



## AOA Critical Issues in Education

# Perception of Residency Program Diversity Is Associated With Vulnerability to Race and Gender Stereotype Threat Among Minority and Female Orthopaedic Trainees

Risa T. Reid, MD, Susan M. Odum, PhD, Patrick J. Rosopa, PhD, Jaysson T. Brooks, MD, FAOA, Brian P. Scannell, MD, FAOA, Selina Poon, MD, FAOA, Tyler Williams, BA, Joshua C. Patt, MD, MPH, FAOA, Gabriella E. Ode, MD, FAOA, and the Collaborative Orthopaedic Educational Research Group (COERG)

*Investigation performed at Atrium Health Musculoskeletal Institute, Charlotte, NC*

**Introduction:** Stereotype threat (ST) is a psychological phenomenon in which perceived fear of confirming negative stereotypes about one's identity group leads to impaired performance. Gender and racial ST has been described in various academic settings. However, it is prevalence in orthopaedic surgery, where women and minorities are underrepresented, has not been examined. This study analyzes the prevalence of ST among orthopaedic surgery residents and fellows.

**Methods:** US orthopaedic trainees completed a voluntary anonymous survey, which included demographics, perceived program diversity based on percentage of racial-ethnic and gender-diverse faculty and trainees, and a validated, modified version of the Stereotype Vulnerability Scale (SVS). Higher scores indicate greater ST vulnerability. ST prevalence was analyzed with descriptive statistics, and associations between program diversity, resident demographics, and ST vulnerability were compared using nonparametric tests.

**Results:** Of 1,127 orthopaedic trainees at 40 programs, 322 responded (response rate 28.6%). Twenty-five percent identified as female, and 26% identified as an underrepresented minority in medicine (i.e., Asian, Black, or Hispanic). Asian (12 points), Black (12.5 points), and Hispanic (13.5 points) trainees had significantly higher SVS scores than White trainees (9 points) ( $p = 0.0003$ ;  $p < 0.0001$ ;  $p = 0.0028$ , respectively). Black trainees at perceived racially nondiverse residencies had the highest mean SVS scores ( $16.4 \pm 1.03$  points), while White trainees at perceived racially nondiverse residencies had the lowest SVS scores ( $9.3 \pm 0.3$  points),  $p = 0.011$ . Women had significantly higher gender stereotype vulnerability than men ( $p < 0.0001$ ) in both gender-diverse ( $17.9 \pm 0.2$  vs.  $9.0 \pm 0.3$  points) and gender nondiverse residencies ( $16.4 \pm 0.4$  vs.  $9.6 \pm 0.2$  points).

*continued*

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**Conclusion:** Minority and female orthopaedic trainees had higher ST vulnerability, especially in programs perceived as lacking racial or gender diversity. While perceived program diversity may offer some protection for minority and women trainees, women trainees still met the threshold for high vulnerability regardless of program gender diversity. Future strategies to mitigate ST should be explored in orthopaedic training.

## Introduction

Stereotypes are generalized beliefs that a group shares the same traits and characteristics. Stereotypes can be descriptive or prescriptive, dictating expected behavior<sup>1</sup>. For example, when women violate certain role prescriptions, they may be evaluated less favorably than men<sup>2</sup>. Although some stereotypes are perceived as positive (e.g., Asians are good at math), stereotypes often have a negative valence.

Evidence shows that negative stereotypes can substantially influence performance of those stereotyped<sup>3</sup>. Stereotype threat (ST), first described by Steele and Aronson in 1995<sup>4</sup>, is the awareness that one is at risk of confirming a stereotype associated with their group. ST negatively influences performance in many areas, especially academic performance<sup>5</sup>.

Despite extensive research on ST and its impact on performance, there is little published on its impact in residency programs. Understanding and mitigating ST is especially important in orthopaedic surgery, which is one of the least diverse medical specialties<sup>6</sup>.

ST is a behavioral response to stereotype vulnerability<sup>7</sup>, which refers to how susceptible an individual is to ST. Stereotype vulnerability has been measured using the Stereotype Vulnerability Scale (SVS), developed by Spencer et al.<sup>5</sup> to assess how much students feel their success is threatened by negative stereotypes<sup>8</sup>. The 10-item SVS is a validated and reliable measure of stereotype vulnerability by race and gender across populations<sup>9–11</sup>. A recent study found that 82% of Black 4th year medical students reported high stereotype vulnerability (based on a modified SVS score), compared with 45% of Asian and 43% of Latinx students, and only 4% of White students.

Recent studies have examined the intersection of race and gender bias in medicine, and the literature shows how stereotyping negatively affects well-being<sup>12,13</sup>. Marginalization based on race, gender, or both may contribute to underrepresentation within orthopaedic surgery. Women who experience ST at work are less likely to recommend their field to other women<sup>14</sup>. Other studies show that negative stereotyping of Black women may contribute to higher rates of psychological stress and underperformance<sup>15</sup>. Trainees exposed to discrimination report higher symptoms of burnout<sup>16</sup>. Given the underrepresentation of minorities and women in orthopaedics, women and minority trainees may feel marginalized in their work environment and may be more at risk of ST.

Prevalence of ST has not been examined in orthopaedic surgery. Using stereotype vulnerability as a proxy for ST, the aim of this study was to 1) evaluate the prevalence of gender and racial ST among orthopaedic trainees, measured with SVS

scores and 2) describe variation in SVS scores across demographic groups. We hypothesized that racial-ethnic minority and female trainees would experience higher stereotype vulnerability than their peers.

## Methods

### Study Population

A survey (Fig. 1) was distributed to 1,127 orthopaedic residents and fellows at 40 orthopaedic surgery residency programs who participated in the Collaborative Orthopaedic Educational Research Group. After functional testing of the electronic survey by the authors, it was sent to program directors through email, followed by 2 reminder emails at 6-week intervals. Survey participation was voluntary without incentives, and data were collected from September 2021 to December 2021.

### Survey Design

The survey solicited demographic information, perceptions of program diversity, and the primary outcome of stereotype vulnerability. Stereotype vulnerability was measured using a modified SVS<sup>11,17</sup>, specifying either gender or race-ethnicity in the context of residency training (Fig. 1). Response to the 10 SVS items were measured on a 5-point Likert scale (1 = strongly disagree, 3 = neither agree/disagree, 5 = strongly agree), with one reverse coded item to optimize accurate responses. The 2 subscores—race/ethnic SVS score and gender SVS score—are the sum of 5 questions each, ranging from 5 to 15 points. Based on prior SVS use, an item response of >3 points, a subscore of >15 points, and a total score of >30 points indicate high vulnerability to ST<sup>11</sup>.

Additional demographic details included age, gender, race, year in training (Program Year 1 [PGY1] to PGY6), and geographic region. Participants were asked if they self-identified as a visible minority or were perceived as phenotypically non-White. The term “visible minority” has been used since 1975 to assess inequalities due to perceptions of race or ethnicity<sup>18</sup>. Respondents also described their perception of racial-ethnic and gender diversity among faculty and trainees in their program and approximated the percentage of diverse faculty and trainees in their program.

After institutional review board approval, consent was obtained from all participants, who were informed of the study's purpose, the investigating group, survey length, and data storage. The 3-page, 20-item survey was administered electronically through Research Electronic Data Capture (REDCap), a secure, web-based platform for data capture for research studies<sup>19</sup>. Respondents could modify their answers before submission, and responses were in the locally hosted REDCap database<sup>19</sup>. No

Stereotype Threat Among Orthopaedic Residents
Please complete the survey below.
Thank you!
Enter age (in years)
Gender
<ul style="list-style-type: none"><li>• Female</li><li>• Male</li><li>• Nonbinary</li><li>• Decline to Answer</li></ul>
Race/Ethnicity (select all that apply)
<ul style="list-style-type: none"><li>• White/ Caucasian</li><li>• Black/ African American</li><li>• Asian/ Pacific Islander</li><li>• American Indian/ Alaskan Native</li><li>• Hispanic or Latinx</li><li>• Decline to Answer</li></ul>
Would you classify yourself as a Visible Minority? (Defined as 'phenotypically visible as Non-White')
<ul style="list-style-type: none"><li>• Yes</li><li>• No</li></ul>
Current program year
If you are currently in a research year, enter the year you will be entering following completion of research year (e.g. if between PGY2-3 years, select PGY3).
* must provide value
<ul style="list-style-type: none"><li>• PGY-1</li><li>• PGY-2</li><li>• PGY-3</li><li>• PGY-4</li><li>• PGY-5</li><li>• Fellow</li></ul>
Location of Residency Program
* must provide value
<ul style="list-style-type: none"><li>• Northeast (ME, NH, VT, MA, RI, CT, NY, NJ, PA)</li><li>• South (DE, MD, DC, VA, WV, NC, SC, GA, FL, KY, TN, AL, MS, AR, LA, OK, TX)</li><li>• Midwest (OH, MI, IN, IL, WI, MN, IA, MO, ND, SD, NE, KS)</li><li>• West (MT, WY, CO, NM, ID, UT, AZ, NV, WA, OR, CA, AK, HI)</li><li>• Other</li></ul>

What is the approximate percent of non-White residents in your residency program?					
<input type="radio"/> 0-5% <input type="radio"/> 6-10% <input type="radio"/> 11-20% <input type="radio"/> 21-30% <input type="radio"/> 31-40% <input type="radio"/> 41-50% <input type="radio"/> >50%					
Would you consider your program diverse based on race/ethnicity?					
<input type="radio"/> Yes <input type="radio"/> No					
What is the approximate percentage of female residents in your residency program?					
<input type="radio"/> 0-5% <input type="radio"/> 6-10% <input type="radio"/> 11-20% <input type="radio"/> 21-30% <input type="radio"/> 31-40% <input type="radio"/> 41-50% <input type="radio"/> >50%					
Would you consider your program diverse based on gender?					
<input type="radio"/> Yes <input type="radio"/> No					
<b>Stereotype Vulnerability Scale</b> The following survey questions will ask you about the perceived effect of your race or your gender on your residency training experience. Please rate your response to the following questions from Strongly Disagree to Strongly Agree					
RACE SVS	Strongly Disagree	Disagree	Neither Agree Nor Disagree	Agree	Strongly Agree
1. During residency clinical rotations, my evaluators expected me to do poorly on the rotation because of my race/ethnicity.	1	2	3	4	5
2. Residency clinical rotations may have been easier for people of my race/ethnicity.	5	4	3	2	1
3. During residency clinical rotations, some people felt I had less medical/surgical ability because of my race/ethnicity.	1	2	3	4	5
4. During residency clinical rotations, people of my ethnicity often face biased evaluations from others.	1	2	3	4	5
5. In residency, I often felt that others look down on me because of my race/ethnicity.	1	2	3	4	5
GENDER SVS	Strongly Disagree	Disagree	Neither Agree Nor Disagree	Agree	Strongly Agree
1. During residency clinical rotations, my evaluators expected me to do poorly on the rotation because of my gender.	1	2	3	4	5
2. Residency clinical rotations may have been easier for people of my gender.	5	4	3	2	1
3. During residency clinical rotations, some people felt I had less medical/surgical ability because of my gender.	1	2	3	4	5
4. During residency clinical rotations, people of my gender often face biased evaluations from others.	1	2	3	4	5
5. In residency, I often felt that others look down on me because of my gender.	1	2	3	4	5

Fig. 1

Online survey administered through REDCap. REDCap = Research Electronic Data Capture.

TABLE I SVS Scores Based on Individual Item Responses From the Race SVS Questionnaire

SVS Question	Median SVS Score (Interquartile Range (Q1-Q3) by Self-selected Race		p-value
	Nonvisible Minority (n = 242)	Visible Minority (n = 79)*	
During residency clinical rotations, my evaluators expected me to do poorly on rotations because of my race/ethnicity	1 (1-2)	2 (1-2)	0.0012
Residency clinical rotations may have been easier for people of my race/ethnicity (reverse scored)	4 (3-5)	4 (3-5)	0.0022
During residency clinical rotations, some people felt I had less medical/surgical ability because of my race/ethnicity	1 (1-2)	2 (1-3)	<0.0001
During residency clinical rotations, people of my ethnicity often face biased evaluations from others	1 (1-2)	2 (1-4)	<0.0001
In residency, I have often felt that others look down on me because of my race/ethnicity	1 (1-2)	2 (1-3)	0.0008
*1 missing value for race/ethnicity. SVS scores presented as median (interquartile range: Q1-Q3) and compared using the Kruskal-Wallis test. SVS = Stereotype Vulnerability Scale.			

cookies or IP addresses were recorded, but log file analysis was used to identify and exclude duplicate entries. Only completed surveys were analyzed.

### Statistical Analysis

All analyses were conducted using SAS/STAT software, Version 9.4 (SAS Institute). SAS and all other SAS Institute Inc. product or service names are registered trademarks or trademarks of SAS Institute. Descriptive statistics reported demographics. Standard descriptive statistics were reported including measures of central tendency, variance, frequencies, and proportions. Quantile-Quantile plots and Shapiro-Wilk tests confirmed that SVS scores were not normally distributed, so nonparametric tests were used to statistically compare associations between demographic characteristics and SVS scores. Wilcoxon rank-sum tests compared SVS scores between 2 groups, and Kruskal-Wallis tests compared SVS scores between more than 2 groups. Bonferroni correction was applied to pairwise comparisons. Post hoc subanalyses exam-

ined associations between ST vulnerability and perceived program diversity, stratified by minority and gender status.

### Results

Of the 1,142 orthopaedic trainees (PGY1-PGY6) surveyed, 28.2% (322) responded. The training year of respondents was 61 PGY1 (19.1%), 66 PGY2 (20.1%), 69 PGY3 (21.6%), 54 PGY4 (16.9%), 63 PGY5 (19.7%), and 7 PGY6 (2%). PGY6 residents included resident trainees who were completing an additional training year and clinical fellows. The mean age was 30 years (range 24-39). About 25% of participants (79) identified as female, and 26% of participants (79) identified as an underrepresented minority in medicine (Asian, Black, or Hispanic). Overall, 72% (232 of 322) considered their program diverse in terms of gender and/or race among peers and/or faculty. Demographic characteristics are reported in Appendix 1. Aggregated scores for each of the 10 SVS items are reported in Appendix 2, and Tables I and II.

TABLE II SVS Scores Based on Individual Item Responses From the Gender SVS Questionnaire\*

SVS Question	SVS Score			p-value
	Overall	Women	Men	
During residency clinical rotations, my evaluators expected me to do poorly on rotations because of my gender	1 (1-2)	3 (2-4)	1 (1-2)	<0.0001
Residency clinical rotations may have been easier for people of my gender (reverse scored)	4 (2-5)	4 (4-5)	4 (2-5)	0.0077
During residency clinical rotations, some people felt I had less medical/surgical ability because of my gender	2 (1-3)	4 (3-4)	1 (1-2)	<0.0001
During residency clinical rotations, people of my ethnicity often face biased evaluations from others	2 (1-3)	4 (3-4)	1 (1-2)	<0.0001
In residency, I have often felt that others look down on me because of my gender	1 (1-2)	3 (2-4)	1 (1-2)	<0.0001
*SVS scores presented as median (Interquartile Range: Q1-Q3) and compared using the Kruskal-Wallis test. SVS = Stereotype Vulnerability Scale.				

**TABLE III SVS Scores of Programs Stratified by Whether Respondent Is in a Visible Minority Status\***

	Racially Diverse Program	
	No	Yes
Total SVS		
Visible minority	26 (18-33)	22 (18-26)
Not visible minority	19 (16-24.5)	19 (18-26)
Gender SVS		
Visible minority	10 (9-15)	9 (8.5-12)
Not visible minority	10 (9-15)	9 (9-15)
Race SVS		
Visible Minority	15 (10-19)	12 (9-13)
Not Visible minority	9 (7-11)	9 (9-11)

\*SVS = Stereotype Vulnerability Scale.

### Stereotype Vulnerability and Gender

The median total SVS score was 20 (interquartile range [IQR] 18-26). Table III presents the SVS total score, race and gender subscores, and associations with demographics and perceptions of program diversity. There was a significant association between gender and stereotype vulnerability, as women reported higher median SVS total scores than men (27 [IQR 7] vs 18 [IQR 5];  $p < 0.0001$ ), respectively. Women training in programs perceived as lacking gender diversity reported the highest median total SVS score of 30 (24-35) compared with those in gender-diverse programs.

The median gender SVS score was 9 (IQR 9-14). Women reported significantly higher gender stereotype vulnerability with median gender SVS scores (16 [IQR 5] vs 9 [IQR 3] for men;  $p < 0.0001$ ). Post hoc subanalyses revealed that women in non-gender-diverse programs experienced higher gender stereotype vulnerability than those in gender-diverse programs. In

both settings, significantly ( $p < 0.0001$ ) more women than men experienced high stereotype vulnerability (total SVS score  $>15$ ). Median race SVS scores were similar for men and women regardless of gender diversity in their program.

### Stereotype Vulnerability and Race

There was significant variation in total SVS score based on race and ethnicity (Fig. 2). Underrepresented racial and ethnic minorities (Asian, Black, Hispanic, or multiracial) reported significantly ( $p = 0.0099$ ) higher stereotype vulnerability than non-Hispanic Whites. Pairwise comparisons showed Black orthopaedic trainees experienced significantly ( $p = 0.0035$ ) higher stereotype vulnerability than non-Hispanic Whites (Median 28 [IQR 18-33] 19 vs [IQR 18-25]). Asian/Pacific Islanders ( $p = 0.1774$ ), Hispanic/Latinx ( $p = 0.1581$ ), and multiracial respondents ( $p = 0.2695$ ) reported similar total SVS scores (Median 21, 22.5, 22, respectively) that were not significantly different from non-Hispanic Whites.

Pairwise comparisons of the race SVS subscore showed that Asian/Pacific Islander ( $p < 0.0001$ ), Hispanic/Latinx ( $p = 0.0007$ ), Multiracial ( $p = 0.1295$ ), or non-Hispanic Black ( $p = 0.0003$ ) trainees had higher stereotype vulnerability compared with non-Hispanic Whites (Median 9, 12, 13.5, 10.5, 12.5, 9, respectively). Post hoc, stratified analyses describing stereotype vulnerability at the intersection of gender, visible minority, and program diversity are in Table IV.

### Discussion

This study measured ST vulnerability in orthopaedic trainees across the United States. Our results suggest that women and racial/ethnic minorities had similar or higher scores for each item on the SVS when compared with their White male colleagues. Furthermore, SVS scores increased for female and underrepresented minority trainees at programs perceived as nondiverse in gender and race.

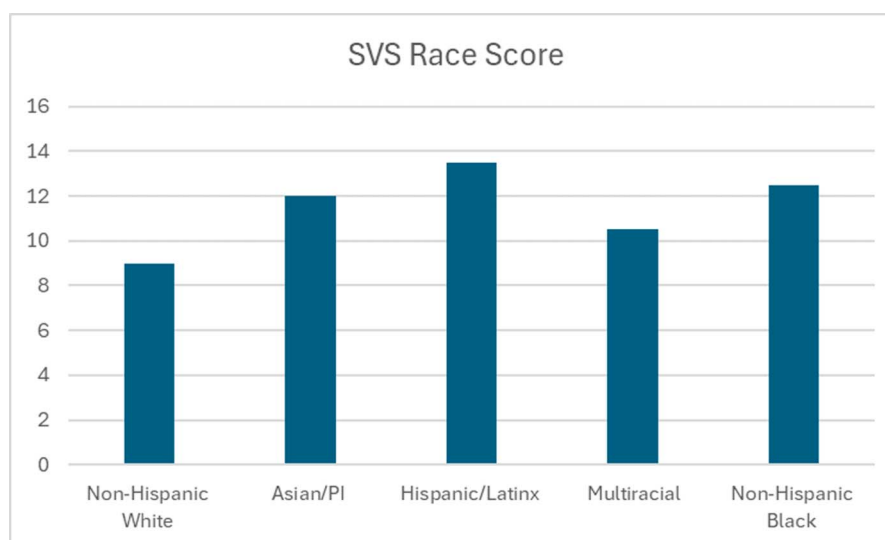


Fig. 2  
Stereotype Vulnerability Scale Race score by race/ethnicity.



**TABLE IV** Respondents Perceptions of Program Diversity Compared With the Perceived Percentage of Those Who Are in a Gender or Racial Minority Group\*

	Gender-Diverse Program		Racially Diverse Program	
	No	Yes	No	Yes
Percent women and race				
0%-5%	29 (88)	4 (12)	24 (92)	2 (8)
6%-10%	27 (73)	10 (27)	43 (84)	8 (16)
11%-20%	27 (30)	62 (70)	42 (39)	66 (61)
21%-30%	6 (6)	102 (94)	11 (16)	57 (84)
31%-40%	1 (2)	43 (98)	0 (0)	27 (100)
41%-50%	0 (0)	9 (100)	1 (4)	26 (96)
>50%	0 (0)	0 (0)	6 (46)	7 (54)

\*Data presented as frequency (percentage).

Previous literature describes how negative stereotypes can negatively affect workplace performance, especially in populations vulnerable to ST<sup>11</sup>. Walton and Spencer found that racial ST contributes to underperformance among students<sup>20</sup>. Their results show that students stereotyped by race performed better when psychological threat was reduced<sup>20</sup>. Acker et al. found that first-year medical students vulnerable to ST were less interested in surgical careers<sup>21</sup>. Considering racial and gender disparities in orthopaedics, it is important to assess stereotype vulnerability among underrepresented minority and female orthopaedic trainees to address the challenges inhibiting their professional growth and to promote diversity in the field.

Although the exact relationship between ST and underperformance is unclear, several theories have been proposed. Steele and Aronson suggested that states of anxiety and self-doubt interfere with task performance<sup>4</sup>. Others argue that ST consumes working memory needed for problem solving by increasing anxiety and stereotype-related thoughts in a testing environment<sup>22,23</sup>. The added stress of being the target of a negative stereotype about one's social identity promotes several defensive reactions<sup>24</sup>. Experiments show that the pressure to disprove negative stereotypes depletes the cognitive resources needed to overcome them<sup>25</sup>. Thus, stereotyped individuals may subconsciously revert to behaviors aligned with stereotype. Given the complex interplay between power dynamics and high stakes surrounding underperformance for underrepresented populations, ST may explain poor performance unrelated to actual ability<sup>11</sup>.

In this study, female residents scored 16 on the gender SVS and 10 on the race SVS, while men scored 9 on both. Visible minorities scored 9.6 on the gender SVS and 12 on the race SVS, compared with 9 for nonminority men SVS. Visible minority participants had the highest stereotype vulnerability, with scores reaching statistical significance. High vulnerability in previous SVS studies is defined by an SVS item score >3 or a combined score across 5 questions > 15, 11, 17. Only female respondents were initially classified as highly vulnerable, but

most visible minorities' race SVS item scores also reached statistical significance compared with nonvisible minorities.

Although there is limited literature on stereotype in orthopaedics, the effect of ST and gender bias in general surgery training has been studied. A randomized control trial found that female residents reminded of negative gender stereotypes performed worse on a laparoscopy skills examination<sup>26</sup>. Male trainees exposed to the same negative stereotypes about women performed better—a phenomenon called stereotype lift<sup>28</sup>. While the behaviors that facilitate or impede surgical training remain multifactorial, recognizing and reducing the impact of negative stereotypes on skill performance is essential in orthopaedic training.

ST is more likely to occur when an individual is the only member from their group or is a “token minority” (<15%)<sup>27</sup>. Studies show that women isolated from same-gender peers expect to be negatively stereotyped and have lower performance expectations<sup>28,29</sup>. Our study corroborated that having same-gender or same-race peers is protective and that perceptions of program diversity matters.


While this study does not define thresholds for program diversity, it is important to consider how the perception of diversity affects trainees. Visible minority trainees at nondiverse programs had the highest racial SVS scores while nonminority trainees at nondiverse programs had the lowest scores. Women in non-gender-diverse program nearly doubled the stereotype vulnerability score compared with men, who had the lowest overall scores. As stereotypes are unlikely to disappear quickly, fostering an inclusive environment with diverse representation among trainees and faculty is critical. Individual level and institutional interventions to mitigate ST include valuing diversity among employees, communicating high expectations and a belief in the ability for trainee's to reach those expectations, reattribution training, belonging interventions such as acknowledging challenges and communicating about similar experiences, and teaching about ST<sup>30</sup>. Recent work in this field has shown that a value-affirmation intervention for reducing ST among women in surgical training improved their performance by reinforcing feelings of integrity and self-worth<sup>31</sup>. Creating a culture that supports these changes can improve diversity in health care, addresses health care disparities, and enhance the ability to provide culturally competent care for all patients<sup>24</sup>.

This study has limitations. The response rate was 28%. While this rate is not uncommon among survey studies, the low rate introduces nonresponse bias, making the results less representative of orthopaedic trainees. In addition, 72% of respondents considered their program diverse in race and gender, which may have led to selection bias, as trainees in diverse programs had lower SVS scores. Also, while our survey shows factors associated with stereotype vulnerability it does not prove causation. Last, the correlation between SVS scores and residency performance was not assessed.

This study highlights ST prevalence among orthopaedic trainees. While underrepresented minority and women trainees had increased SVS scores, perceived program diversity was associated with lower vulnerability to ST for underrepresented minorities. However, gender stereotype vulnerability among women trainees persisted, regardless of perceived program diversity. Future strategies for threat mitigation should be explored. These findings

are particularly relevant to orthopaedics, which continues to lag behind other subspecialties in diversity. This study emphasizes the need for programs that prioritize diversity and strategies to reduce ST for trainees.

## Appendix

 Supporting material provided by the author is posted with the online version of this article as a data supplement at [jbjs.org \(http://links.lww.com/JBJSOA/A726\)](http://links.lww.com/JBJSOA/A726). This content has not been copyedited or verified. ■

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Risa T. Reid, MD<sup>1</sup>  
Susan M. Odum, PhD<sup>1</sup>

Patrick J. Rosopa, PhD<sup>2</sup>  
Jaysson T. Brooks, MD, FAOA<sup>3</sup>  
Brian P. Scannell, MD, FAOA<sup>1</sup>  
Selina Poon, MD, FAOA<sup>4</sup>  
Tyler Williams, BA<sup>5</sup>  
Joshua C. Patt, MD, MPH, FAOA<sup>1</sup>  
Gabriella E. Ode, MD, FAOA<sup>6</sup>  
the Collaborative Orthopaedic Educational Research Group (COERG)

<sup>1</sup>Atrium Health Musculoskeletal Institute, Charlotte, North Carolina

<sup>2</sup>Department of Psychology, Clemson University, Clemson, South Carolina

<sup>3</sup>Texas Scottish Rite Hospital for Children, Dallas, Texas

<sup>4</sup>Shriners for Children Medical Center, Pasadena, California

<sup>5</sup>Emory School of Medicine, Atlanta, Georgia

<sup>6</sup>Hospital for Special Surgery, New York, New York

E-mail address for G. Ode: [odeg@hss.edu](mailto:odeg@hss.edu)

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