

## RESEARCH ARTICLE OPEN ACCESS

# Medical Student Perceptions of the Barriers to Entering Orthopaedic Surgery Differ by Gender

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**Received:** 17 November 2024 | **Revised:** 26 January 2025 | **Accepted:** 22 February 2025

**Funding:** The authors received no specific funding for this work.

**Keywords:** barriers | gender equity | medical students | orthopaedic surgery | survey

## ABSTRACT

**Background:** The value of gender representation has been increasingly recognised in medicine, yet women represent only 13.6% of orthopaedic surgeons in Canada. The primary objective of this study was to determine barriers identified by medical students considering pursuing a career in orthopaedic surgery. The secondary objective was to assess for gender-based differences in barriers identified by medical students.

**Methods:** A cross-sectional mixed-methods survey was distributed to final-year students at a Canadian medical school. Descriptive analyses were calculated for the study population and gender subgroups. To compare responses between gender subgroups, chi-square or Fisher's exact tests were employed for binary data, and non-parametric Mann–Whitney *U* tests for ordinal data. Open-text responses were reviewed for descriptions of students' experiences in orthopaedics.

**Results:** Sixty-four medical students participated, representing a response rate of 59.3%. Male culture and the need for physical strength were identified as strong barriers to pursuing a career in orthopaedics. Additionally, women reported less exposure ( $p=0.003$ ), disproportionate constraints (i.e., scrutiny of performance based on gender,  $p=0.001$ ), less mentorship ( $p=0.028$ ), more concerns about verbal ( $p<0.001$ ) and sexual abuse ( $p=0.013$ ), and higher rates of direct discouragement from pursuing orthopaedics than men ( $p=0.035$ ). Open-text responses indicated that orthopaedics was not considered welcoming to all medical students.

**Conclusions:** This study is the first to characterise medical student perceptions of barriers to gender equity in orthopaedic surgery in Canada. Fostering a more equitable environment will necessitate a paradigm shift in the educational framework toward orthopaedic surgery.

Location of work: This work was conducted at Queen's University, Kingston, ON, Canada.

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## 1 | Introduction

The value of representation has been increasingly recognised in medicine, with emerging studies demonstrating enhanced care quality attributable to a gender-diverse healthcare workforce [1–5]. The positive impacts of a diverse healthcare workforce include strong physician-patient relationships [6, 7], increased focus on preventative medicine allowing for earlier detection of and intervention for various conditions [8, 9], and greater overall patient satisfaction [10, 11]. Despite this recognition, significant gender inequities persist within the medical profession [12]. This issue is especially pervasive within surgical specialties. Although women have consistently made up more than half of Canadian medical students for over a quarter of a century, they represent only 30.3% of surgical specialists [13, 14]. Orthopaedic surgery ranks among the least gender diverse surgical specialties [15], with women comprising only 13.6% of orthopaedic surgeons in Canada in 2020 [14, 15].

Gender parity, where there are equal numbers of men and women in a specialty, may not be an overarching goal; however, gender equity, where there is no gender-based discrimination and equal opportunity for all, is essential for fairness and justice as central tenets of medicine [5]. In Canada it has taken 20 years for the proportion of female orthopaedic surgeons to increase from 5.4% in 2000 to 13.6% in 2020 [16]. In the United States, female surgeons made up 8.0% of orthopaedic surgeons in 2020, an increase from 6.0% in 2010 [17]. A primary concern with the substantial gender disparity in orthopaedics is denying patients the benefits of a gender-diverse workforce [18]. Efforts to cultivate greater gender diversity must begin by attracting and supporting a diverse population of medical students to the field. A recent study reported that Canadian female orthopaedic surgeons identified five significant career barriers including constrained communication, unequal standards, male culture, lack of mentoring and workplace harassment [15]. Determining if these barriers are unique to female orthopaedic surgeons, or if similar perceptions exist for medical students considering a career in orthopaedics, will be important for improving equity of opportunity in the profession.

Medical students' experiences and perceptions of the various specialties throughout their education greatly influences their career choices and trajectories [19]. A recent study of residency match rates of traditionally underrepresented groups within orthopaedic surgery found the matches of female candidates reflected their application rates [20]. This suggests that the low proportion of female orthopaedic surgeons may be related to a lower likelihood of pursuing orthopaedics compared with male medical students [20]. Medical students have also identified that orthopaedic surgery culture encourages a sense of belonging specifically for those who match the cultural stereotypes of the specialty [21]. Similarly, the culture in orthopaedics discourages students who feel that they are not part of the cultural in-group, and these students pursue other specialties due to a lack of social belonging [21].

The primary objective of this study was to determine the barriers identified by medical students when considering a career in orthopaedic surgery. The secondary objective was to assess

whether there were gender-based differences in the barriers identified by medical students considering pursuing a career in orthopaedic surgery.

## 2 | Methods

A cross-sectional survey was distributed to all final-year medical students at a single institution from April to May 2023. Undergraduate medical training at the institution entails a 4-year programme: 2 years of didactic and interactive small-group sessions (pre-clerkship) and 2 years of clinical rotations (clerkship). Students participate in a musculoskeletal course covering basic orthopaedic surgery principles in the first year of pre-clerkship. Students may elect to further explore orthopaedics during pre-clerkship by arranging optional days shadowing an orthopaedic surgeon. Students complete core and elective clinical rotations in their clerkship years. As a part of their core rotations, students complete a three-week rotation in either orthopaedic surgery or urology, dictated by student preference and placement availability. Students may opt to complete further rotations in orthopaedic surgery during their elective rotations.

Final-year medical students were invited to participate in the study after completing all core and elective rotations. Institutional research ethics board approval was granted (6037289). An electronic survey was distributed via email and a private social media group for class members at the institution of interest. Qualtrix software (Qualtrics, Provo, UT) was used to administer the survey. Informed consent was obtained from all subjects involved in the study.

### 2.1 | Survey

The survey consisted of 27 questions (Appendix A). No identifiable information was collected. The first two questions confirmed participant eligibility. Three questions were related to participant demographics, including gender identity, sexual orientation and race. Demographic data were collected according to the Canadian Institute of Health Information [22]. One question assessed exposure types to orthopaedic surgery (none, pre-clerkship learning, observerships/shadowing, clinical rotation and other). Two questions assessed consideration of a career in orthopaedic surgery. Seventeen questions assessed perceptions of potential barriers to pursuing a career in orthopaedic surgery based on the barriers described in the currently available literature [23–26] as well as barriers to workplace equity for Canadian female orthopaedic surgeons identified by Hiemstra et al. [15]. These questions were grouped into the barriers of male privilege, physical strength, lack of exposure, insufficient support, hostility, disproportionate constraints and work-life integration. Questions pertaining to male privilege, insufficient support, hostility and disproportionate constraints were derived from the Gender Bias Scale (GBS), a validated measure of how women leaders perceive and experience gender bias in the workplace [27]. The survey questions about male privilege focused on a male-dominated organisational culture containing pressure to conform to gender stereotypes; questions pertaining to insufficient support focused on mentorship and

direct discouragement about pursuing a career in orthopaedic surgery; questions relating to hostility focused on workplace harassment in forms such as verbal abuse and sexual abuse; and questions relating to disproportionate constraints focused on constrained career choices and unequal standards in the workplace [27]. A 5-point Likert scale (1 = *strongly disagree*, 2 = *disagree*, 3 = *neither agree nor disagree*, 4 = *agree* or 5 = *strongly agree*) or close-ended (yes or no) questions were used to measure responses. The final two questions were open-text, where participants could elaborate on their preceding answers and offer additional insights into barriers when considering a career in orthopaedics.

2.2 | Data Analysis

Data were imported into IBM SPSS (version 29.0 for Windows, Armonk, New York, 2022) for statistical analysis. Descriptive statistics were used to summarise quantitative survey data.

TABLE 1 | Demographic characteristics of respondents.

Demographic characteristic	Number of respondents, <i>N</i>	Percent of respondents, % <sup>a</sup>
Gender identity		
Male	20	31.3
Female	44	68.8
Sexual orientation		
Heterosexual	43	67.2
Other	21	32.8
Race		
White	43	67.2
Other	21	32.8

<sup>a</sup>The percentage of respondents among those who participated in the study.

Due to sample sizes, for statistical analyses, all demographic characteristics were classified as binary data (woman and man for gender; heterosexual and other for sexual orientation; and white and other for race). Any participant identifying multiple sexual orientations or races was classified into the ‘other’ category for these characteristics. For Likert scale questions with higher-scoring responses indicating a barrier, a mean score of  $\geq 4$  was used to identify strong barriers to pursuing a career in orthopaedics. Conversely, for Likert scale questions with lower-scoring responses indicating a barrier, a mean score of  $\leq 2$  was used to identify strong barriers. Means and standard deviations were also calculated for the Likert scale questions for the entire study population and for gender subgroups. Differences in perceptions of barriers between women and men were assessed using chi-square or Fisher’s exact tests for binary data and non-parametric Mann–Whitney *U* tests for ordinal data. The significance level  $p < 0.05$  was established a priori, with no adjustment for multiple comparisons. Open-text responses were reviewed by the first author, and responses exemplifying barriers to pursuing a career in orthopaedic surgery were identified.

3 | Results

One hundred and eight medical students were eligible and invited to participate in the study. Of these, 64 students completed the survey, representing a response rate of 59.3%. Forty-four respondents identified as women and 20 as men, representing 61.1% of the women and 58.8% of the men in the invited population. The demographic data of the respondents are presented in Table 1. Sexual orientation and race are presented in Figure 1 and Figure 2, respectively. Subgroup analyses revealed no statistically significant differences in sexual orientation ( $p = 0.141$ ) or race ( $p = 0.162$ ) between respondents identifying as women versus men.

The study population identified male culture and the need for physical strength as strong barriers to pursuing a career in

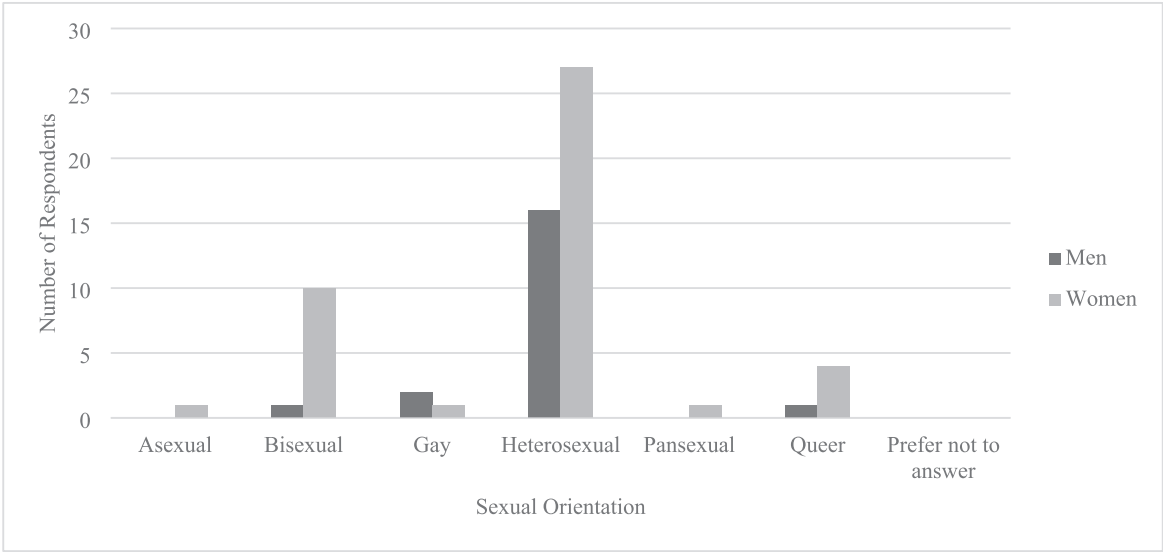
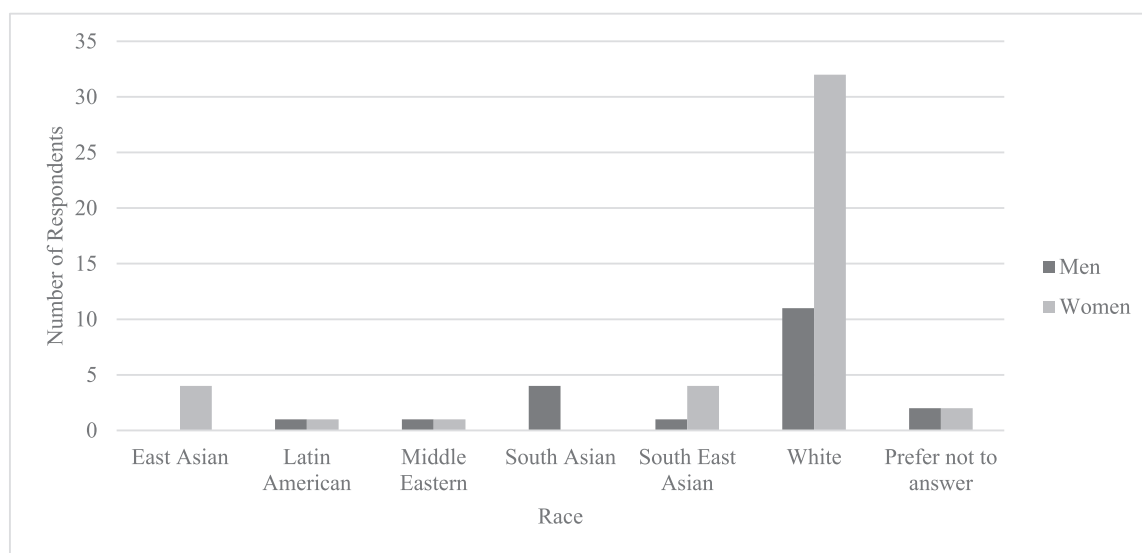


FIGURE 1 | Sexual orientation of study participants.



**FIGURE 2** | Race of study participants.

orthopaedic surgery (Table 2). Specific to male culture, the respondents overwhelmingly indicated that the ‘boys’ club’ mentality is common in the specialty (mean=4.57), and that men are more likely to be leaders (mean=4.52). The belief that physical strength is required to be successful in orthopaedics was significant overall for the study participants; however, there was a significant difference between the groups, with women more strongly perceiving physical strength to be required in orthopaedics ( $p < 0.001$ ).

“The study population identified male culture and the need for physical strength as strong barriers to pursuing a career in orthopaedic surgery.”

Additional factors affecting the consideration of a career in orthopaedic surgery that demonstrated significant differences between women and men included lack of exposure, disproportionate constraints, insufficient support and concerns about verbal and sexual abuse (Table 2). Regarding exposure, significantly fewer women (11.4%) than men (55.0%) expressed interest in pursuing a career in orthopaedic surgery ( $p < 0.001$ ). Additionally, significantly fewer women (38.6%) than men (75.0%) reported having shadowed an orthopaedic surgeon ( $p = 0.007$ ) (Table 3). Overall, only men reported that they had sufficient exposure to a career in orthopaedic surgery (mean=4.30). Specific to disproportionate constraints, female students believed more strongly than men that their performance would be scrutinised differently in this specialty based on their gender identity (mean=3.89 versus 2.79,  $p = 0.001$ ). Regarding insufficient support, women disagreed that they had received mentorship from someone in orthopaedic surgery (mean=1.98). Additionally, only 9.1% of women endorsed having a mentor of their gender identity compared with 36.8% of men ( $p = 0.013$ ); however, women were neutral (mean=3.19) in believing that it was important to have a mentor of concordant gender identity. Women reported higher rates of direct discouragement to pursue a career in orthopaedic surgery from individuals in their personal lives

compared with men (39.5% versus 10.5%,  $p = 0.035$ ) (Table 4). Additionally, 12 out of 43 women compared with 1 out of 18 men reported being discouraged from pursuing orthopaedic surgery by individuals in their academic careers (e.g., lecturers and preceptors), although this finding did not reach statistical significance (27.9% versus 5.6%,  $p = 0.085$ ). Women and men reported statistically significant differences in concerns about verbal and sexual abuse within orthopaedics, with women demonstrating increased concern compared with men (verbal abuse: mean=3.52 versus 2.42,  $p < 0.001$ ; sexual abuse: mean=2.44 versus 1.58,  $p = 0.013$ ) (Table 2). Women and men reported similar concerns about balancing family planning and/or family-life with a career in orthopaedics (mean=3.65 versus 3.11,  $p = 0.081$ ).

“Only 9.1% of women endorsed having a mentor of their gender identity compared with 36.8% of men ( $p = 0.013$ ).”

Open-text responses were provided by 26.5% of respondents and reinforced some of the barriers identified in the survey’s preceding Likert scale and close-ended questions (Table 5). For example, two respondents referenced the ‘boys’ club’, stating it negatively affected their consideration of a career in orthopaedic surgery. One respondent suggested a paucity of mentorship opportunities contributed to their lack of interest in orthopaedics. One respondent described being ‘ridiculed in the operating room for being overly liberal’ when shadowing an orthopaedic surgeon. One respondent identified the intersectionality of their gender and racial identities as a barrier in their clinical rotation in orthopaedics, and described experiencing exclusion and unequal standards.

## 4 | Discussion

This study sought to determine the barriers to pursuing a career in orthopaedic surgery as perceived by medical students

**TABLE 2** | Responses to questions about barriers to a career in orthopaedic surgery assessed by gender.

Question	Gender	N	Mean <sup>a</sup>	Standard deviation	p
Male privilege					
There is pressure to conform to gender stereotypes in this specialty.	Men	20	3.85	1.09	0.273
	Women	44	4.20	0.73	
Leaders in this specialty are more likely to be men.	Men	20	4.15	0.93	0.012 <sup>b</sup>
	Women	44	4.68	0.52	
The ‘boys’ club’ mentality is common in this specialty.	Men	20	4.45	1.05	0.985
	Women	43	4.63	0.62	
Physical strength					
Physical strength is required to succeed in this specialty.	Men	19	3.32	1.06	<0.001 <sup>b</sup>
	Women	43	4.35	0.72	
Lack of exposure					
I have a good understanding of what a career in this specialty would entail.	Men	20	4.15	0.49	0.003 <sup>b</sup>
	Women	44	3.50	0.88	
I have had sufficient exposure to this specialty to determine whether it is a career I would like to pursue.	Men	20	4.30	0.57	0.003 <sup>b</sup>
	Women	44	3.48	1.05	
Insufficient support					
I have received mentorship from someone in this specialty.	Men	19	2.79	1.51	0.028 <sup>b</sup>
	Women	44	1.98	1.15	
It is important to me to have a mentor of my gender identity in this specialty.	Men	19	2.21	1.08	0.008 <sup>b</sup>
	Women	43	3.19	1.35	
Disproportionate constraints					
Individuals who do not identify as men are able to pursue careers in this specialty without facing gender-based discrimination.	Men	19	2.58	1.12	0.710
	Women	44	2.52	1.28	
My gender identity affects the likelihood that I will pursue a career in this specialty.	Men	19	2.63	1.30	0.084
	Women	44	3.30	1.42	
My performance will be scrutinised differently depending on my gender identity in this specialty.	Men	19	2.79	1.23	0.001 <sup>b</sup>
	Women	44	3.89	0.81	
Hostility					
I am concerned about experiencing verbal abuse in the workplace in this specialty.	Men	19	2.42	1.07	<0.001 <sup>b</sup>
	Women	42	3.52	1.11	
I am concerned about experiencing sexual abuse in the workplace in this specialty.	Men	19	1.58	0.77	0.013 <sup>b</sup>
	Women	43	2.44	1.28	
Work–life integration					
I think I will not be able to balance family planning and/or family-life with a career in this specialty.	Men	19	3.11	1.15	0.081
	Women	43	3.65	1.07	

<sup>a</sup>Responses are based on a Likert scale of *strongly disagree* (1) to *strongly agree* (5).<sup>b</sup>Statistical significance,  $p < 0.05$ .

**TABLE 3** | Exposure to orthopaedic surgery of the study participants by gender.

Exposure type	Men, N (%)	Women, N (%)	p
None	1 (5.0)	1 (2.3)	0.531
Pre-clerkship learning	16 (80.0)	30 (68.2)	0.384
Observership(s)/ shadowing	15 (75.0)	17 (38.6)	0.007 <sup>a</sup>
Clinical rotation	12 (60)	27 (61.4)	0.917
Other	1 (5.0)	2 (4.5)	1.000

Note: Participants could select all exposure types for their experience and percentages were calculated for each exposure type by gender based on number of participants.

<sup>a</sup>Statistical significance,  $p < 0.05$ .

at one Canadian institution. Male privilege and the need for physical strength were recognised as strong barriers to pursuing a career in surgery by the study population as a whole. Factors that differentially affected the consideration of a career in orthopaedic surgery by women included lack of exposure, disproportionate constraints, insufficient support and concerns about sexual abuse. Open-text responses indicated a culture in orthopaedics that was not inclusive or welcoming to all medical students.

“Factors that differentially affected the consideration of a career in orthopaedic surgery by women included lack of exposure, disproportionate constraints, insufficient support and concerns about sexual abuse. Open-text responses indicated a culture in orthopaedics that was not inclusive or welcoming to all medical students.”

**TABLE 4** | Experience of explicit discouragement to pursue a career in orthopaedic surgery by gender.

Question	Men		Women		p
	Yes, N (%)	No, N (%)	Yes, N (%)	No, N (%)	
I have been told by individuals during my academic career (lecturers, preceptors, etc.) not to pursue a career in orthopaedic surgery, or that I am not suited to a career in orthopaedic surgery.	1 (5.6)	17 (94.4)	12 (27.9)	31 (72.1)	0.085
I have been told by individuals in my personal life (family, friends, etc.) not to pursue a career in orthopaedic surgery, or that I am not suited to a career in orthopaedic surgery.	2 (10.5)	17 (89.5)	17 (39.5)	26 (60.5)	0.035 <sup>a</sup>

<sup>a</sup>Statistical significance,  $p < 0.05$ .

**TABLE 5** | Open-text responses addressing the culture of orthopaedic surgery.

Quote
‘As a woman who fell in love with surgery, there are countless surgical specialties which I never even considered because the culture felt so much like a boys’ club that I would never fit in or find like-minded people and mentors in the specialty.’
‘I matched to a [medical specialty], not surgery. At one point I considered [surgery] and sought mentorship, only to find I did not click with the OR culture; although I did have a good female mentor.’
‘I never considered [orthopaedic surgery as] it is widely known to be a boys’ club and I do not have a personality conducive to that environment.’
‘I was never really interested in pursuing surgery and did not explore it very much in general. But I do wonder if there were reasons I never pursued exploring it and if it had felt more accessible to have mentors, perhaps that would have been different.’
‘During my pre-clerkship [shadowing] experience, I wore a pronoun pin identifying ‘he/him’ and was ridiculed in the operating room for being ‘overly liberal’. I knew that I would not want to be a part of a career in a field that had this mentality.’
‘[I had a] poor experience with orthopaedic surgeons favouring cis white male medical students (junior learners in [first and second] year) over me for clinical experiences while being the clinical clerk on service. [I] experienced poor treatment by both male and female staff in orthopaedics as compared to my non-female, Caucasian peers ... The only positive experience I had with an orthopaedic surgeon was another surgeon of color. Overall, I had a negative experience mainly based on my intersecting identities and not my performance (which was assessed as above my peers and at the level of [a] junior resident).’
‘Some factors that played into me not pursuing [orthopaedics] included a lack of jobs upon completion of degree, the ‘boys club’, and having to do multiple fellowships just to secure a job (I was told by an orthopedic surgeon in the city when starting medical school to not even think about getting a job there ...).’



Given the long-standing predominance of men in orthopaedic surgery, the identification of male culture as a strong barrier to the pursuit of a career in this field was noteworthy. This study determined that medical students perceive pressure to conform to gender stereotypes in orthopaedic surgery. Medical students noted that men were more likely to comprise leaders, and the 'boys' club' mentality was considered to be common. Importantly, both female and male medical students expressed their shared perception of these barriers, underscoring the perception of a deeply ingrained male culture within the profession.

“Medical students noted that men were more likely to comprise leaders, and the 'boys' club' mentality was considered to be common.”

A male-dominated culture was also highlighted as one of the most important barriers to entering a career in orthopaedic surgery in a recent global survey study, which included female medical students, trainees and practicing surgeons [28]. This finding suggests a pervasive trend that extends beyond the single institution presented in the current study. The perception of disproportionate constraints, including different judgements of performance based on gender, was also highlighted by the female medical students in this study. While the onus of promoting gender equity is often placed on women, the collaboration of male orthopaedic surgeons will be essential to change the culture [29, 30]. Male orthopaedic surgeons possess the unique opportunity to act as allies for under-represented minorities in the specialty [31]. Acts of allyship must extend into medical training, where male orthopaedic surgeons will be needed to advocate for equal opportunities, provide mentorship for all trainees and actively challenge gender biases and stereotypes in educational settings.

A perceived need for physical strength was an additional barrier to pursuing a career in orthopaedic surgery identified by the participants in this study. This perception is rooted in the misconception that orthopaedics is a profession highly reliant upon physical strength rather than encompassing an array of cognitive, technical and interpersonal skills. This limited perspective undermines the talents that contribute to successful orthopaedic practice and perpetuates gender stereotypes by associating physical strength with male gender. By dispelling the misconception of the need for exceptional physical strength in orthopaedics, the field may attract a more diverse talent pool.

Exposure marks the first opportunity for consideration of a career in orthopaedic surgery. However, this study demonstrated that both female and male medical students felt that they had insufficient exposure to orthopaedics, with women believing more strongly than men that they lacked sufficient exposure. Exposure has been associated with a pronounced increase in application rates to orthopaedic surgery residency programmes among women [32]. In the United States, programmes such as the Perry Initiative and the Nth Dimension have been developed to offer additional avenues of exposure to orthopaedics outside of traditional medical school training and have been successful in influencing women to choose orthopaedic surgery as a profession [33, 34]. Programmes conducted beyond the scope of

medical school training, as well as discretionary activities such as shadowing and elective clinical rotations embedded within medical school training, however, place the responsibility of participation on medical students. This inadvertently leads to the exclusion of those who may not be aware of or are actively deterred from pursuing such opportunities. In this study, approximately one third of female medical students reported having shadowed an orthopaedic surgeon, representing a significant minority compared with the three quarters of male medical students reporting the same. This difference contributed to the disparity in exposure to orthopaedics reported between genders.

Insufficient support was another factor differentially affecting women and men when considering pursuing a career in orthopaedic surgery. Mentorship plays a pivotal role in the pipeline to orthopaedic surgery, with mentors providing invaluable guidance and encouragement to mentees. Mentorship becomes significantly determinative for women given the existing gender disparities and barriers, such as direct discouragement that trainees encounter in their journey toward a career in orthopaedics [35]. Given that women constitute only 11.9% of faculty members in Canadian academic orthopaedic departments [36], relying solely on these individuals for mentorship of female trainees could overwhelm them with excessive mentoring responsibilities [37]. It is thus imperative to leverage the expertise of all existing orthopaedic faculty, regardless of gender, to collectively nurture the aspirations of female medical students, ensuring that mentorship opportunities are accessible to all trainees while protecting female orthopaedic surgeons from burnout. It is important to recognise that women in this study did not agree that it was important to have a mentor of concordant gender identity, suggesting that men, who currently represent the majority of orthopaedic surgeons in Canada, may engage in effective gender non-concordant mentoring relationships with medical students [38, 39]. This is in contrast with the findings of a US-based study of medical students, which found that nearly 60% of medical students have a preference for gender-concordant mentorship [40]. Further studies are required to assess the effectiveness of gender non-concordant mentorship for trainees.

Concerns about verbal and sexual abuse were another factor differentially affecting women and men when considering pursuing a career in orthopaedic surgery, with women reporting more concerns compared with men. Verbal and sexual harassment has been frequently reported by female orthopaedic surgeons [26, 41, 42]. A 2022 Canadian study found that 83% of female orthopaedic surgeons had experienced at least one occurrence of sexual harassment in the workplace [42]. While the findings of this study do not indicate that concerns about abuse act as a strong barrier to pursuing a career in orthopaedic surgery among women, research has demonstrated that exposure to verbal and sexual harassment during undergraduate education may influence medical students' choice of specialty [26].

The findings of this study offer insights into the factors most significantly impacting medical students' decisions to pursue a career in orthopaedic surgery. Male culture was broadly recognised by women and men as a barrier to pursuing a career in orthopaedics. The shared recognition of male culture as a

barrier by both genders underscores widespread concern about this issue. It is also important to recognise that diversity is multifaceted and that individuals with intersecting identities face additional challenges [43]. Discrimination faced by individuals identifying among the minority in several domains is multiplied, increasing the barriers these individuals may face in pursuing a career in orthopaedics [44]. Recognising that gender diversity is just one aspect of promoting overall diversity, comprehensive interventions that address intersecting identities are necessary to foster true inclusivity and equity of opportunity within the orthopaedic workforce.

“The shared recognition of male culture as a barrier by both genders underscores widespread concern about this issue.”

#### 4.1 | Limitations

Limitations of this study include that it was conducted at a single centre, and therefore, the results may not be generalisable to the broader Canadian or International medical student population. It is noteworthy, however, that while this was a single-centre study, the perspectives gathered from medical students provide a novel and valuable contribution to understanding the barriers to pursuing a career in orthopaedic surgery. Surveying medical students at various institutions will be required to confirm the study results. Additionally, a multicentre study would provide a larger study population and greater statistical power. Further limitations pertain to the survey, which was created based on the Gender Bias Scale but was not a validated tool in its entirety. To the authors' knowledge, no tools exploring trainees' perceptions of gender bias in the workplace have been published, presenting another potential objective for future research endeavours. Finally, although the survey enabled open-text responses, only 26.5% of participants provided contributions in this format. These data were reviewed by the first author and were not subjected to formal analysis utilising a grounded theory approach. Future research to gather qualitative data such as via focus groups, and employing a formal qualitative analysis, will derive a more comprehensive understanding of the barriers perceived by medical students considering a career in orthopaedic surgery. Such work could be the basis of the development of interventions aimed at improving equity of opportunity in the profession.

#### 5 | Conclusion

This study provides novel insights into barriers perceived by medical students when considering pursuing a career in orthopaedic surgery. Participants identified male culture and the need for physical strength as strong barriers. Lack of exposure, disproportionate constraints (i.e., scrutiny of performance based on gender identity), less mentorship, concerns about verbal and sexual abuse, and direct discouragement from pursuing a career in orthopaedic surgery were additional barriers that affected women more than men when considering pursuing a career in orthopaedic surgery. Recognising the widespread prevalence of these perceptions among trainees, it becomes evident that dedicated efforts supported by allies within orthopaedics are required

to dismantle these barriers and encourage a gender-diverse population of trainees to pursue a career in orthopaedics. Such efforts are essential to cultivating an inclusive environment that harnesses the full potential of a gender-diverse workforce for the betterment of patient care. Future research could expand this work across multiple institutions to assess the generalisability of these findings within the field of orthopaedics, while also exploring intersecting identities to advance a more comprehensive vision of diversity.

“Recognising the widespread prevalence of these perceptions among trainees, it becomes evident that dedicated efforts supported by allies within orthopaedics are required to dismantle these barriers.”

#### Author Contributions

**Bahar Entezari:** conceptualization, investigation, writing – original draft, methodology, visualization, writing – review and editing. **Sarah Kerslake:** supervision, project administration, writing – review and editing, conceptualization, methodology, resources. **Steve Mann:** writing – review and editing, methodology, supervision, project administration, resources. **Jesse I. Wolfstadt:** writing – review and editing, supervision, methodology, resources. **Wilma Hopman:** formal analysis, writing – review and editing, visualization, methodology. **Peter C. Ferguson:** supervision, resources, writing – review and editing, methodology. **Laurie A. Hiemstra:** conceptualization, investigation, methodology, resources, supervision, writing – review and editing.

#### Ethics Statement

Local institutional research ethics board approval (#6037289), approval letter attached. All student data were anonymised. There were no risks to student associated with this study.

#### Conflicts of Interest

One of the authors certified that he (S.M.) has received or may receive payments or benefits, during the during the study period, in an amount of less than USD 10,000 from Depuy-Synthes; in an amount of less than USD 10,000 from Stryker Inc.; and in an amount of less than USD 10,000 from Zimmer Bionet. One of the authors certified that he (J.I.W.) has received or may receive payments or benefits, during the during the study period, in an amount of less than USD 10,000 from Depuy-Synthes; and in an amount of less than USD 10,000 from Microport Orthopaedics. One of the authors certifies that he (P.C.F.) has received or may receive payments or benefits, during the study period, in an amount of USD 10,000 to USD 100,000 from Stryker Inc. The other authors declare no conflicts of interest.

#### Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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## Appendix A

### Survey Exploring Medical Students' Perceptions of Factors Affecting Pursuing a Career in Orthopaedic Surgery

#### Consent and Eligibility

Do you consent to proceed with participation in the study?

- Yes
- No

Medical school

- Queen's University

Graduating year:

#### Demographics

Q3 Gender identity (select all that apply)

- Gender fluid
- Man
- Non-binary / Non-conforming
- Transgender
- Two-spirit
- Woman
- Prefer not to answer
- Additional gender identity not listed, optional – please specify:

Q4 Sexual orientation (select all that apply)

- Asexual
- Bisexual
- Gay
- Heterosexual
- Lesbian
- Pansexual
- Queer
- Two-spirit
- Additional sexual orientation not listed, optional – please specify: Prefer not to answer

Q5 Race (select all that apply)

- Black
- East Asian
- Indigenous (First Nations, Inuk/Inuit, Métis)
- Latin American
- Middle Eastern
- South Asian
- Southeast Asian
- White
- Another race category optional – please specify: Prefer not to answer

#### Exposure Types

Q6 What exposure have you had to orthopaedic surgery to date (select all that apply)

- None
- Pre-clerkship learning
- Observership(s)/Shadowing
- Clinical rotation
- Other, please specify:

#### Consideration of a career in orthopaedic surgery

Have you considering pursuing a career in orthopaedic surgery?

- Yes
- No

How likely are you to pursue a career in orthopaedic surgery?

Very unlikely	Unlikely	Maybe	Likely	Very likely
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#### Barriers to a Career in Orthopaedic Surgery—Male Privilege

There is pressure to conform to gender stereotypes in orthopaedic surgery.

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
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Leaders in orthopaedic surgery are more likely to be men.

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
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The 'boys' club' mentality is common in orthopaedic surgery.

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
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#### Barriers to a Career in Orthopaedic Surgery—Physical Strength

Physical strength is required to succeed in orthopaedic surgery.

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
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#### Barriers to a Career in Orthopaedic Surgery—Exposure

I have a good understanding of what a career in orthopaedic surgery would entail.

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
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I have had sufficient exposure to orthopaedic surgery to determine whether it is a career I would like to pursue.

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
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#### Barriers to a Career in Orthopaedic Surgery—Insufficient Support

I have received mentorship from someone in orthopaedic surgery.

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
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I have a mentor of my gender identity in orthopaedic surgery.

No	Yes
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It is important to me to have a mentor of my gender identity in orthopaedic surgery.

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
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I have been told by individuals during my academic career (lecturers, preceptors, etc.) not to pursue a career in orthopaedic surgery, or that I am not suited to a career in this specialty.

No	Yes
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I have been told by individuals in my personal life (family, friends, etc.) not to pursue a career in orthopaedic surgery, or that I am not suited to a career in this specialty.

No	Yes
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#### Barriers to a Career in Orthopaedic Surgery—Disproportionate Constraints

Individuals who do not identify as men are able to pursue careers in orthopaedic surgery without facing gender-based discrimination.

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
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My gender identity affects the likelihood that I will pursue a career in orthopaedic surgery.

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
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My performance will be scrutinized differently depending on my gender identity in orthopaedic surgery.

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
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#### Barriers to a Career in Orthopaedic Surgery—Hostility

I am concerned about experiencing verbal abuse in the workplace in orthopaedic surgery.

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
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I am concerned about experiencing sexual abuse in the workplace in orthopaedic surgery.

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
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#### Barriers to a Career in Orthopaedic Surgery—Work-Life Integration.

I think I will not be able to balance family planning and/or family-life with a career in orthopaedic surgery.

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
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#### Open-Text Questions

If you would like to elaborate on any of your above answers, please do so below.

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If there are any other factors that may be influencing your decision regarding pursuing a career in orthopaedic surgery, please describe them below.

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