Racial, Gender, and Socioeconomic Status Bias in Senior Medical Student Clinical Decision-Making: A National Survey

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BACKGROUND: Research suggests stereotyping by clinicians as one contributor to racial and gender-based health disparities. It is necessary to understand the origins of such biases before interventions can be developed to eliminate them. As a first step toward this understanding, we tested for the presence of bias in senior medical students.

OBJECTIVE: The purpose of the study was to determine whether bias based on race, gender, or socioeconomic status influenced clinical decision-making among medical students.

DESIGN: We surveyed seniors at 84 medical schools, who were required to choose between two clinically equivalent management options for a set of cardiac patient vignettes. We examined variations in student recommendations based on patient race, gender, and socioeconomic status.

PARTICIPANTS: The study included senior medical students.

MAIN MEASURES: We investigated the percentage of students selecting cardiac procedural options for vignette patients, analyzed by patient race, gender, and socioeconomic status.

KEY RESULTS: Among 4,603 returned surveys, we found no evidence in the overall sample supporting racial or gender bias in student clinical decision-making. Students were slightly more likely to recommend cardiac procedural options for black (43.9 %) vs. white (42 %, p=.03) patients; there was no difference by patient gender. Patient socioeconomic status was the strongest predictor of student recommendations, with patients described as having the highest socioeconomic status most likely to receive procedural care recommendations (50.3 % vs. 43.2 % for those in the lowest socioeconomic status group, p<.001). Analysis by subgroup, however, showed significant regional geographic variation in the influence of patient race and gender on decision-making. Multilevel analysis showed that white female patients were least likely to receive procedural recommendations.

CONCLUSIONS: In the sample as a whole, we found no evidence of racial or gender bias in student clinical decision-making. However, we did find evidence of bias with regard to the influence of patient socioeconomic status, geographic variations, and the influence of interactions between patient race and gender on student recommendations.

KEY WORDS: students, medical; decision-making; health care disparities.
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INTRODUCTION

Disparities in health and health care continue to plague our nation. Extensive evidence shows differences across racial/ethnic, gender, and geographic groupings.[1] Access to health care, cultural and language differences, communication and trust barriers, and socioeconomic differences are clearly contributors to these disparities.[1] However, there is evidence that stereotyping or decisional biases by clinicians in some situations may also play a role.[1–12] For example, Schulman, et al. found that recommendations among practicing clinicians for standardized video vignette patients presenting with cardiac symptoms varied according to patient race and gender.[13] Another study showed variations by patient race and socioeconomic status in clinician expectations of post-angiogram cardiac patients.[14] Similarly, pain medication administered for major fractures in the emergency setting was shown to vary by patient ethnicity.[15]

Evidence of decisional bias among practicing clinicians raises questions regarding the origin of such biases as well as ways to eliminate them. Do they originate from similar biases that exist prior to entry into a medical career, are they a reflection of training processes, or are they a product of the practice environment? Answers to these questions could be of value to medical educators and policymakers.

Preliminary investigations seeking similar evidence of decisional bias among medical students have shown mixed findings. In one study, students shown videotapes of standardized black female or white male patients ascribed a lower value to the quality of life of the black female "patient" than to the white male "patient."[16] On the other hand, a more recent study failed to show that student assessments of patient vignettes varied by race or social class.[17] Both of these studies, however, were based on students who were early in their medical school training and had no clinical experience, and the studies did not assess clinical decision-making. A third study used clinical-level students from a single institution to demonstrate evidence of situational gender bias in vignette patient diagnoses.[18] We are unaware of any other published studies investigating evidence of bias regarding race, gender, or socioeconomic status in clinical decision-making among clinical-level medical students.

As a first step toward determining the origins of these biases, we undertook a study to test for the presence of such bias among medical students nearing the end of their medical school clinical training. Specifically, we tested for bias with respect to patient race, gender, and socioeconomic status (SES) in student recommendations for cardiac care vignette patients. We chose to study senior medical students in order to test whether such biases are present early in clinical training.

METHODS

Design and Overview. We invited a national sample of senior medical students during the 2011–2012 academic year to participate in a brief online survey in which they were asked to choose between two clinically equivalent diagnostic or therapeutic options for a set of patient vignettes. We evaluated differences in student recommendations among the vignettes, when we varied the patient race, gender, and SES across the sample, with all other elements remaining fixed.

Survey Instrument. Three academic practicing cardiologists developed a set of eight vignettes of patients requiring cardiac diagnostic or treatment services. We focused these vignettes on cardiac care, given the well-supported evidence that blacks and women, despite clinically equivalent circumstances, are less likely to receive cardiac care procedures.[1,19–31] Two clinically equivalent options for recommendations, one involving a procedure and the other a non-procedural option, were developed for each vignette. The vignettes were created under the premise that in situations where clinical equivalency does not allow a clear choice, social psychology concepts would suggest that students would then be forced to base their decisions on secondary, non-clinical factors, such as patient demographics.

We included an additional 15 patient vignettes ("non-cardiac" vignettes) in the survey in order to divert attention from the research questions related to cardiac care patients. These non-cardiac vignettes presented the student with clinical scenarios involving controversy in preventive care services (e.g., age to begin mammography), medication choices (brand vs. generic equivalent), or management strategies for newly diagnosed chronic illness (behavior change vs. medication).

In the cardiac care vignettes, we varied the race and gender of the patient in each vignette across the sample such that individual students receiving the same vignette in their survey versions might see the patient as either male or female and/or black or white. Patient SES (as determined solely by the Hollingshead occupational scale[32]) was fixed for each individual vignette, but varied across the set of eight cardiac vignettes. Patient attributes were not varied for the non-cardiac vignettes.

We designed all vignettes to be quickly readable. Each participating student received a total of eight vignettes—three cardiac and five non-cardiac—randomly mixed and distributed across the sample to reduce the probability of neighboring students receiving the same vignettes. In order to further support students' use of non-clinical factors in decision-making, the accompanying instructions clearly emphasized the clinical equivalence of the options presented and that students should not attempt to determine the "correct" option, as either option would be appropriate.

After students had completed the vignettes, they were asked to provide certain demographic information. They were also offered an opportunity to be entered into drawings to win one of two $50 gift certificates to be drawn at each medical school and one of 20 iPad 2s to be drawn nationally.

Survey invitations and administration were conducted online. We tracked screen time to record the length of time students took to answer each vignette. We preserved participant anonymity by directing survey data and contact email addresses for the drawings to separate, unlinked databases.

Survey Piloting. Cardiac care vignettes were piloted first with family medicine residents at two medical schools and then with earlier classes of graduating seniors at seven medical schools. Readers may view a final version of the survey at: http://www.medical-decision-making.com/.

Distribution Process. We contacted students through their medical schools. Depending on school preference, we sent invitations with embedded links to the survey either directly to the students (with up to five solicitations to non-responders), to a student LISTSERV, or to a contact person at the school, who then forwarded the invitation to the senior students. When a student clicked on the link to the survey, a unique version of the survey in mix of vignettes and cardiac patient race/gender was generated. In addition, we varied the order in which the options for each vignette were presented to the student. Automated re-invitation messages were forwarded every 7 days after the initial invitation.

Review and Approval Process. The study protocol was reviewed by the University of New Mexico Institutional

Review Board and was determined to be exempt. Subsequently, we sought approval to survey school seniors from the administrators at 130 of the 131 U.S. allopathic medical school campuses graduating seniors in 2012. We also sought approval from the institutional review board at each school whose administrators agreed to participate.

Analysis. We eliminated from analysis any returned survey for which the mean recorded viewing time for the cardiac vignettes was less than 10 seconds—considered as the minimum valid length of time needed to read and respond to a vignette—in order to reduce contamination by respondents participating solely to be entered in the incentive drawings. We examined our remaining sample using standard descriptive statistics. We then compared proportions of seniors recommending cardiac procedural options by vignette patient gender, race, and SES using chi-square statistics. We tested for variation in procedural recommendations by student demographics, again with chi-square statistics. Because national database studies have suggested some regional disparities in delivery of cardiac services, we next examined the data for geographic

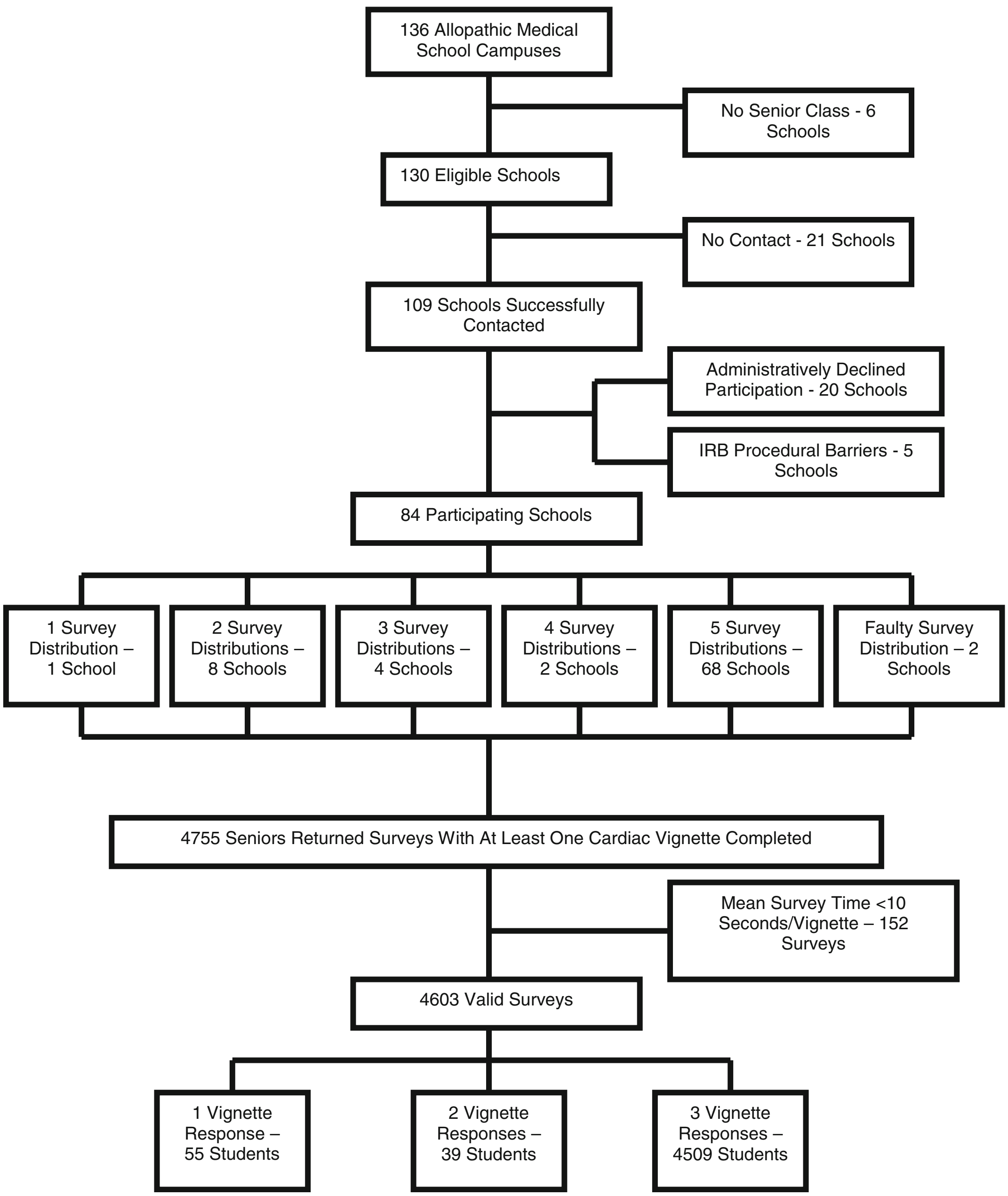

Fig. 1 Flow chart of participation in senior medical student survey

regional differences in recommendations.[33,34] To search for similar geographic patterns in our findings, we grouped students by the Association of American Medical Colleges (AAMC) approach to regional grouping of states: Northeast, South, Central, and West (Appendix).[35]We also used each school's self-description (obtained from its website) as "public" or "private" to categorize the schools. Finally, we used weighted multilevel multivariate models to estimate the effects of patient gender, race, and SES on student recommendations, while controlling for student and school descriptors, as well as for clustering by medical school and for variation in medical school senior class size and response rate. These models were weighted by size of medical school class and individual school response rate. We looked for and found in one of the eight cardiac vignettes response patterns indicating a first position response bias ($p<.01$), so we included a variable for response order.

RESULTS

Sample Characteristics. We successfully contacted administrators of 109 of the 130 school campuses over the 9-month enrollment period from August 2011 to March 2012. Twenty-five contacted schools declined to participate (Fig. 1), for a variety of reasons (e.g., administrator denial, local institutional review board process not open to outside investigators, etc.), resulting in a total of 84 participating schools (77 % of successfully contacted schools, 65 % of eligible schools). Data showed that public schools were more likely than private schools to participate (public 73 % vs. private 50 % participation, $p < 0.01$), and participating schools had a higher median percentage of students entering primary care in 2011 (41 % vs. 38 %, $p<.01$, Wilcoxon signed-rank test).[36]

We received a total of 4,603 valid surveys from 11,438 seniors at the 84 schools (overall response rate 40.2 %). Demographic characteristics of these students compared with the students participating in the 2012 AAMC Graduate Questionnaire are presented in Table 1. Overall, the two samples were similar, though participants in our survey were slightly more likely to be white and non-Hispanic, and slightly more likely to be entering family medicine, internal medicine, or pediatrics.

Table 1 Comparison of Survey Participants to Association of American Medical Colleges (AAMC) Senior Medical Student Survey Participants, 2012*

	Survey respondents	2012 AAMC Graduate Questionnaire respondents*	p value
	n=4,603	*n*=13,681	
Age (median)	26	27	–
Female (%)	50.4	48.9	0.08
Race/ethnicity (%)			
Hispanic/Latino	5.2	7	<0.001
Not Hispanic/Latino	94.8	93	
White	76.3	71.6	<0.001
Black/African American	5.2	6.9	<0.001
Asian	17.7	23.8	<0.001
Native Hawaiian/ Pacific Islander	0.5	0.3	0.02
American Indian/ Alaska Native	1.1	0.9	0.15
Socioeconomic status, family of origin (%)			
Upper	6.4	–	–
Upper middle	38.6	–	–
Middle	40.6	–	–
Lower middle, lower	14.4	–	–
Specialty training plans (%)			
		N=10,167	
Anesthesiology	6.8	7.9	<0.001
Dermatology	2.1	2.6	
Emergency medicine	7.6	9.0	
Family medicine	9.9	5.9	
Internal medicine, incl. subspecialties	20.0	16.1	
Neurology	2.1	2.6	
Obstetrics & gynecology	6.6	6.4	
Ophthalmology	2.4	3.1	
Pathology	1.2	2.0	
Pediatrics	12.2	9.9	
Physical medicine & rehabilitation	1.2	1.3	
Preventive medicine	<0.1	0.1	
Psychiatry	3.4	4.0	
Radiology	4.6	5.8	
Surgery, incl. subspecialties	17.6	18.9	
Other	1.5	4.3	
Unknown	0.7	N/A	

**Association of American Medical Colleges: "2012 Medical School Graduation Questionnaire." Available at: https://www.aamc.org/download/300448/data/2012gqallschoolssummaryreport.pdf*

Sample size variations: age/gender n=4,460; race/ethnicity n=4,463; SES n=4,414; specialty training plans n=4,429

Principal Analysis: Relationship of Vignette Race, Gender, and SES to Student Recommendations. Table 2 presents the results of bivariate analyses of student recommendations for cardiac vignette patients based on patient race and gender. Overall, students were slightly but statistically significantly more likely to recommend a procedural option for patients who were described as black (43.9 %) than patients described as white (42.0 %) ($p=.03$). With regard to gender, there was no statistically significant difference in recommendations between vignette patients presented as male (43.5 % procedural recommendation) vs. female (42.4 %) ($p=.18$). On the other hand, patient SES was a strong and significant predictor of student recommendations, as

Table 2 Comparison of Senior Medical Student Recommendations for Cardiac Vignette Patients Based on Vignette Patient Gender and Race, 2012

Student group	Vignette gender					Vignette race				
	Male		Female		X^2 (p value)	Black		White		X^2 (p value)
	N	Procedure (%)	N	Procedure (%)		N	Procedure (%)	N	Procedure (%)	
Overall	6,758	43.5	6,902	42.4	1.76 (0.18)	6,845	43.9	6,815	42.0	4.75 (0.03)
Vignette SES*										
1–2	2,501	41.1	2,586	38.8	2.66 (0.10)	2,541	41.6	2,546	38.2	6.20 (0.01)
3–4	1,738	42.8	1,713	40.1	2.49 (0.11)	1,773	42.6	1,678	40.2	1.97 (0.16)
7–9	2,519	46.5	2,603	47.4	0.47 (0.49)	2,531	47.0	2,591	46.9	0.004 (0.95)
Student gender										
Male	3,325	42.7	3,309	41.7	0.72 (0.39)	3,371	43.2	3,263	41.3	2.48 (0.12)
Female	3,312	44.0	3,431	42.8	1.05 (0.31)	3,333	44.1	3,410	42.7	1.36 (0.24)
Unknown	121	51.2	162	48.1		141	55.3	142	43.7	
Student race/ethnicity										
AA, H, NA †	717	45.6	767	45.8	0.004 (0.95)	751	45.8	733	45.6	0.01 (0.93)
Other	5,838	43.1	5,875	41.8	2.11 (0.15)	5,869	43.4	5,844	41.6	3.88 (0.05)
Unknown	203	47.3	260	45.8		225	5.7	238	42.4	
Student SES										
Low or lower middle	908	45.5	993	42.5	1.72 (0.19)	911	44.2	990	43.6	0.07 (0.79)
Middle	2,692	42.5	2,690	41.6	0.48 (0.49)	2,758	42.6	2,624	41.4	0.77 (0.38)
Upper middle	2,546	44.0	2,561	42.7	0.79 (0.37)	2,528	44.9	2,579	41.8	4.74 (0.03)
Upper	420	4.7	429	43.4	0.61 (0.44)	434	41.2	415	42.9	0.24 (0.63)
Unknown	192	49.0	229	46.3 %		214	52.3 %	207	42.5	
Geographic region										
Central	1,836	44.0	1,894	41.3	2.82 (0.09)	1,906	42.4	1,824	42.9	0.09 (0.77)
Northeast	1,470	43.7	1,504	39.8	4.68 (0.03)	1,484	43.7	1,490	39.7	4.73 (0.03)
South	2,599	43.4	2,674	45.0	1.48 (0.22)	2,638	45.7	2,635	42.7	4.64 (0.03)
West	853	42.7	830	41.2	0.37 (0.54)	817	41.9	866	42.0	0.01 (0.94)
School ownership										
Private	1,852	44.4	1,836	40.6	5.31 (0.02)	1,848	43.6	1,840	41.5	1.65 (0.20)
Public	4,906	43.2	5,066	43.0	0.03 (0.87)	4,997	44.0	4,975	42.2	3.13 (0.08)

* *Socioeconomic Status Grouped by Ranking, with Level 1 Lowest SES and Level 9 Highest SES*
†*African American, Hispanic, and Native American*

shown in Table 3, with the highest SES grouping (SES levels 7–9) most likely to receive procedural recommendations (p<.001).

Interactions of Race, Gender, and SES. We next examined recommendation proportions for the four combinations of patient race and gender (Table 4). Overall, there was a non-significant difference in white females being offered procedures less frequently than any other group. With inclusion of SES, when the patient was presented as being in the lowest SES group (SES 1–2), students were more likely to recommend procedures for black patients (Table 2), and least likely to do so for white female patients (Table 4).

Subgroup Analysis: Relationship of Student Demographics, Geographic Region, and School Type to Student Recommendations. Student Demographics. We found that students who described their family of origin as upper middle class or who described their race/ethnicity as other than African American, Hispanic, or Native American were more likely to recommend procedural options for patients described as black (Table 2). Recommendations based on patient vignette gender and on patient SES did not vary across student demographic subgroups, with one exception: students who described themselves as African American, Hispanic, or Native American showed no differences in recommendations based on the patient SES (Table 3).

Geographic Region. In examining geographic area subgroups, we found that students from schools in the Northeast and the South demonstrated greater preference for procedural options with black patients (Table 2), and those from schools in the Northeast were significantly less likely to recommend procedural options if the patient was presented as a female (Table 2). Students across geographic areas showed the same preference for procedural options among higher SES patients (Table 3), with the exception of students attending schools in the West, where that difference was not seen.

School Type. Type of school, private or public, had no influence on overall group patterns with regard to patient race or SES (Tables 2 and 3), but those from private schools

Table 3 Comparison of Senior Medical Student Recommendations for Cardiac Vignette Patients Based on Vignette Patient Socioeconomic Status (SES), 2012

Variable	Vignette patient SES*						X^2 (p value)
	1–2		3–4		7–9		
	N	Procedure (%)	N	Procedure (%)	N	Procedure (%)	
Total	5,087	39.9	3,451	41.4	5,122	47.0	56.06 (<0.001)
Vignette patient							
Black male	1,232	41.9	911	44.5	1,246	46.1	4.62 (0.10)
Black female	1,309	41.4	862	40.6	1,285	47.9	15.19 (<0.001)
White male	1,269	40.3	827	40.9	1,273	46.8	12.96 (0.002)
White female	1,277	36.2	851	39.6	1,318	47.0	32.76 (<0.001)
Student gender							
Male	2,516	38.6	1,654	42.4	2,464	45.8	26.08 (<0.001)
Female	2,461	41.1	1,740	39.9	2,542	48.0	35.13 (<0.001)
Unknown	110	42.7	57	59.6	118	50.9	
Student race/ ethnicity							
AA, H, NA	561	44.0	396	44.2	527	48.6	2.75 (0.25)
Other	4,355	39.4	2,952	40.5	4,406	46.7	53.48 (<0.001)
Unknown	171	38.6	103	56.3	189	48.1	
Student SES†							
Low/lower middle	727	40.2	490	44.3	684	47.7	8.07 (0.02)
Middle	2,040	39.5	1,335	40.1	2,007	45.9	20.21 (<0.001)
Upper middle	1,836	40.3	1,327	41.3	1,944	47.6	23.39 (<0.001)
Upper	326	39.0	204	39.2	319	47.0	5.19 (0.07)
Unknown	158	42.4	95	52.6	168	49.4	
Geographic region							
Central	1,401	38.3	947	40.4	1,382	48.5	31.79 (<0.001)
Northeast	1,089	38.9	733	38.7	1,152	46.2	15.57 (<0.001)
South	1,956	41.1	1,361	42.8	1,956	48.3	22.16 (<0.000)
West	641	41.5	410	44.1	632	41.0	1.11 (0.57)
School ownership							
Private	1,350	40.3	932	39.4	1,406	46.7	16.69 (<0.001)
Public	3,737	39.8	2,519	42.2	3,716	47.	41.36 (<0.001)

**Socioeconomic status, grouped by ranking, with level 1 lowest SES and level 9 highest SES*
†Self-categorized socioeconomic status of family of origin

were significantly less likely to recommend procedural options for female patients (Table 2).

Multilevel Analysis. Results of multilevel modeling (Table 5) showed findings similar to bivariate analyses. Black male patients were statistically significantly more likely to receive procedural recommendations than white female patients; patients in the highest SES were most likely to receive procedural recommendations. Students from the Northeast were least likely and those from the South most likely to recommend procedural options. The intraclass correlation coefficient was 0.005, indicating a low level of cluster bias.

DISCUSSION

We found no evidence in the overall sample of racial bias in clinical decision-making leading to fewer recommendations for cardiac procedural services for black vignette patients. Indeed, students recommended procedural services slightly more frequently for black than white patients. We also found no evidence in our overall sample of clinical decision-making bias related to patient gender. We did find a clear variation in student recommendations by patient SES, with the highest SES patients more likely to receive procedural recommendations.

Our results present a more complex picture, however, when subjected to detailed secondary analyses. We found regional differences, with students graduating from schools in the Northeast more likely to recommend procedures if the patient was black or was male. Students from private schools were less likely to recommend procedural choices for female patients.

Our findings are open to a variety of interpretations, the most optimistic of which is that, overall, they reveal evolving clinical decision-making, perhaps reflecting increasing sensitivity to the problem of racial and gender-based disparities. The variations by patient SES, however, suggest that even with the overall findings related to race, more work needs to be done to fully eliminate bias in clinical decision-making.

An alternative interpretation is that overall rates related to racial and gender-based decision-making may

Table 4 Comparison of Senior Medical Student Recommendations for Cardiac Vignette Patients Based on Combinations of Vignette Patient Race and Gender, 2012

Variable	Vignette race and gender								X^2 (p value)
	Black male		Black female		White male		White female		
	N	Procedure (%)	N	Procedure (%)	N	Procedure (%)	N	Procedure (%)	
Total	3,389	44.1	3,456	43.6	3,369	42.9	3,446	41.2	6.99 (0.07)
Vignette SES*									
1–2	1,232	41.9	1,309	41.4	1,269	40.3	1,277	36.2	10.70 (0.01)
3–4	911	44.5	862	40.6	827	40.9	851	39.6	4.96 (0.17)
7–9	1,246	46.1	1,285	47.9	1,273	46.8	1,318	47.0	0.76 (0.86)
Student gender									
Male	1,660	43.6	1,711	42.8	1,665	41.9	1,598	40.6	3.32 (0.34)
Female	1,672	44.3	1,661	43.9	1,640	43.8	1,770	41.7	2.90 (0.41)
Unknown	57	57.9	84	53.6	64	45.3	78	42.3	
Student race/ethnicity									
AA, H, NA†	360	45.0	391	46.5	357	46.2	376	44.9	0.31 (0.96)
Other	2,936	43.8	2,933	42.9	2,902	42.5	2,942	40.7	6.21 (0.10)
Unknown	93	51.6	132	50.0	110	43.6	128	41.4	
Student SES									
Low/lower middle	440	44.3	471	44.2	468	46.6	522	41.0	3.20 (0.36)
Middle	1,370	42.4	1,388	42.8	1,322	42.6	1,302	40.2	2.28 (0.52)
Upper middle	1,279	45.9	1,249	43.8	1,267	42.0	1,312	41.7	5.90 (0.12)
Upper	208	40.4	226	42.0	212	41.0	203	44.8	0.97 (0.81)
Unknown	92	53.3	122	51.6	100	45.0	107	40.2%	
Geographic region									
Central	943	44.8	963	40.1	893	43.2	931	42.5	4.42 (0.22)
Northeast	725	44.8	759	42.6	745	42.6	745	36.9	10.39 (0.02)
South	1,305	44.5	1,333	46.8	1,294	42.2	1,341	43.3	6.34 (0.10)
West	416	40.4	401	43.4	437	44.9	429	39.2	3.64 (0.30)
School ownership									
Private	932	45.0	916	42.1	920	43.8	920	39.1	7.27 (0.06)
Public	2,457	43.8	2,540	44.1	2,449	42.6	2,526	41.9	3.37 (0.34)

**Socioeconomic status, grouped by ranking, with level 1 lowest SES and level 9 highest SES*
†African American, Hispanic, and Native American

obscure important differences within the population of students. Counterbalancing pockets (e.g., geographic regions) of bias might still exist within the larger medical student population. Evidence of differences in rates of procedural choice by region and type of school support this interpretation, especially with regard to white female patients. These latter results emphasize the work that lies ahead in determining the basis for these observations, and they also underscore the importance of considering the interaction between race, gender, and SES in disparities in decision-making.

A further interpretation of our findings is that, in general, they demonstrate success in reducing or eliminating explicit bias, while not addressing implicit bias. Explicit bias, operating at a conscious level, is under an individual's control, and is therefore subject to training, reflection, social pressure, and correction.[37] Implicit bias, on the other hand, operates at a subconscious level, is not under voluntary control, and surfaces only under certain conditions, such as fatigue, decisional time pressures, or situational stresses, without the individual's awareness.[38]

Haider et al. studied matriculating medical students and found evidence among these students that implicit bias may exist in the absence of explicit bias.[17] Our design attempted to elicit implicit as well as explicit bias through our emphasis on rapid response to the survey questions and use of toss-up scenarios. However, it is quite possible that this effort was ineffective in evoking implicit biases. This study, therefore, should not be considered a test for the presence or absence of implicit bias.

Limitations. Although our study had none of the quality flaws noted in a recent systematic review of research on racial bias in health care practitioners,[11] it does have several potential limitations. It is possible that our efforts at blinding students to our interest in stereotyping in decision-making were not successful, and as a result, our findings are not valid representations of the students' true decision-making tendencies. In this case, a social desirability bias may have influenced student recommendations, resulting in the slightly increased rate of procedural recommendations for blacks.

Table 5 Results of Multilevel Multivariable Analysis of Student Recommendations for Cardiac Vignette Patients

Variables included in the analysis	Procedure (%)	p value	Significant differences
Vignette race and gender			
Black male	47.4	0.02	Black male vs. white female
Black female	47.0		
White male	46.4		
White female	44.1		
Vignette SES			
1–2	43.2	<0.001	1–2 vs. 7–9
3–4	45.2		3–4 vs. 7–9
7–9	50.3		
Student gender			
Male	44.4	0.64	N/A
Female	44.8		
Unknown	49.5		
Student race/ethnicity - black, Hispanic, or American Indian			
Yes	48.4	0.03	No vs. yes
No	45.0		
Unknown	45.3		
Student SES*			
Low/lower middle	46.5	0.20	N/A
Middle	44.2		
Upper middle	45.8		
Upper	46.2		
Unknown	48.4		
Type of school			
Private	46.3	0.93	N/A
Public	46.2		
Location of school			
Central	46.8	0.02	Northeast vs. South
Northeast	44.9		
South	47.9		
West	45.3		

**Self-described socioeconomic status of family of origin*

However, this possibility would be difficult to reconcile with our findings demonstrating evidence of decision-making bias in interactions between race, gender, and SES. Another concern might be the use of vignettes to search for evidence of stereotyping in decision-making, although several studies have shown vignettes to be accurate in reflecting actual clinical practice.[39–43] The survey response rate among students at participating schools (40.2 %) is low enough that some might question the validity of the sample. Although our data show relatively few differences among survey respondents and the larger population of senior medical students as depicted by the AAMC survey, suggesting sample validity, it is possible that non-participants and students from non-participating schools may demonstrate different decision-making tendencies than those reflected in these data. Finally, with regard to variations in student recommendations by patient SES, it is possible that cost-of-care perspectives led students to select care options based on expected ability to pay.

Because of the large sample size, we were able to demonstrate statistically significant results despite relatively small absolute differences in recommendations among study groups. Given the high prevalence of cardiac disease, however, even small variations across the population can translate into large numbers of individuals affected. This importance of small differences is comparable to that seen in the post-myocardial infarction use of beta-blocker medications, which have been shown to produce a 1.8 % reduction in long-term mortality rates compared with patients not using beta-blockers.[44]

Conclusions. Our national survey of senior medical students is reason for cautious optimism that racial bias in clinical decision-making may be less common in the future. Much work still needs to be done, however, as reflected in our findings of variations by region and between public and private schools, of the strong influence of patient SES on students' approach to toss-up clinical scenarios, and of the interplay between race, gender, and SES. We need to better understand these differences and their origins, whether subsequent medical training changes the picture painted by our findings, and the influence, if any, of implicit bias on clinical decision-making. Research to explore the driving influences on decision-making among medical students and the elements present in the training environment that promote or eliminate bias is an important next step. Most importantly, we need to use such understanding to promote effective solutions for preventing these tendencies in the future and for eliminating any lingering biases in current clinical decision-making.

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APPENDIX

Table 6 Association of American Medical Colleges Geographic Categorization of Medical Schools[33]

Northeast	Central	South	West
University of Connecticut School of Medicine	Loyola University Chicago Stritch School of Medicine	University of Alabama School of Medicine	University of Arizona College of Medicine
Georgetown University School of Medicine	Southern Illinois University School of Medicine	University of South Alabama College of Medicine	University of California, Davis, School of Medicine
Howard University College of Medicine	University of Chicago Division of the Biological Sciences The Pritzker School of Medicine	University of Arkansas for Medical Sciences College of Medicine	University of California, Irvine, School of Medicine
Johns Hopkins University School of Medicine	University of Illinois - Chicago	University of Florida College of Medicine	University of California, San Diego School of Medicine
Boston University School of Medicine	University of Illinois - Urbana	University of Miami Leonard M. Miller School of Medicine	University of California, San Francisco, School of Medicine
Tufts University School of Medicine	University of Illinois - Peoria	University of South Florida College of Medicine	University of Colorado School of Medicine
University of Massachusetts Medical School	University of Illinois - Rockford	Emory University School of Medicine	University of Nevada - Las Vegas
Dartmouth Medical School	Indiana University School of Medicine	Medical College of Georgia School of Medicine	University of Nevada School of Medicine - Reno
Albany Medical College	University of Kansas School of Medicine	Mercer University School of Medicine	University of New Mexico School of Medicine
Albert Einstein College of Medicine of Yeshiva University	Michigan State University College of Human Medicine	Morehouse School of Medicine	Oregon Health & Science University School of Medicine
Mount Sinai School of Medicine	University of Michigan Medical School	University of Kentucky College of Medicine	University of Utah School of Medicine
State University of New York Downstate Medical Center College of Medicine	Wayne State University School of Medicine	Louisiana State University School of Medicine in Shreveport	University of Washington School of Medicine
The School of Medicine at Stony Brook University Medical Center	Saint Louis University School of Medicine	Duke University School of Medicine	
University at Buffalo State University of New York School of Medicine & Biomedical Sciences	University of Missouri-Columbia School of Medicine	The Brody School of Medicine at East Carolina University	
University of Rochester School of Medicine and Dentistry	Washington University in St. Louis School of Medicine	University of North Carolina at Chapel Hill School of Medicine	
Pennsylvania State University College of Medicine	Creighton University School of Medicine	University of Oklahoma College of Medicine	
University of Pennsylvania School of Medicine	University of Nebraska College of Medicine	Ponce School of Medicine and Health Sciences	
The Warren Alpert Medical School of Brown University	University of North Dakota School of Medicine and Health Sciences	Medical University of South Carolina College of Medicine	
University of Vermont College of Medicine	Case Western Reserve University School of Medicine	University of Tennessee Health Science Center College of Medicine	
	Northeastern Ohio Universities Colleges of Medicine and Pharmacy	Baylor College of Medicine	
	Ohio State University College of Medicine	Texas A&M Health Science Center College of Medicine	
	Wright State University Boonshoft School of Medicine	Texas Tech University Health Sciences Center School of Medicine	
	Sanford School of Medicine The University of South Dakota	The University of Texas School of Medicine at San Antonio	
	University of Wisconsin School of Medicine and Public Health	University of Texas Medical Branch School of Medicine	
		University of Texas Medical School at Houston	
		University of Texas Southwestern Medical Center at Dallas Southwestern Medical School	
		Eastern Virginia Medical School	
		University of Virginia School of Medicine	
		Virginia Commonwealth University School of Medicine	
		West Virginia University School of Medicine	