

ORIGINAL ARTICLE

Invisible Barriers To Female Participation In Orthopaedic Surgery Among Female Medical Students And House Officers in Pakistan: A Cross-Sectional Study

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Background/Aims: Women remain markedly underrepresented in orthopaedic surgery despite increasing female enrolment in medical schools. This study aimed to assess perceptions, interests, and perceived barriers influencing female medical students and house officers in Pakistan when considering orthopaedic surgery as a career, and to identify factors that may hinder or facilitate females.

Methods: A multicentre cross-sectional survey was conducted between March and June 2025 across public and private medical colleges and affiliated hospitals in Karachi, Pakistan. Fourth- and final-year medical students and house officers were recruited using convenience sampling. Data were collected using a validated, self-administered questionnaire assessing demographics, perceptions toward women in orthopaedics, subspecialty preferences, and perceived barriers. Descriptive statistics were calculated, and subgroup analyses were performed based on gender, training level, and orthopaedic exposure. Statistical analyses were conducted using SPSS and R, with a significance threshold of $p < 0.05$.

Results: A total of 368 participants were included (73% female; mean age 22.86 ± 2.44 years). Only 26% considered orthopaedic surgery for postgraduate training, with 20.1% of females (54/269) and 42.4% of males (42/99) of their respective subgroups expressing interest. Patient preference for male orthopaedic surgeons (78%), family and social commitments (75%), physical demands (67%), and gender discrimination (65%) were the most frequently reported barriers. Paediatric orthopaedics was perceived as the most suitable subspecialty for women. Participants with orthopaedic exposure demonstrated greater awareness of gender-based challenges.

Conclusion: Despite increasing awareness, substantial sociocultural and structural barriers continue to limit women's participation in orthopaedic surgery in Pakistan. Targeted mentorship, institutional support, and strategies to address gender bias are essential to promote a more inclusive orthopaedic workforce.

Keywords: Barriers, gender bias, orthopaedics, surgery, women, Pakistan

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Introduction

Women remain underrepresented in several professions, particularly in surgical specialties. Despite the growing demand for female surgeons and a broad consensus on the importance of developing a workforce that reflects the populations it serves; women continue to be inadequately represented in surgery (1). Currently, female surgeons constitute only 11% of consultant surgeons in the United Kingdom and Australia (2,3). A major concern is the disproportionately high attrition rate among women in surgical training programs, with many leaving before completion, despite evidence suggesting that women have strong potential to enter and succeed in these programs (1). Women pursuing surgical careers often encounter unfavorable work environments, compounded by personal and

family-related pressures, which contribute significantly to professional burnout (4).

Orthopaedic surgery is among the most male-dominated surgical specialties. According to reports, only 5% and 6% of active orthopaedic surgeons in the United States and England, respectively, are women (2,5). Although women represent approximately 50% of medical school graduates, only 15% of orthopaedic residents or fellows are female. This proportion is even lower in developing countries such as India and Pakistan. While female participation in surgical specialties has improved over time, growth within orthopaedics has been particularly slow when compared with other fields such as neurosurgery or thoracic surgery (6).

It is well recognised that female physicians interested in pursuing orthopaedic residency face multiple barriers

worldwide, with these challenges being more pronounced in Pakistan.

This study aims to address the barriers and difficulties faced by female doctors when considering orthopaedic surgery as a career choice to identify common challenges that hinder female doctors in Pakistan from choosing orthopaedic residency. Ultimately, this research seeks to propose targeted solutions, expand opportunities for women in orthopaedics, and establish a framework for future studies on gender disparities in surgical specialties.

Methods

Study Design

This was a cross-sectional survey conducted to assess perceptions and perceived barriers related to women pursuing orthopaedic surgery as a career.

Study Setting

The study was carried out at multiple public and private medical colleges and affiliated hospitals in Karachi, Pakistan, between March and June 2025.

Participants

The study population included fourth- and final-year undergraduate medical students and house officers (medical graduates undergoing clinical training). The response rate of this survey was 56%.

Inclusion criteria

Undergraduate Medical Students: Participants must be currently enrolled in an undergraduate medical education program.

Year of Study: First-, second-, third-, fourth-, and final-year undergraduate medical students, as well as house officers, were eligible. Third-year students were explicitly included as they had commenced clinical training and were enrolled at the participating institutions at the time of data collection; this is consistent with the participant data reported in Table 1 (third year n=97, 26.4%).

Exclusion criteria

Non-Medical Students: Individuals who are not currently enrolled in an undergraduate medical education program are excluded.

Postgraduate Students: Students who have already completed their undergraduate medical education and are pursuing postgraduate studies are excluded.

Incomplete Responses: Participants who do not fully complete the survey questionnaire will be excluded from the analysis.

Ethical Considerations

The study was conducted in accordance with the ethical guidelines formulated in the Declaration of Helsinki. Ethical

approval was obtained from the Ameen Medical and Dental Center (Reference No. ERC-CIRS-2023-603). Participation was voluntary, and informed consent was obtained from all participants prior to data collection. All questionnaire data were anonymised before analysis by removing identifying information. Confidentiality and anonymity of responses were maintained throughout the study.

Sampling and Recruitment

Non-probability convenience sampling was employed to select participating institutions and hospitals. Members of the research team visited selected public and private medical colleges and hospitals to recruit participants. Institutional permission was obtained prior to data collection. Eligible participants were approached in person, and informed consent was obtained before survey administration.

Data Collection Tool

Data were collected using a structured, self-administered questionnaire adapted from a previously published study conducted in Saudi Arabia (7). The questionnaire was selected following a comprehensive literature review and further evaluated by orthopaedic experts to ensure content validity and contextual relevance.

A pilot study was conducted to assess the reliability and validity of the questionnaire. The instrument demonstrated good internal consistency, with a Cronbach's alpha coefficient of 0.82.

Study Variables

The questionnaire consisted of 18 items divided into three sections:

- Section A: Collected demographic information, including age, gender, type of institution, and year of medical training.
- Section B: Assessed perceptions regarding women pursuing orthopaedic surgery as a career. This section included 13 items rated on a 5-point Likert scale ranging from "strongly agree" to "strongly disagree." Participants were also asked to identify one orthopaedic subspecialty they perceived as most suitable for women and orthopaedic exposure of females. Orthopaedic exposure was defined as completion of a formal orthopaedic surgery rotation or course during undergraduate medical training, as self-reported by participants.
- Section C: Explored perceived barriers faced by women in orthopaedic surgery. Respondents indicated agreement or disagreement with nine predefined barriers.

Bias

Potential sources of bias included the use of convenience sampling and self-reported responses, which may introduce selection and response bias. Efforts were made to minimize these biases by recruiting participants from multiple institutions and ensuring anonymity of responses.

Statistical Analysis and Sample Size

The sample size of 217 was estimated using OpenEpi version 3.01, based on an anticipated frequency of 17% from a previous study (7), with a 5% margin of error and a 95% confidence interval. Data analysis was conducted using R (version 4.1.1) and SPSS software (Version 26). The mean and standard deviation (SD) were calculated for descriptive statistics of numeric variables, such as age. Categorical variables, like barriers and perceptions, were summarized using frequencies and percentages. The Shapiro-Wilk test was applied to assess the normality of the data. The distribution of categorical variables across different groups was compared using the Chi-square test. Likert scale responses for individual questions were analysed with one-sample tests to determine

statistical significance, while two-sample t-tests were used to compare Likert scale ratings between different groups and subgroups. A p-value of less than 0.05 was considered statistically significant.

Results

A total of 368 participants completed the survey and included in the analysis. Among them, 73% were female and 27% male. The mean age of all participants was 22.86 ± 2.44 years. Almost 26.4% of the participants were in the third professional years, whereas 23.1% and 24.7% were in final year and house-officers respectively. Most of them (81.8%) were in their clinical years. All the detailed sociodemo-graphic characteristics are presented in Table 1.

Table.1. Sociodemographic of study participants

Participants	Total number of participants (N= 368)	Female n (% of females) (n = 269)	Male n (% of males) (n=99)	P- value
Age (in years)	22.86 $\pm$ 2.44 (Range:18-31)	22.5 $\pm$ 2.39	23.85 $\pm$ 2.32	<0.001**
Marital status	Marital status	Marital status	Marital status	Marital status
Single	327 (88.9%)	241 (89.6%)	86 (86.9%)	0.46
Married	41 (11.1%)	28 (10.4%)	13 (13.1%)	0.46
Designation/ academic year of medicine	Designation/ academic year of medicine	Designation/ academic year of medicine	Designation/ academic year of medicine	Designation/ academic year of medicine
First year	48 (13%)	45 (16.7%)	3 (3.0%)	<0.001**
Second year	19 (5.2%)	13 (4.8%)	6 (6.1%)	<0.001**
Third year	97 (26.4%)	79 (29.4%)	18 (18.2%)	<0.001**
Fourth year	28 (7.6%)	20 (7.4%)	8 (8.1%)	<0.001**
Final year	85 (23.1%)	64 (23.8%)	21 (21.2%)	<0.001**
House officers	91 (24.7)	48 (17.8%)	43 (43.4%)	<0.001**
Level of exposure	Level of exposure	Level of exposure	Level of exposure	Level of exposure
Pre-clinical years	67 (18.2%)	58 (21.6%)	9 (9.1%)	0.002*
Clinical years	301 (81.8)	211 (78.4%)	90 (90.9%)	0.002*
Institute	Institute	Institute	Institute	Institute
Public	208 (56.5%)	157 (58.4%)	51 (51.5%)	0.24
Private	160 (43.5%)	112 (41.6%)	48 (48.5%)	0.24
Taken orthopaedic surgery course				0.24
Yes	182 (49.5%)	117 (43.5%)	65 (65.7%)	<0.001**
No	186 (50.5%)	152 (56.5%)	34 (34.3%)	<0.001**
Planning to pursue postgraduate training in orthopaedics				<0.001**
Yes	96 (26.1%)	54 (20.1%)	42 (42.4%)	<0.001**
No	196 (53.3%)	156 (58.0%)	39 (39.4%)	<0.001**
Do not know	76 (20.7%)	58 (21.6%)	18 (18.2%)	<0.001**

A limited number of participants (26%) considered orthopaedic surgery for postgraduate training, while 20.7% were unsure about choosing orthopaedics. Further subgroup analysis

showed that 54 females (20.1% of female participants) and 42 males (42.4% of male participants) were interested in pursuing orthopaedics as a . However, 49.5% of the total participants had

exposure of orthopaedics. The subgroup analysis revealed that a higher number of males (65.7%) had previous exposure of orthopaedics. Subgroup responses by level of progression in professional years showed an increase trend from 1- 4th

professional years. Only 18.7% of 1st years participants were interested in orthopaedics, which was increased up to 35.1% in graduated house officers (Figure.1).

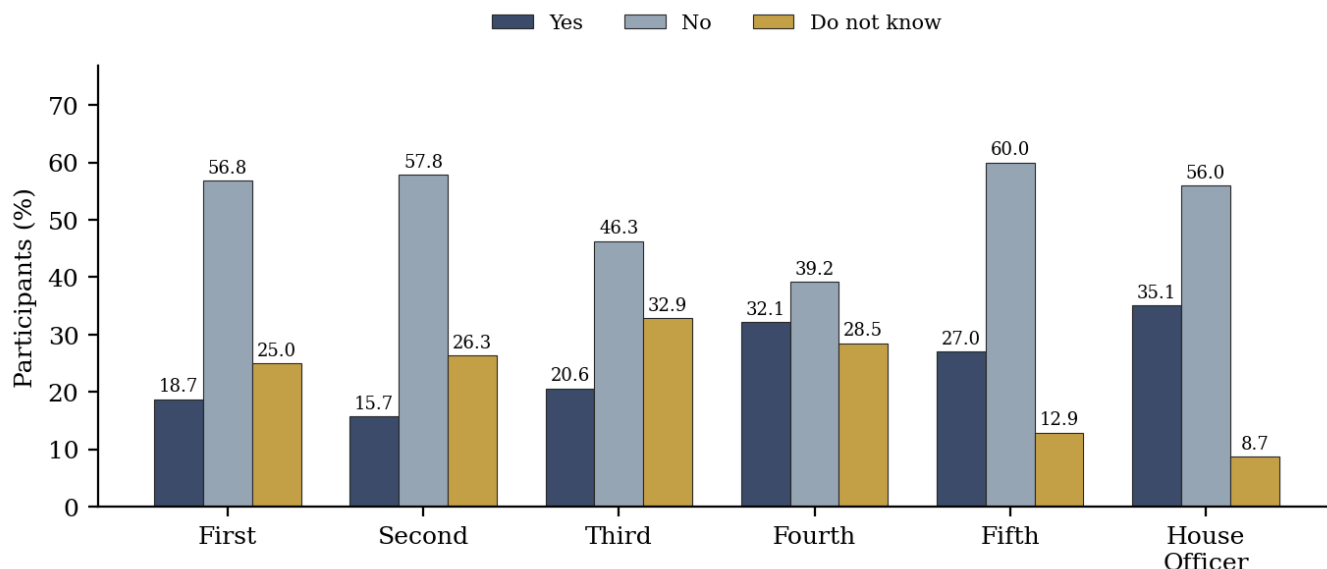


Figure 1. Level of progression in professional years and interest in orthopaedic surgery.

Sub-specialty in orthopaedics preferred for women

Almost 35 participants agreed that all specialties are perceived as suitable for women. However, 44.6% of female participants and 33.3% of male participants suggested paediatric orthopaedics as the most suitable specialty for women followed by sports medicine, orthopaedic oncology and hands and upper extremity. Deformity and shoulder surgery were the least chosen specialties for women. Furthermore, participants who

had not taken an orthopaedic surgery course had a higher preference for paediatric orthopaedics compared to those who had (48.4% vs 34.6%). However, participants who took orthopaedic course had high preferences for sports medicine, orthopaedic oncology, and hands and upper extremity than those who did not. Among all of them, 12.1% of participants who had taken an orthopaedic course suggested that women can choose any specialty. All detailed responses about sub-specialty preferences of women are presented in Table 2.

Table.2. Subgroup analysis of chosen subspecialties perceived as most suitable for women in orthopaedic surgery according to gender and prior orthopaedic exposure

Specialty	Number of participants	Number of participants	Taken orthopaedics surgery course	Taken orthopaedics surgery course
	Female (%) n=269	Male (%) n=99	Yes n=182	No n=186
Pediatric orthopedics (n=153)	120 (44.6)	33 (33.3)	63 (34.6)	90 (48.4)
Sports medicine (n=24)	14 (5.2)	10 (10.1)	13 (7.1)	11 (5.9)
Trauma (n=16)	11 (4.1)	5 (5.1)	10 (5.5)	6 (3.2)
Spine surgery (n=15)	13 (4.8)	2 (2.0)	8 (4.4)	7 (3.8)
Shoulder (n=7)	6 (2.2)	1 (1.0)	2 (1.1)	5 (2.7)
Deformity (n=3)	1 (0.4)	2 (2.0)	2 (1.1)	1 (0.5)
Arthroscopy (n=11)	5 (1.9)	6 (6.1)	7 (3.8)	4 (2.2)
Foot and ankle surgery (n=13)	9 (3.3)	4 (4.0)	7 (3.8)	6 (3.2)
Hand and upper extremity (n=23)	20 (7.4)	3 (3.0)	12 (6.6)	11 (5.9)
Orthopedics oncology (n=24)	19 (7.1)	5 (5.1)	15 (8.2)	9 (4.8)
Do not know (n=44)	26 (9.7)	18 (18.2)	23 (12.6)	21 (11.3)

All of them (n=35)	25 (9.3)	10 (10.1)	22 (12.1)	13 (7.0)
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Perception of participants about barriers for women in orthopaedics

The overall response of all participants revealed that there are certain barriers that prevent women to pursue orthopaedic surgery as a career. Overall, 78% of the participants considered patients' preference of male orthopaedic surgeon as the leading barrier for women. Similarly, 75% of the participant chose family and social commitment as barrier for women in orthopaedics followed by physical strength and body build (67%), gender discrimination (65%), on- call duties and covering trauma and emergency (63%), stress and burn out (59%), long working hours and workload (59%) and radiation exposure in orthopaedics (58%). However, 37% of the total participants believe that there are any barriers for women in orthopaedic surgery. The gender-based sub grouping between

female and male revealed preference of male orthopaedic surgeons (78.1% vs 78.8%, $P=0.88$), family and social commitments (75.8% vs 73.7%, $P=0.67$) and physical strength and body build (65.1% vs 71.7%, $P=0.22$) as the most commonly reported barriers in both sub-groups; however, none of these gender differences reached statistical significance (all $p > 0.05$).

The group analysis of participants who had taken an orthopaedic course perceived patients' preference of male orthopaedic surgeon (80.2%), gender discrimination (75.3%) and family and social commitments (73.6%) as the top barriers for women. There was statistically significant difference observed in barriers like gender discrimination and on call duties and covering trauma and emergencies between participants who took orthopaedic course and who did not ($P < 0.05$). Details are presented in Table 3.

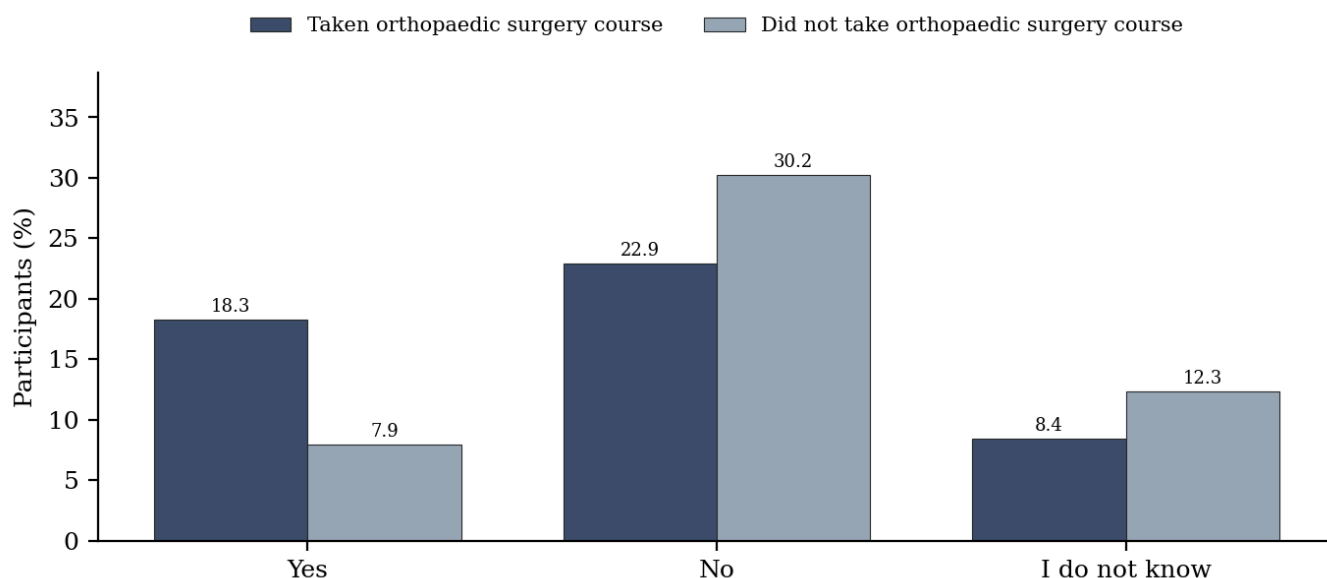


Figure 2. Exposure of orthopaedic surgery and intentions to pursue postgraduate training in orthopaedics.

Table 3. Subgroup analysis of perceived barriers to female participation in orthopaedic surgery according to gender and prior orthopaedic course exposure

Barriers for females in orthopaedic surgery (N)	Number of participants	Number of participants	P-value	Taken orthopaedic surgery course	Taken orthopaedic surgery course	P-value
Barriers for females in orthopaedic surgery (N)	Female N (%) n=269	Male N (%) n=99	P-value	Yes N (%) n=182	No N (%) n=186	P-value
Gender discrimination (n=239)	174 (64.7)	65 (65.7)	0.86	137 (75.3)	102 (54.8)	<0.001**
I do not believe that there are any barriers (n=137)	92 (34.2)	45 (45.5)	0.04	53 (29.1)	84 (45.2)	0.001**
On-call duties and covering trauma and emergencies (n=232)	170 (63.2)	62 (62.6)	0.92	105 (57.7)	127 (68.3)	0.03*
Stress and burn-out (n=216)	156 (58.0)	60 (60.6)	0.65	105 (57.7)	111 (59.7)	0.69
The family and social commitments (n=277)	204 (75.8)	73 (73.7)	0.67	134 (73.6)	143 (76.9)	0.46

The long working hours and heavy workload (n=216)	157 (58.4)	59 (59.6)	0.83	99 (54.4)	117 (62.9)	0.09
The patients' preference of male orthopaedic surgeon (n=288)	210 (78.1)	78 (78.8)	0.88	146 (80.2)	142 (76.3)	0.36
The physical strength and body build (n=246)	175 (65.1)	71 (71.7)	0.22	121 (66.5)	125 (67.2)	0.88
The radiation exposure in orthopaedics (n=214)	165 (61.3)	49 (49.5)	0.03	104 (57.1)	110 (59.1)	0.74

Note: Values are presented as number (percentage). Percentages were calculated within each subgroup category. The table demonstrates the association of perceived barriers for females in orthopaedic surgery according to participant gender and previous exposure to an orthopaedic surgery course. Comparisons between groups were performed using the Chi-square test. A p-value of <0.05 was considered statistically significant. Participants were allowed to select more than one barrier; therefore, cumulative percentages may exceed 100%.

Gender differences in perception of orthopaedic surgery suitability

The perceptions about barriers did not vary significantly between male and female participants except perception about women are as suitable for orthopaedic surgery, orthopaedic surgeons possess greater surgical skills, stress and burn out and

orthopaedic surgery is not a suitable for women as shown in Table 4. The female had significantly higher agreement about suitability of orthopaedics for women. However, male participants showed significant agreement about orthopaedic surgeons possess greater surgical skills, stress and burn out and orthopaedic surgery is not a suitable for women (P <0.05) (Table 4).

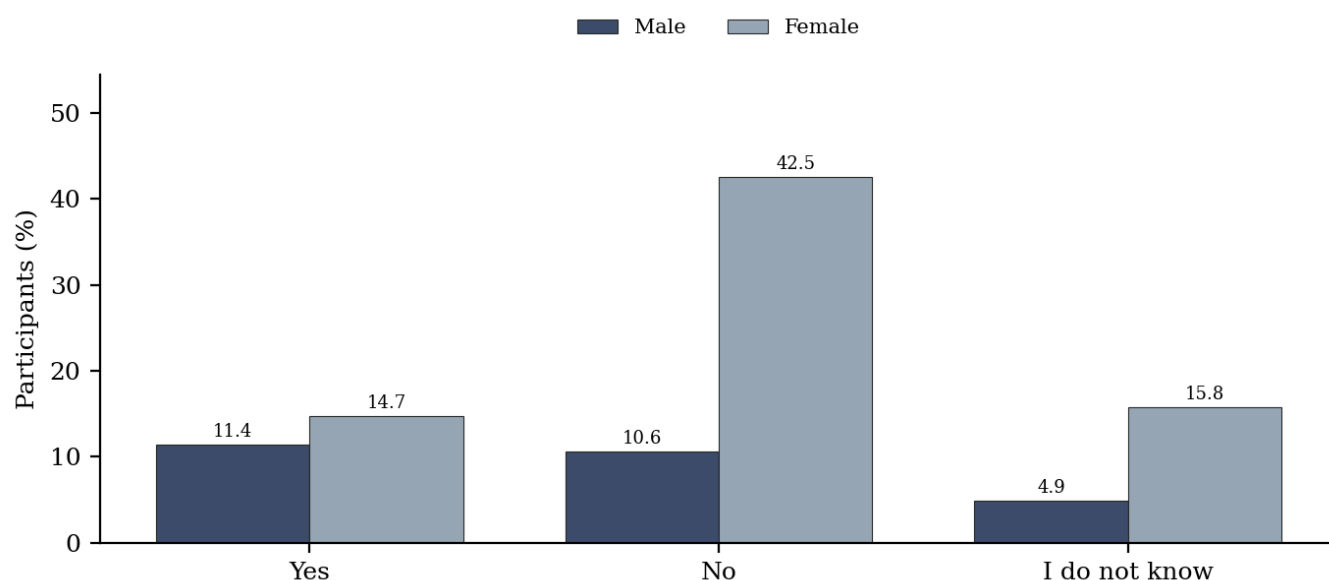


Figure 3. Gender-wise distribution of respondents' intentions to pursue postgraduate training in orthopaedics.

Table 4. Perception of participants about barriers for women in orthopaedics and its association with gender

Questions	Overall score	Perception differences in male and female	Perception differences in male and female	Perception differences in male and female
Questions	Mean Likert score ^b	Female	Male	P-value
1 Is gender diversity important in the field of orthopaedic surgery?	2.62	2.60	2.68	0.81
2 Do you believe that women are as suitable for orthopaedic surgery? ^a	2.80	2.89	2.54	0.01**
3 I think that male orthopaedic surgeons are often perceived as more trustworthy by patients compared to their female counterparts	2.63	2.57	2.77	0.22
4 I think that the potential risk of radiation exposure in orthopaedics could act as an obstacle for women pursuing a career in orthopaedic surgery	2.21	2.19	2.26	0.63
5 I think that the responsibilities of being on-call, particularly for trauma and emergencies in orthopaedics, might present a challenge for women in the field of orthopaedic surgery	2.18	2.14	2.29	0.33

	effectiveness of the profession and the cohesion of the orthopaedic surgery community	2.83	2.86	2.75	0.66
7	I think that male orthopaedic surgeons possess greater surgical skills compared to their female counterparts in orthopaedics	1.72	1.56	2.15	<0.001**
8	I believe that familial and societal responsibilities can present an obstacle for women pursuing a career in orthopaedic surgery	2.60	2.58	2.63	0.77
9	I think that the physical strength and body composition required for practicing orthopaedic surgery can hinder women's participation in the field	2.38	2.32	2.56	0.06
10	I think that the demanding work hours and substantial workload can pose a challenge for women who wish to practice orthopaedic surgery	2.28	2.25	2.38	0.35
11	I believe that the stress and potential burnout experienced in the field of orthopaedics can serve as obstacles for women pursuing a career in orthopaedic surgery	2.10	2.03	2.30	0.05*
12	I hold the belief that orthopaedic surgery is not a suitable or fitting career choice for women	1.34	1.20	1.73	<0.001**

Note.^a This item represents a negation response option (i.e., denial of any barrier), not a barrier per se, and should be interpreted separately from the barrier items above.^b **Likert scale:** 1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly Agree. Lower mean scores reflect greater disagreement. Bold p-values indicate statistically significant differences ($p < 0.05$) between female and male subgroups, tested using two-sample t-tests. *P-value < 0.05 was considered as significant

Impact of level of exposure on perception

Overall, the level of exposure in term of clinical years did not statistically significantly impact the perception of participants, except importance of gender diversity and preference of male orthopaedic surgeons by patients ($P < 0.05$). The female

participants in their clinical years had significant higher agreement about importance of gender diversity, preference of male orthopaedic surgeons by patients and diverse gender representation. The level of exposure was not significantly impacting the perception among male participants. All details are mentioned in Table 5.

Table.5. Impact of level of exposure on perception

Question	Overall Likert score	Overall Likert score	Overall Likert score	Female students Likert score	Female students Likert score	Female students Likert score	Male student Likert score	Male student Likert score	Male student Likert score
Question	Pre-clinical year (N=115) Mean	Clinical year (N=253) Mean	P- value	Pre-clinical year (N=96) Mean	Clinical year (N=173) Mean	P- value	Pre-clinical year (N=19) Mean	Clinical year (N=80) Mean	P-value
Is gender diversity important in the field of orthopaedic surgery?	2.34	2.75	0.01	2.21	2.82	0.001	3	2.60	0.15
Do you believe that women are as suitable for orthopaedic surgery?	2.91	2.75	0.13	3.01	2.83	0.13	2.42	2.57	0.71
I think that male orthopaedic surgeons are often perceived as more trustworthy by patients compared to their female counterparts	2.37	2.74	0.01	2.30	2.72	0.01	2.73	2.78	0.80
I think that the potential risk of radiation exposure in orthopaedics could act as an obstacle for women pursuing a career in orthopaedic surgery	2.20	2.22	0.92	2.12	2.23	0.48	2.57	2.18	0.19
I think that the responsibilities of being on-call, particularly for trauma and emergencies in orthopaedics, might present a challenge for women in the field of orthopaedic surgery	2.33	2.12	0.19	2.32	2.05	0.12	2.36	2.27	0.75
I think that having a diverse gender representation within the field of orthopaedic surgery is a crucial element that enhances both the effectiveness of the profession and the cohesion of the orthopaedic surgery community	2.71	2.88	0.13	2.64	2.98	0.01	3.05	2.68	0.15
I think that male orthopaedic surgeons possess greater surgical skills compared to their female counterparts in orthopaedics	1.63	1.76	0.41	1.57	1.56	0.96	1.94	2.20	0.49

I believe that familial and societal responsibilities can present an obstacle for women pursuing a career in orthopaedic surgery	2.66	2.57	0.44	2.61	2.57	0.75	2.89	2.57	0.22
I think that the physical strength and body composition required for practicing orthopaedic surgery can hinder women's participation in the field	2.26	2.44	0.26	2.25	2.36	0.49	2.36	2.61	0.58
I think that the demanding work hours and substantial workload can pose a challenge for women who wish to practice orthopaedic surgery	2.33	2.26	0.63	2.32	2.21	0.44	2.36	2.38	0.93
I believe that the stress and potential burnout experienced in the field of orthopaedics can serve as obstacles for women pursuing a career in orthopaedic surgery	2.12	2.09	0.89	2.09	2	0.55	2.26	2.31	0.93
I hold the belief that orthopaedic surgery is not a suitable or fitting career choice for women (chose any one option)	1.22	1.39	0.24	1.10	1.25	0.35	1.84	1.71	0.65

reports mean Likert scores stratified by clinical exposure level (pre-clinical vs clinical years) for the overall sample, and separately for female and male subgroups. Likert scale: 1 = Strongly Disagree, 5 = Strongly Agree. Bold p-values indicate $p < 0.05$ (two-sample t-tests).

Discussion

This cross-sectional study provides important insights into perceptions, interests, and perceived barriers related to women pursuing orthopaedic surgery among medical students and house officers in Pakistan. Despite an increasing global emphasis on gender equity in medicine, our findings highlight that orthopaedic surgery continues to be perceived as a challenging and less attractive career option for women, largely due to sociocultural, professional, and structural barriers.

One of the most notable findings was that only 26% of participants reported considering orthopaedic surgery for postgraduate training, and when broken down by gender, males showed proportionally higher interest within their subgroup (42.4% of males vs 20.1% of females). This is a particularly noteworthy finding: despite 49.5% of all participants reporting prior orthopaedic exposure, interest in the specialty remained consistently low and did not meaningfully differ between exposed and unexposed groups. This suggests that the quality, context, and culture of orthopaedic training environments — rather than mere exposure — may be the critical determinant of career interest. Negative experiences during rotations, such as witnessing gender bias, physically demanding working conditions, or a lack of female mentors, may actively discourage female trainees regardless of the quantity of exposure received. Future interventions should therefore focus not only on increasing access to orthopaedic rotations but on ensuring that those experiences are structured, supportive, and inclusive of women. This aligns with global trends demonstrating persistently low female representation in orthopaedics despite women comprising approximately half of medical graduates worldwide^{2,5,6}. However, the upward trend in interest among house officers compared to earlier-year students indicates that prolonged clinical interaction and mentorship may gradually shift perceptions, an important consideration for curriculum developers and policymakers.

In line with the global literature, the perceived barriers identified in this study were multi-dimensional. Patient preference for male orthopaedic surgeons emerged as the most prominent barrier (78%), underscoring a deeply rooted societal

bias that extends beyond the healthcare system. Similar concerns have been reported in other countries, where cultural expectations and gender norms shape patients' comfort levels with surgeons of different genders. In Pakistan, where gendered social norms strongly influence professional roles, this barrier may be particularly amplified.

Interestingly, although nearly half of participants reported prior exposure to orthopaedics, only a small fraction of those exposed expressed interest in pursuing it as a career. This contrasts with some studies from high-income countries where increased exposure has been associated with greater interest in orthopaedic careers^{8,9}. In the Pakistani context, exposure may instead reinforce negative perceptions related to workload, physical demands, and gender bias, highlighting qualitative differences in training environments across settings.

Participants predominantly perceived paediatric orthopaedics as the most suitable subspecialty for women, followed by sports medicine and upper extremity surgery. This pattern reflects gender stereotyping observed in previous studies, where women are often steered toward subspecialties perceived as less physically demanding or more “family-friendly”^{10,11}. The finding that participants who completed orthopaedic rotations were more likely to endorse a wider range of subspecialties including oncology and sports medicine suggests that structured exposure may help challenge such stereotypes, although its impact remains limited.

Consistent with international literature, patient preference for male orthopaedic surgeons emerged as the most commonly perceived barrier, followed by family and social commitments, physical strength requirements, and gender discrimination^{7,12–14}. These findings underscore the persistence of both external (societal expectations, patient bias) and internal (self-perception, work–life balance concerns) deterrents to female participation in orthopaedics.

Male and female respondents differed in their perceptions of certain barriers. Female participants were more likely to affirm the suitability of women for orthopaedic surgery ($p=0.01$), whereas male participants more frequently endorsed views related to higher stress, burnout ($p=0.05$, borderline), and

unsuitability of orthopaedics for women ($p < 0.001$). Caution is warranted in interpreting the stress/burnout difference, as it only reached borderline significance. Similar gender-based perception gaps have been reported elsewhere and may reflect unconscious bias and deeply ingrained professional norms^{13,15}.

Participants who had completed an orthopaedic course demonstrated greater awareness of gender discrimination and on-call demands as barriers, with statistically significant differences compared to those without exposure. This suggests that direct experience may uncover systemic issues within orthopaedic training environments, reinforcing the need for structural reforms rather than solely focusing on recruitment. Our findings are broadly consistent with studies from Saudi Arabia, India, and Western countries, which report low interest among female trainees and identify similar barriers, including workload intensity, gender bias, and lack of mentorship^{7,10,12}. However, the magnitude of perceived barriers particularly sociocultural and family-related constraints appears more pronounced in Pakistan, reflecting contextual differences in societal expectations and healthcare systems.

To our knowledge, this is among the few studies from Pakistan that comprehensively evaluates perceptions, subspecialty preferences, and barriers related to women in orthopaedic surgery using a validated instrument. The inclusion of both undergraduate students and house officers provides a developmental perspective on career decision-making. Furthermore, subgroup analyses based on gender, level of training, and orthopaedic exposure offer nuanced insights that can inform targeted interventions.

A key strength of this study is its focus on an underexplored yet critically important issue within Pakistan's surgical workforce. By surveying medical students and house officers from multiple public and private institutions, the study captures the perspectives of trainees at different stages of their medical education. This enhances the diversity and representativeness of the sample. The strengths of this study include its multicentre design, relatively large sample size, inclusion of both genders, and use of a validated questionnaire with good internal consistency.

However, several limitations must be acknowledged. The use of convenience sampling may limit generalisability, and the predominance of female respondents may introduce response bias. Specifically, the sample comprised 73% female participants, which may skew perceptions of barriers and subspecialty preferences toward those more salient to women; male perspectives are correspondingly underrepresented and findings should not be generalized equally to both groups. Self-reported perceptions are subject to social desirability bias, and the cross-sectional design precludes causal inferences. Additionally, qualitative data was not collected, limiting deeper exploration of participants' lived experiences. The

questionnaire had a good Cronbach's alpha that represented good internal consistency reliability, however, test re-test reliability was not tested and reported. Furthermore, confidence intervals were not reported alongside p-values for the main group comparisons, which limits readers' ability to assess the precision and clinical magnitude of effect estimates; future studies should routinely report 95% CIs.

Addressing gender disparities in orthopaedic surgery requires multifaceted strategies. These include early mentorship programs, visible female role models, flexible training pathways, institutional policies supporting work-life balance, and initiatives to counter patient and professional gender bias. Future research should incorporate qualitative methodologies to explore underlying attitudes in greater depth and longitudinal designs to assess how perceptions evolve over time. National-level studies and intervention-based research are also needed to evaluate the effectiveness of targeted programs aimed at improving female recruitment and retention in orthopaedics.

In conclusion, this study highlights that although awareness and exposure to orthopaedics are increasing among female medical trainees in Pakistan, substantial cultural, structural, and perception-based barriers continue to limit women's participation in the specialty. Addressing these barriers requires coordinated efforts across medical schools, hospitals, professional societies, and policymakers. Having supportive training environments and promoting gender equity, Pakistan can build a more diverse orthopaedic workforce that better reflects and serves its population.

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