an economic situation or hospital practice. In particular, academic surgery departments are heavily influenced by such factors, as their ability to fund residency and medical student education is strongly driven by surgical reimbursements [18]. Furthering complicating this issue, a study by Hoballah et al. [18] reported that reimbursement rates for general surgical procedures steadily decreased from 1960 to 2006 despite the concurrent growth the healthcare industry.

Minimally-invasive surgery requires a higher level of technical skill, more time in the operating room, and costlier equipment and supplies. Despite this, current public insurance payment structures do not necessarily reflect this and often reimburse surgeons less for performing minimally-invasive surgery. Surgeons are therefore sometimes faced with a financial disincentive in choosing a laparoscopic approach to an operation [19, 20]. Although reimbursement rates would ideally not affect clinical decision making, current literature demonstrates that this is not the case. Low reimbursement rates not only may cause an inclination toward or preference for performing surgeries by an open approach but may also financially disincentive surgeons with little background in laparoscopy to work at becoming proficient in methods of minimally-invasive surgery. Angus et al. [21] has shown that physicians are faced with a financial disincentive in performing laparoscopic Roux-en-Y gastric bypass on patients with morbid obesity covered by public insurance. This pushed bariatric surgeons to perform open gastric bypass surgery on a patient that may otherwise be an appropriate candidate for laparoscopic Roux-en-Y gastric bypass surgery. Public healthcare reimbursement rates may also disincentivize certain hospitals to promote minimally-invasive surgery. Frazee et al. [22] found that low-volume hospitals struggle to achieve positive financial margins for laparoscopic cholecystectomy under Medicaid reimbursement rates, which may negatively impact the quality of care received by populations who use such hospitals.

The consequences of coverage by insurance that reimburses physicians at relatively low rates may disproportionately affect minority patients. According to Medicaid Enrollment by race and ethnicity as of 2013, Medicaid recipients are 40% white, 21% black, 25% Hispanic, and 14% as others. Given the relative disincentive for surgeons to treated publicly-insured patients, it may be that disparities in quality of care received by patients of minority backgrounds begin in the economic differences generated by medical insurance. Research has shown that uninsured and publicly-insured individuals have higher morbidity and mortality rates [23–27]. Because minority patients are more likely to fall into these insurance categories, they may face higher morbidity and mortality rates. But importantly, this trend has also been shown to persist when insurance status is controlled for [28].

Geographic differences in access to standard of care

Utilization of minimally-invasive surgery varies in different regions of the United States. Cooper et al. [29] investigated this geographic variance by querying the United States nationwide inpatient sample database to identify all patients who underwent appendectomy, colectomy, total abdominal hysterectomy, and lung lobectomy in 2010. In the case of colectomy and appendectomy, this study found that minimally-invasive surgery is more likely to be conducted in urban locations, teaching hospitals, large hospitals, and the Midwest. This finding underscores the import of the hospital itself in influencing patient access to minimally-invasive surgery. Moreover, Cooper et al. [29] emphasized that certain hospitals have a more minimally-invasive culture, whereas others have a more open surgery culture.

Individuals of minority race and/or ethnicity tend to live in urban areas where there are a variety of teaching and community hospitals to choose from. But this may not necessarily translate into flexibility in hospital choice, as black individuals may likely to be treated at low-volume hospitals [30, 31], which have been shown to struggle to provide similar access to laparoscopic surgery due to current reimbursement models [22]. Indeed, several studies on racial disparities in access to high-quality surgical care have found that the phenomenon may be due to hospital-level factors. In cardiac [32], vascular [33], emergency [34], and trauma surgery [35], the risk of mortality among non-white patients has been shown to be positively correlated with the proportion of non-white patients treated a hospital, suggesting that the institutions predominantly responsible for providing care to non-white populations tend to underperform. In more rural areas, which tend to serve populations with a smaller proportion of non-white individuals, it is likely that individuals needing surgery are all sent to one large, teaching hospital that serves as a regional medical center. As such, it may be that the racial disparities identified in this study were influenced by geography.

Implicit bias in healthcare

Lastly, one of the theories suggested by experts regarding the racial disparities in healthcare quality is the role of implicit bias and its influence on clinical decision making [11, 12, 36]. Implicit bias refers to an unintentional and unrecognized preference for one group over another. Because implicit biases necessarily exist unacknowledged, an individual may explicitly believe in social equity but simultaneously have an inadvertent implicit bias against a given group. This implicit bias can affect social interactions with individuals who are members of the group against which the implicit bias is held [37]. It has been demonstrated that clinicians' implicit biases and minority patients' physician mistrust, which is largely resultant of institutional racism, are associated with poor patient-clinician communication [38–42]; which may translate into inferior patient outcomes and quality of care. Researchers have found that this may in fact be the case, as it has been shown that physicians' implicit biases are associated with outcome differences [39–41, 43].

A study by Borkhoff et al. [44] demonstrated that implicit biases can be held against demographic groups other than race. In this study, a group of orthopedic surgeons and family practitioners were provided with radiograph images revealing osteoarthritis coupled with patient vignettes describing moderate unilateral knee pain. When the vignettes were ascribed to a male patient, orthopedic surgeons were 22 times more likely to recommend total knee arthroplasty and family practitioners were 2 times more likely to recommend total knee arthroplasty. Furthermore, Schwartz et al. [45] investigated the prevalence of pro-thin bias in physicians. When given images of obese and non-obese people, healthcare providers were more likely to associate obese people with negative qualities (provided the following three stereotypes: lazy-motivated, smart-stupid, and valuable-worthless) even if their work emphasized obesity research or clinical care. Our investigation utilized a propensity score matching algorithm that balanced for patient gender and BMI. Given the compelling existing research suggesting the prevalence of pro-male and pro-thin bias among physicians, the authors recognize the need for further investigation into the influence of these factors to independently influence access to minimally-invasive surgery.

Heightened insight into the depth of demographic disparities in clinical care has elucidated a widespread need to address the issue of implicit bias in the medical community [12, 46]. It has been shown that physicians of all races demonstrate measurable pro-white bias, as determined by the Race Attitude Implicit Association Test (IAT), a widely-used measure of hidden bias that has been shown to reliably predict behavior [47, 48]. Several studies have shown the impact of implicit bias on clinical decision making. This phenomenon is particularly well studied in cardiovascular disease. Compared to white patients, black patients are less likely to be diagnosed with thrombolysis or indicated for coronary artery bypass surgery and less invasive cardiovascular surgeries [49–51].

Understanding the source of disparities in clinical decision making is complex. Some researchers have speculated that the thorough scientific training received by physicians may strengthen their confidence in their own objectivity, which can in turn cause these individuals to be more likely to act upon biases [52]. It has also been suggested that the time pressure faced by physicians in the clinical setting increases their susceptibility to unconscious bias [12, 53]. Similarly, clinical uncertainty may push doctors to inadvertently rely of inferences about the patient rather than evidence about the patient [36]. The findings herein underscore the far-reaching influence of implicit bias in healthcare, in that they clearly show outcome disparities on the basis of race alone.

Racial disparities in access to other high cost minimally-invasive surgeries

In an effort to contextualize the findings herein, a literature search was conducted to identify current understanding of racial disparities in access to a laparoscopic approach to surgeries that, like those investigated in this study, are high in volume and cost. Bariatric surgery, a widely accepted and scientifically proven method for control of both morbid obesity and obesity-related medical conditions, is one type of surgery where significant disparities according to race, income, education level, and insurance type continue to exist [54]. Similar disparities have been seen in endovascular procedures for peripheral arterial disease. Loja et al. [55] conducted an evaluation of California hospital systems between 2005 and 2009 and noted racial disparities in outcomes of treatment of peripheral arterial disease. The study concluded that Hispanic and black patients had worse amputation-free survival than non-Hispanic whites following endovascular therapy. Additionally, Hispanic and black patients were more likely to undergo lower extremity arterial reinterventions than non-Hispanic white patients. These are just two specific examples that demonstrate difference in access to minimally-invasive procedures in the surgical fields.

The authors have proposed that economic, geographic, and provider-level mechanisms contribute to the racial disparity in access to laparoscopic surgery. We propose that similar factors contribute to racial disparities across general surgery; however, further investigation is required.

Future outlook: minimizing demographic disparities in healthcare

There exists a clear need to address the root of evident racial disparities in patient diagnoses, treatments, and outcomes

and promote clinical decision making that is truly evidence-based and not informed by heuristics. It has been proposed by investigators that the United States ought to implement what is known as a value-based payment system, which provide higher reimbursement rates for procedures that are associated with better patient outcomes [20]. A value-based payment system would include patient reported outcome measures in determining which procedures to incentivize via a higher reimbursement rates. While patient reported outcome measures are qualitative in nature, such measures can be effectively and accurately used and their incorporation into payment reform is widely supported by members of the healthcare industry who conduct research on the relationship between payment and quality of care [56, 57]. Further, a value-based payment system would also satisfy proponents of reimbursement rates founded in resource intensity, as minimally-invasive surgery requires more time and surgical skill [19]. Movement toward minimally-invasive surgery also presents financial benefit to insurance companies and health employers, as demonstrated by Keller et al. in the case of colectomy [58]. Despite the clear import of working to eliminate disparities in healthcare, revising current policy would doubtlessly be a lengthy and arduous task.

Addressing implicit bias in healthcare is equally complex. Perhaps the most logical time to work toward minimizing physician implicit bias is during medical training. Students matriculate with pre-established implicit biases, which have been shown to remain relatively unchanging throughout medical training [12]. Research suggests that simply confronting medical students with data demonstrating their implicit biases (i.e., a high IAT score) accomplishes little, because such data are at odds with self-perceived egalitarianism and is therefore regarded as a personal attack [59, 60]. It has been shown that underscoring the egalitarian goals of medical students prior to engagement in self-reflective discourse increases the likelihood that a student is open to discussing potential need to change his or her own biases [59]. However, awareness of one's own implicit biases alone is not sufficient in truly altering the way an individual perceives others [12]. As such, intentional intervention is required.

Lai et al. [61] conducted comparative testing of 17 interventional methods for reducing implicit biases using IAT scores as a measure of intervention success. This study showed that exposure to counter stereotypical exemplars (i.e., a vignette in which a white man is violent and cruel and a black man is heroic), evaluative conditioning (in which stimuli are paired, such as "black" and "good"), and clearly outlined strategies for overcoming implicit biases are most effective. Devine et al. [62] developed a multi-faceted strategy that effectively reduced anti-black implicit bias among participants over 12-weeks. Here, all participants completed an IAT, ensuring awareness of their own implicit biases. This was followed by training sessions that provided participants with a wide array of bias-reducing strategies, intended to give participants flexibility. Participants also demonstrated increased concern for the undesirable consequences of racial bias [62]. Generally, researchers have advocated for intervention that is multi-faceted, longitudinal, and well-incorporated into medical education curriculum [61–63].

Further exploration is needed to develop an intervention that is both effective and durable [61, 64]. Additionally, some researchers have proposed that increasing the number of black physicians could reduce the incidence of anti-black bias in healthcare [12, 39], a claim that has been well-supported by investigation [47, 65, 66]. For example, Sabin et al. [47] found significant implicit bias amongst physicians of all racial groups with the exception of black physicians, who were neutral, and female physicians, who were found to demonstrate lower implicit bias than their male counterparts. Regardless of the manner in which implicit bias in healthcare are addressed, the path toward minimizing the effects of physician biases on clinical decision making will be complex and challenging.

Study strengths and limitations

Opportunities for training is an important topic that might explain some differences in access to minimally-invasive surgeries. Cooper et al. [29] suggested that variability in appropriate residency and fellowship training may be one reason that a given hospital underperforms minimally-invasive surgery. In a Canadian survey of a colorectal surgeons conducted in 2009, lack of adequate operative time and formal training were cited by surgeons as the main reasons for not performing laparoscopic colon resection [67]. Additionally, it is important to note that fellowship training in minimally-invasive surgery was not formalized until 1997 when minimally-invasive surgery fellowships began to develop. These fellowships were designed to train surgeons in advanced laparoscopic procedures and incorporate novel techniques such as single incision laparoscopic surgery into the skill set of attending surgeons with traditional training. It has been shown that the benefits of minimally-invasive surgery fellowship training improve outcomes for both complicated procedures such as laparoscopic Roux-en-Y gastric bypass and basic laparoscopic procedures such as appendectomies [68, 69]. While laparoscopic equipment may be readily available across all programs, there is lack of literature available demonstrating surgeon comfort level with basic laparoscopic procedures following residency training.

Of note, ACS-NSQIP does not provide specific hospital or physician identification. As a result, the potentially confounding effects of this variable could not be balanced by the propensity score matching algorithm used in the present study. Further, the propensity score matching did not balance for hospital location, and so the effect of geographic

and provider-level characteristics on access to laparoscopic surgery is suggested because it is well-supported by current literature.

In the original data obtained from ACS-NSQIP, there were approximately ten-times more white patients than black patients in all four general surgical procedures. As a result, this study is limited in that many white patients had to be eliminated from analyses in order to implement propensity matching. However, the methodology utilized herein provides a statistically valid model to demonstrate the independent association between race and the surgical approach to abdominal operations. Lastly, because the data used in this study were obtained from ACS-NSQIP, the findings herein are not limited to a single institution and are therefore relevant to general surgical practices across the country.

Concluding remarks

There appears to be racial disparity in the application of a minimally-invasive approach to patients undergoing inguinal hernia repair, cholecystectomy, appendectomy, and colectomy. The authors propose that this disparity is a result of complex social, economic, and geographic factors. The findings herein warrant further investigation into the barriers preventing access to laparoscopic general surgical procedures that racial minorities might face. Additional work to determine if there exists a racial disparity in outcomes for patients undergoing these four surgical procedures needs to be performed.

Compliance with ethical standards

Disclosures Kasey Leigh Wood, Syed F. Haider, Anthony H. Bui, and I. Michael Leitman have no conflicts of interest or financial ties to disclose.

References

1. Cavazzola LT, Rosen MJ (2013) Laparoscopic versus open inguinal hernia repair. Surg Clin N Am 93:1269–1279. https://doi.org/10.1016/j.suc.2013.06.013
2. Coccolini F, Catena F, Pisano M, Gheza F, Fagiuoli S, Di Saverio S, Leandro G, Montori G, Ceresoli M, Corbella D, Sartelli M, Sugrue M, Ansaloni L (2015) Open versus laparoscopic cholecystectomy in acute cholecystitis. Systematic review and meta-analysis. Int J Surg 18:196–204. https://doi.org/10.1016/j.ijsu.2015.04.083
3. Guller U, Hervey S, Purves H, Muhlbaier LH, Peterson ED, Eubanks S, Pietrobon R (2004) Laparoscopic versus open appendectomy: outcomes comparison based on a large administrative database. Ann Surg 239:43–52. https://doi.org/10.1097/01.sla.0000103071.35986.c1
4. Athanasiou CD, Robinson J, Yiasemidou M, Lockwood S, Markides GA (2017) Laparoscopic vs open approach for transverse colon cancer. A systematic review and meta-analysis of short and long term outcomes. Int J Surg 41:78–85
5. Sauerland S, Jaschinski T, Neugebauer EA (2010) Laparoscopic versus open surgery for suspected appendicitis. Cochrane Database Syst Rev. https://doi.org/10.1002/14651858.CD001546.pub3
6. Schwenk W, Haase O, Neudecker J, Muller JM (2005) Short term benefits for laparoscopic colorectal resection. Cochrane Database Syst Rev. https://doi.org/10.1002/14651858.CD003145.pub2
7. Nelson H, Sargent DJ, Wieand HS, Fleshman J, Anvari M, Stryker SJ, Beart RWJ, Hellinger M, Flanagan RJ, Peters W, Ota D (2004) A comparison of laparoscopically assisted and open colectomy for colon cancer. N Engl J Med 350:2050–2059. https://doi.org/10.1056/NEJMoa032651
8. Saber AA, Meslemani AM, Davis R, Pimentel R (2004) Safety zones for anterior abdominal wall entry during laparoscopy: a CT scan mapping of epigastric vessels. Ann Surg 239:182–185. https://doi.org/10.1097/01.sla.0000109151.53296.07
9. Pickett SD, Rodewald KJ, Billow MR, Giannios NM, Hurd WW (2010) Avoiding major vessel injury during laparoscopic instrument insertion. Obstet Gynecol Clin N Am 37:387–397. https://doi.org/10.1016/j.ogc.2010.05.002
10. Gandaglia G, Ghani KR, Sood A, Meyers JR, Sammon JD, Schmid M, Varda B, Briganti A, Montorsi F, Sun M, Menon M, Kibel AS, Trinh QD (2014) Effect of minimally invasive surgery on the risk for surgical site infections results from the national surgical quality improvement program (NSQIP) database. JAMA Surg 149:1039–1044. https://doi.org/10.1001/jamasurg.2014.292
11. Hajjaj FM, Salek MS, Basra MKA, Finlay AY (2010) Non-clinical influences on clinical decision-making: a major challenge to evidence-based practice. J R Soc Med 103:178–187. https://doi.org/10.1258/jrsm.2010.100104
12. Chapman EN, Kaatz A, Carnes M (2013) Physicians and implicit bias: how doctors may unwittingly perpetuate health care disparities. J Gen Intern Med 28:1504–1510. https://doi.org/10.1007/s11606-013-2441-1
13. Varela JE, Nguyen NT (2011) Disparities in access to basic laparoscopic surgery at U.S. academic medical centers. Surg Endosc Other Interv Tech 25:1209–1214. https://doi.org/10.1007/s00464-010-1345-y
14. Austin PC (2014) A comparison of 12 algorithms for matching on the propensity score. Stat Med 33:1057–1069. https://doi.org/10.1002/sim.6004
15. Esnaola NF, Hall BL, Hosokawa PW, Ayanian JZ, Henderson WG, Khuri SF, Zinner MJ, Rogers SO Jr (2008) Race and surgical outcomes: it is not all black and white. Ann Surg 248:647–655
16. Haider AH, Scott VK, Rehman KA, Velopulos C, Bentley JM, Cornwell EE III, Al-Feraie W (2014) Racial disparities in surgical care and outcomes in the United States: a comprehensive review of patient, provider and systemic factors. J Am Coll Surg 15:34–48. https://doi.org/10.1038/nrg3575.Systems
17. Beck DE, Margolin DA (2007) Physician coding and reimbursement. Ochsner J 7:8–15
18. Hoballah JJ, Liao J, Salameh M, Weigel RJ (2008) Physician reimbursement for general surgical procedures in the last century: 1906-2006. J Am Coll Surg 206:670–677. https://doi.org/10.1016/j.jamcollsurg.2007.11.008
19. Roumm AR, Pizzi L, Goldfarb NI, Cohn H (2005) Minimally invasive: minimally reimbursed? An examination of six laparoscopic surgical procedures. Surg Innov 12:261–287. https://doi.org/10.1177/155335060501200313
20. Fader AN, Xu T, Dunkin BJ, Makary MA (2016) A perverse quality incentive in surgery: implications of reimbursing surgeons less for doing laparoscopic surgery. Surg Endosc Other Interv Tech 30:4665–4667. https://doi.org/10.1007/s00464-016-5170-9
21. Angus LDG, Cottam DR, Gorecki PJ, Mourello R, Ortega RE, Adamski J (2003) DRG, costs and reimbursement following

Roux-en-Y gastric bypass: an economic appraisal. Obes Surg 13:591–595
22. Frazee RC, Elliott VG, Larsen W, Lerner S, Minnis KW, Huber C, Nolan J, Papaconstantinou H, Smythe WR (2014) Can laparoscopic cholecystectomy be performed with a positive margin at medicaid reimbursement rates? J Am Coll Surg 218:546–551. https://doi.org/10.1016/j.jamcollsurg.2013.12.031
23. Lemaire A, Cook C, Tackett S, Mendes DM, Shortell CK (2008) The impact of race and insurance type on the outcome of endovascular abdominal aortic aneurysm (AAA) repair. J Vasc Surg 47:1172–1180. https://doi.org/10.1016/j.jvs.2008.01.033
24. Kelz RR, Gimotty PA, Polsky D, Norman S, Fraker D, DeMichele A (2004) Morbidity and mortality of colorectal carcinomasurgery differs by insurance status. Cancer 101:2187–2194
25. Davison KK, Birch LL (2008) Primary payer status affects outcomes for cardiac valve operations. J Am Coll Surg 64:2391–2404. https://doi.org/10.1038/jid.2014.371
26. Ricciardi R, Selker HP, Baxter NN, Marcello PW, Roberts PL, Virnig BA (2008) Disparate use of minimally invasive surgery in benign surgical conditions. Surg Endosc Other Interv Tech 22:1977–1986. https://doi.org/10.1007/s00464-008-0003-0
27. Brookfield KF, Cheung MC, Lucci J, Fleming LE, Koniaris LG (2009) Diparities in survival among women with invasive cervical cancer: a problem of access to care. Cancer 115:166–178
28. Nathan H, Frederick W, Choti MA, Schulick RD, Pawlik TM (2008) Racial disparity in surgical mortality after major hepatectomy. J Am Coll Surg 207:312–319. https://doi.org/10.1016/j.jamcollsurg.2008.04.015
29. Cooper MA, Hutfless S, Segev DL, Ibrahim A, Lyu H, Makary MA (2014) Hospital level under-utilization of minimally invasive surgery in the United States: retrospective review. BMJ 349:g4198
30. Trivedi AN, Sequist TD, Ayanian JZ (2006) Impact of hospital volume on racial disparities in cardiovascular procedure mortality. J Am Coll Cardiol 47:417–424. https://doi.org/10.1016/j.jacc.2005.08.068
31. Gonzalez AA, Sutzko DC, Osborne NH (2017) A national study evaluating hospital volume and inpatient mortality after open abdominal aortic aneurysm repair in vulnerable populations. Ann Vasc Surg 41:1–2. https://doi.org/10.1016/j.avsg.2017.03.113
32. Rangrass G, Ghaferi AA, Dimick JB (2014) Explaining racial disparities in outcomes after cardiac surgery: the role of hospital quality. JAMA Surg 149:223–227. https://doi.org/10.1001/jamasurg.2013.4041
33. Osborne NH, Upchurch GR, Mathur AK, Dimick JB (2009) Explaining racial disparities in mortality after abdominal aortic aneurysm repair. J Vasc Surg 50:709–713. https://doi.org/10.1016/j.jvs.2009.05.020
34. Hall EC, Hashmi ZG, Zafar SN, Zogg CK, Cornwell EE, Haider AH (2019) Racial/ethnic disparities in emergency general surgery: explained by hospital-level characteristics ? Am J Surg 209:604–609. https://doi.org/10.1016/j.amjsurg.2014.11.005
35. Haider AH, Ong'uti S, Efron DT, Oyetunji TA, Crandall ML, Scott VK, Haut ER, Schneider EB, Powe NR, Cooper LA, Cornwell EE (2012) Association between hospitals caring for a disproportionately high percentage of minority trauma patients and increased mortality: a nationwide analysis of 434 hospitals. Arch Surg 147:63–70. https://doi.org/10.1001/archsurg.2011.254
36. Balsa AI, McGuire TG (2003) Prejudice, clinical uncertainty and stereotyping as sources of health disparities. J Health Econ 22:89–116. https://doi.org/10.1016/S0167-6296(02)00098-X
37. Devine PG, Plant EA (2012) Advances in experiemntal social psychology. Academic Press, San Diago
38. Cooper LA, Roter DL, Carson KA, Beach MC, Sabin JA, Greenwald AG, Inui TS (2012) The associations of clinicians' implicit attitudes about race with medical visit communication and patient ratings of interpersonal care. Am J Public Health 102:979–987. https://doi.org/10.2105/AJPH.2011.300558
39. Penner LA, Dovidio JF, Hagiwara N, Foster T, Albrecht TL, Chapman RA, Eggly S (2016) An analysis of race-related attitudes and beliefs in Black cancer patients: implications for health care disparities. J Health Care Poor Underserved 27:1503–1520. https://doi.org/10.1353/hpu.2016.0115
40. Penner LA, Dovidio JF, West TV, Gaertner SL, Albrecht TL, Dailey RK, Markova T (2010) Aversive racism and medical interactions with Black patients: a field study. J Exp Soc Psychol 46:436–440. https://doi.org/10.1016/j.jesp.2009.11.004
41. Blair IV, Steiner JF, Fairclough DL, Hanratty R, Price DW, Hirsh HK, Wright LA, Bronsert M, Karimkhani E, Magid DJ, Havranek EP (2013) Clinicians' implicit ethnic/racial bias and perceptions of care among Black and Latino patients. Ann Fam Med 11:43–52. https://doi.org/10.1370/afm.1442
42. Hagiwara N, Penner LA, Gonzalez R, Eggly S, Dovidio JF, Gaertner SL, West T, Albrecht TL (2013) Racial attitudes, physician-patient talk time ratio, and adherence in racially discordant medical interactions. Soc Sci Med 87:123–131. https://doi.org/10.1016/j.socscimed.2013.03.016
43. Hausmann LRM, Myaskovsky L, Niyonkuru C, Oyster ML, Switzer GE, Burkitt KH, Fine MJ, Gao S, Boninger ML (2015) Examining implicit bias of physicians who care for individuals with spinal cord injury: a pilot study and future directions. J Spinal Cord Med 38:102–110. https://doi.org/10.1179/2045772313Y.0000000184
44. Borkhoff CM, Hawker GA, Kreder HJ, Glazier RH, Mahomed NN, Wright JG (2008) The effect of patients' sex on physicians' recommendations for total knee arthroplasty. Research 178:1–7
45. Schwartz MB, Chambliss HO, Brownell KD, Blair SN, Billington C (2003) Weight bias among health professionals specializing in obesity. Obes Res Clin Pract 11:1033–1039
46. Blair IV, Steiner JF, Havranek EP (2011) Unconscious (implicit) bias and health disparities: where do we go from here? Perm J 15:71–78
47. Sabin JA, Nosek BA, Greenwald AG, Rivera FP (2009) Physicians' implicit and explicit attitudes about race by MD race, ethnicity, and gender. J Health Care Poor Underserved 20:896–913
48. Greenwald AG, Poehlman TA, Uhlmann EL, Banaji MR (2009) Understanding and using the implicit association test: III. Meta-analysis of predictive validity. J Pers Soc Psychol 97:17–41. https://doi.org/10.1037/a0015575
49. Green AR, Carney DR, Pallin DJ, Ngo LH, Raymond KL, Iezzoni LI, Banaji MR (2007) Implicit bias among physicians and its prediction of thrombolysis decisions for black and white patients. J Gen Intern Med 22:1231–1238. https://doi.org/10.1007/s11606-007-0258-5
50. Maynard C, Fisher LD, Passamani ER, Pullum T (1986) Blacks in the coronary artery surgery study (CASS): race and clinical decision making. Am J Public Health 76:1446–1448
51. Kressin NR, Petersen LA (2013) Racial differences in the use of invasive cardiovascular procedures: review of the literature and prescription for future research. Ann Intern Med 135:352–366
52. Uhlmann EL, Cohen GL (2007) "I think it, therefore it's true": effects of self-perceived objectivity on hiring discrimination. Organ Behav Hum Decis Process 104:207–223. https://doi.org/10.1016/j.obhdp.2007.07.001
53. Croskerry P (2002) Achieving quality in clincal decision making: cognitive strategies and detection of bias. Acad Emerg Med 9:1184–1204
54. Martin M, Beekley A, Kjorstad R, Sebesta J (2010) Socioeconomic disparities in eligibility and access to bariatric surgery: a national population-based analysis. Surg Obes Relat Dis 6:8–15. https://doi.org/10.1016/j.soard.2009.07.003

55. Loja MN, Brunson A, Li CS, Carson JG, White RH, Romano PS, Hedayati N (2015) Racial disparities in outcomes of endovascular procedures for peripheral arterial disease: an evaluation of California hospitals, 2005-2009. Ann Vasc Surg 29:950–959. https://doi.org/10.1016/j.avsg.2015.01.006
56. Basch E, Spertus J, Adams Dudley R, Wu A, Chuahan C, Cohen P, Lou Smith M, Black N, Crawford A, Christensen K, Blake K, Goertz C (2015) Methods for developing patient-reported outcome-based performance measures (PRO-PMs). Value Health 18:493–504. https://doi.org/10.1016/j.jval.2015.02.018
57. Squitieri L, Bozic K, Pusic AL (2017) The role of patient-reported outcome measures in value-based payment reform. Value Health 20:834–836. https://doi.org/10.1038/nrg3575.Systems
58. Keller DS, Senagore AJ, Fitch K, Bochner A, Haas EM (2017) A new perspective on the value of minimally invasive colorectal surgery—payer, provider, and patient benefits. Surg Endosc Other Interv Tech 31:2846–2853. https://doi.org/10.1007/s00464-016-5295-x
59. Zestcott CA, Blair IV, Stone J (2015) Examining the presence, consequences, and reduction of implicit bias in health care: a narrative review. Gr Process Intergr Relat 91:165–171. https://doi.org/10.1016/j.chemosphere.2012.12.037.Reactivity
60. Burgess D, Van Ryn M, Dovidio J, Saha S (2007) Reducing racial bias among health care providers: lessons from social-cognitive psychology. J Gen Intern Med 22:882–887. https://doi.org/10.1007/s11606-007-0160-1
61. Lai CK, Marini M, Lehr SA, Cerruti C, Shin JEL, Joy-Gaba JA, Ho AK, Teachman BA, Wojcik SP, Koleva SP, Frazier RS, Heiphetz L, Chen EE, Turner RN, Haidt J, Kesebir S, Hawkins CB, Schaefer HS, Rubichi S, Sartori G, Dial CM, Sriram N, Banaji MR, Nosek BA (2014) Reducing implicit racial preferences: I. A comparative investigation of 17 interventions. J Exp Psychol Gen 143:1765–1785. https://doi.org/10.1037/a0036260
62. Devine PG, Forscher PS, Austin AJ, Cox WTL (2012) Long-term reduction in implicit race bias: a prejudice habit-breaking intervention. J Exp Soc Psychol 48:1267–1278. https://doi.org/10.1016/j.jesp.2012.06.003
63. Gonzalez CM, Kim MY, Marantz PR (2014) Implicit bias and its relation to health disparities: a teaching program and survey of medical students. Teach Learn Med 26:64–71
64. Zestcott CA, Blair IV, Stone J (2016) Examining the presence, consequences, and reduction of implicit bias in health care: a narrative review. Gr Process Intergr Relat 19:528–542. https://doi.org/10.1177/1368430216642029
65. Komaromy M, Grumbach K, Drake M, Vranizan K, Lurie N, Keane D, Bindman AB (1996) The role of Black and Hispanic physicians in providing health care for Underserved populations. N Engl J Med 334:1305–1310. https://doi.org/10.1097/njh.0000000000000338
66. Lyndonna MM, Zallman L, Woolhandler S, Bor DH, McCormick D (2014) Minority physicians' role in the care of underserved patients: diversifying the physician workforce may be key in addressing health disparities. JAMA Intern Med 174:289–291
67. Moloo H, Haggar F, Martel G, Grimshaw J, Coyle D (2009) The adoption of laparoscopic colorectal surgery: a national survey of general surgeons. Can J Surg 52:455–462
68. Ali MR, Tichansky DS, Kothari SN, McBride CL, Fernandez AZ, Sugerman HJ, Kellum JM, Wolfe LG, Demaria EJ (2010) Validation that a 1-year fellowship in minimally invasive and bariatric surgery can eliminate the learning curve for laparoscopic gastric bypass. Surg Endosc Other Interv Tech 24:138–144. https://doi.org/10.1007/s00464-009-0550-z
69. Gray KD, Burshtein JG, Obeid L, Moore MD, Dakin G, Pomp A, Afaneh C (2018) Laparoscopic appendectomy: minimally invasive surgery training improves outcomes in basic laparoscopic procedures. World J Surg 42:1706–1713. https://doi.org/10.1007/s00268-017-4374-z