ORIGINAL

How should we intervene to increase the number of female spine surgeons? A preliminary survey of trainees in Japan from medical school through spine fellowship

Saori Soeda[1], Nori Sato[2], Kosuke Sugiura[1], Hiroaki Manabe[1], Masatoshi Morimoto[1], Fumitake Tezuka[1], Kazuta Yamashita[1], Junzo Fujitani[1], and Koichi Sairyo[1]

[1]Department of Orthopedics, Tokushima University, Tokushima, Japan, [2]Department of Rehabilitation Medicine, Tokushima University Hospital, Tokushima, Japan

Abstract : Background : Women account for 23.6% of physicians in Japan yet account for only 5% of orthopedic surgeons and <1% of board-certified spine surgeons. We identified points along the training pathway where women perceive barriers to pursuing spine surgery. Methods : In this sequential explanatory mixed-methods study, we surveyed all 5th- and 6th-year medical students at our institution and postgraduate year-1–2 residents and received responses from 62 trainees (29 women, 33 men). Counts, percentages, and χ^2 or Fisher exact tests were used to compare the groups. We thematically analyzed the semi-structured e-mail interviews conducted with 10 female orthopedic trainees (4 residents, 1 non-spine surgeon, and 5 spine fellows). Results : Interest in orthopedics was reported by 45% of women and 64% of men (p = 0.22) ; within that subgroup interest in spine surgery was similar (31% vs. 33% ; p = 1.00). From the interviews, four categories of barriers to choosing spine surgery as a subspecialty emerged : (1) physical limitations, (2) radiation exposure, (3) demanding working hours/on-call, and (4) a gender-imbalanced environment. Conclusions : Many early-career women already express interest in orthopedics. However, translating that interest into careers as spine surgeons will require sustained mentorship plus the adoption of assistive technologies, ergonomic instruments, and team-based shift schedules—interventions that could benefit the entire surgical workforce. J. Med. Invest. 72 : 425-429, August, 2025

Keywords **:** *Female, Orthopedic Surgeons, Spine, Mentors, Career Choice*

INTRODUCTION

Gender disparity among spine surgeons is a worldwide phenomenon. In Japan, women account for 23.6% of all physicians but only about 5% of orthopedic surgeons and <1% of board-certified spine surgeons, placing the country near the bottom of global diversity rankings for the specialty (1-3).

Importantly, the pipeline of potential recruits is expanding, with the proportion of women entering Japanese medical schools climbing steadily since 2018 and surpassing 40% of enrollees in 2024 (4). Unless the number of female spine surgeons increases, Japan will not be able to secure an adequate spine-surgery workforce—especially as the demand for spine surgery increases with population aging and the overall surgical labor pool continues to shrink (5).

From a clinical-needs perspective, several disorders disproportionately affect female patients or benefit from gender-concordant care. For example, adolescent idiopathic scoliosis is both more prevalent and more likely to progress in girls than in boys, and surveys show that female adolescents and their guardians often prefer a same-gender physician (6). Expanding the number of female spine surgeons is therefore not only an equity goal but also a workforce and patient-satisfaction imperative.

Most previous studies on gender disparity have examined academic visibility—including, authorship and invited roles at national meetings in Japan and the United States—rather than the perceptions of trainees (7, 8). Consequently, little is known about where along the training pathway women disengage or which barriers feel most pressing to them. We hypothesized that the reasons why young women do not pursue spine surgery may lie not in academic aptitude or interest, but rather in non-academic factors—such as perceived physical demands. The present sequential explanatory mixed-methods study addresses this gap. First, we quantified interest in orthopedics and spine surgery among medical students and early residents and then explored sex-specific barriers through in-depth interviews. The aims of our study were (1) to measure baseline interest, (2) to identify barriers unique to female orthopedic trainees, and (3) to pinpoint training stages where targeted interventions could most effectively enlarge the pipeline of female spine surgeons.

Received for publication July 3, 2025 ; accepted July 31, 2025.

Address correspondence and reprint requests to Koichi Sairyo, MD, PhD, Professor and Chairman, Department of Orthopedics, Tokushima University, 3-18-15 Kuramoto, Tokushima City, Tokushima 770-8503, Japan and Fax : +81-88-633-0178. E-mail : sairyokun@gmail.com

MATERIALS AND METHODS

Study Design

We employed a sequential explanatory mixed-methods approach. A cross-sectional questionnaire was used in the quantitative phase, and its findings guided a second, qualitative phase involving semi-structured interviews that clarified and enriched the survey results.

Participants and Recruitment

We used a single-center convenience sample. A Google Forms survey link was e-mailed to all fifth- and sixth-year medical students in our institution and circulated in a private messaging group that included postgraduate-year (PGY)-1–2 residents known to the investigators. After preliminary analysis of the survey data, we purposively invited 10 female orthopedic trainees to participate in follow-up interviews : 4 orthopedic residents,

1 non-spine staff surgeon, and 5 spine fellows. All participation was voluntary, and electronic informed consent was obtained for both study phases.

Questionnaire

The questionnaire captured (i) training stage (fifth-year student, sixth-year student, PGY 1, or PGY 2), (ii) gender (female, male, or prefer not to answer), (iii) factors influencing specialty choice (multiple selection from personal interest, departmental atmosphere, lifestyle, income expectations, exposure to mentors, and other), (iv) current interest in orthopedics (yes/no), (v) reason for interest if "yes," (vi) reason for lack of interest if "no," and (vii) subspecialty preferences for respondents interested in orthopedics. The full item list is provided in Table 1.

Table 1. Questionnaire used to assess career interests and influencing factors

Question	Response Options
Q1. What is your gender?	• Female • Male • Other
Q2. What is your current year / training level?	• 5th-year medical student • 6th-year medical student • PGY-1 resident • PGY-2 resident • Other
Q3. Which clinical specialties are you currently interested in? (Select up to 3)	• Internal medicine (general, cardiology, pulmonology, neurology, hematology) • Pediatrics • Obstetrics & gynecology • Gastrointestinal surgery • Orthopedic surgery • Neurosurgery • Anesthesiology • Emergency medicine • Radiology • Dermatology • Cosmetic surgery • Other
Q4. When choosing your future specialty, which factors will be most important to you? (Select up to 3)	• Personal interest • Good income • Presence of mentors • Working hours and number of on-call shifts • Compatibility with family/childcare responsibilities • Department atmosphere • Geographic location of workplace • Other
Q5. How interested are you in orthopedic surgery?	• Very interested • Somewhat interested • Not very interested • Not at all interested
Q6. If you answered "interested" in Q5 : Why are you interested in orthopedic surgery? (Select all that apply)	• I find the field intellectually interesting • I want to perform surgery in the future • It is related to sports • The orthopedic surgeons I know are appealing role-models • I have previously been an orthopedic patient • The patient population is diverse and broad • I have experience as an athlete • Other (free text)
Q7. If you answered "interested" in Q5 : Are you interested in spine?	• Yes • No
Q8. If you answered "not very interested" or "not at all interested" in Q5 : Why are you not interested in orthopedic surgery? (Select all that apply)	• I do not want to perform surgery • I am not interested in the field itself • I perceive it as a male-dominated field • The physical demands seem too high • It appears to involve many emergencies/off-hours duties • There are few female orthopedic surgeons • I do not know much about orthopedics because I have no mentors in the field • Other (free text)

Interview Guide

We interviewed 10 female orthopedic doctors (4 residents, 5 spine fellows, and 1 attending orthopedic surgeon not currently in spine). The question was where did you feel the difficulty as spine surgeon or spine rotator? Using a directed content-analysis approach, two independent coders labelled all transcripts ; disagreements were resolved by discussion, and the final coding scheme reflected full consensus. Interviews were conducted by e-mail ; the question set was sent to each participant, and written replies were returned in free-text format for thematic analysis.

Statistical Analysis

Categorical variables are reported as counts and percentages. Group differences by sex and training stage were examined using Pearson's χ^2 test ; Fisher's exact test was used when any expected cell count was <5. Two-tailed p-values <0.05 were considered statistically significant. Analyses were performed with EZR ver. 1.63 (Jichi Medical University, Tochigi, Japan). Given the small number of respondents, a post hoc calculation of statistical power was performed using G*Power statistical software (version 3.1.9.2, Düsseldorf, Germany). A sample size calculation based on the observed difference in proportions (women 45% vs men 64%) demonstrated that 107 participants per group (total n=214) would be sufficient to detect a statistically significant difference with 80% power at a two-sided α of 0.05.

RESULTS

Survey Characteristics

A total of 62 complete questionnaires were returned (response rate 28%), comprising 29 women (47%) and 33 men (53%). By training stage, there were 23 fifth-year medical students, 21 sixth-year students, 4 PGY-1 residents and 12 PGY-2 residents.

Factors that Determine Specialty Choice

For both genders, personal interest in the discipline was the most frequently cited determinant (men 30/33, 94% ; women 27/29, 93%). The second-ranked factor was departmental atmosphere (men 22/33, 69% ; women 18/29, 62%). The third-ranked factor diverged by sex : men most often selected expected income (12/33, 38%), whereas women most often selected compatibility with family life (13/29, 45%).

Interest in Orthopedics and Spine

A total of 13 women (45%) and 21 men (64%) reported having an interest in orthopedics, although the difference was not statistically significant ($\chi^2 = 1.51$, $p = 0.22$). Among the 34 respondents interested in orthopedics, 4 of the 13 women (31%) and 7 of the 21 men (33%) expressed interest in spine surgery ($\chi^2 = 0.00$, $p = 1.00$). Interest in orthopedics was higher among medical students (27/45, 60%) than among residents (7/17, 41%), but the difference was not significant ($\chi^2 = 1.77$, $p = 0.18$).

Reasons Given by Respondents Who Were Interested in Orthopedics

The leading motivations were strong interest in the field (22, 64.7%), prior personal experience in competitive sports (16, 47.1%), the desire to perform surgery (15, 44.1%), an opportunity to remain involved in sports medicine (15, 44.1%), and having been an orthopedic patient themselves (12, 35.3%). A total of 10 respondents (29.4%) valued the breadth of patient demographics, and 6 (17.6%) cited inspiring mentors in the field.

Reasons Given by Respondents Who Were Not Interested in Orthopedics

Nearly half of these participants cited a simple lack of personal interest in the field (13/28, 46.4%). Among the women in this subgroup, 2 answered that orthopedics was a male-dominated profession, 2 were uneasy because they did not know any female orthopedic surgeons, and 1 mentioned a concern about radiation exposure. Among the men, 2 expressed doubts about having sufficient physical strength for operative work.

Interview Results

10 orthopedic female surgeons had replied to the interview. Four categories emerged (not mutually exclusive) : 1) Physical limitations, 2) Radiation exposure, 3) Demanding working hours/on-call, and 4) Gender-imbalanced environment (including lack of mentors/role models).

As summarized in Table 2, physical limitations were the most frequently cited concern (n=7, 70%), exemplified by difficulty cutting rods, inserting pedicle screws, or achieving adequate exposure at the L5/S1 level. Demanding working hours were mentioned by 2 participants (20%), typically linked to frequent emergency cases and lengthy procedures. Radiation exposure was raised by 1 participant (10%). A gender-imbalanced environment was noted by 2 participants (20%) ; importantly, two interviewees explicitly stated that the absence of a mentor or role model made it harder to overcome these challenges and to envision a sustainable spine career.

DISCUSSION

To our knowledge, this is the first study in Japan to combine a trainee survey and qualitative interviews to explore the emerging potential of increasing the number of women orthopedic and spine surgeons, while identifying barriers that hinder their progression, particularly when choosing spine as a subspecialty. The study aimed to (1) assess baseline interest in orthopedics among female trainees, (2) identify barriers specific to women pursuing orthopedic and spine surgery, and (3) determine key training stages where targeted interventions may be most effective.

Table 2. Barriers to Subspecialization in Spine Surgery Among Women

Category	n	%	Illustrative examples (add quotes if available)
Physical limitations	7	70	Difficulty cutting rods ; pedicle-screw insertion ; L5/S1 exposure
Demanding working hours / on-call	2	20	Frequent emergency cases ; concern about work–family balance
Radiation exposure	1	10	Anxiety about cumulative intraoperative exposure
Gender-imbalanced environment (incl. lack of mentors/role models)	2	20	"Hard to join a male-dominant field" ; few visible female spine surgeons

From the survey results, it was found that personal interest in the field was the most important factor influencing specialty choice for both male and female trainees. Approximately half of the female respondents reported some level of interest in orthopedics, and this rate did not statistically differ from that of male respondents. These findings suggest that the gender gap is not due to a lack of initial interest among women, but rather to attrition during the training process. Since "interest in the field" was prioritized over lifestyle or income by both genders, early exposure and encouragement are likely to have a strong impact on career choice (7).

The answers from the trainee who are not interest in orthopedic shows the potential barriers unique to female orthopedic trainees. Women cited the absence of female role models and the perception that orthopedics is a male-dominated field as primary deterrents. Strikingly, the same concerns were echoed by current female orthopedic residents, but those residents managed to overcome them through mentorship. Having a family member or senior colleague who acted as a mentor provided two decisive advantages : (1) invitations to skills courses or operating-room shadowing that created early exposure, and (2) a trusted channel for discussing scheduling conflicts, pregnancy planning, or other sensitive topics that can be daunting in a predominantly male environment. These findings align with international evidence that structured mentorship triples the likelihood that female students will enter orthopedics (8).

This study also aimed to identify key training stages where targeted interventions could most effectively support the advancement of women into spine surgery. Based on the interview results from orthopedic residents and spine fellows, four main categories of barriers were identified : (1) physical limitations, (2) radiation exposure, (3) demanding work hours and on-call burden, and (4) a gender-imbalanced environment. These categories were used to assess possible intervention strategies.

The first two barriers were physical workload and radiation exposure. Seven interviewees cited physical-strength anxiety, and 1 interviewees was concerned of radiation risk. Both issues are being mitigated by new technologies such as robotic surgery. Large multicenter series now show that robotic spine surgery reduced the time needed to perform fluoroscopy to roughly 30% of conventional levels and cuts manual insertion torque during pedicle-screw placement by half, all while maintaining millimeter-scale accuracy (9, 10). Additionally, parallel ergonomic fixes—such as triangular or larger-diameter screwdriver handles—decrease the required grip strength and reduce fatigue at negligible cost (11). These interventions require the cooperation of medical device companies. Moreover, looking back through history, this mirrors the evolution of universal design in which devices engineered for a specific minority (e.g. automatic doors for wheelchair users) quickly became standard conveniences for all.

The third barrier was the demanding working hours. Work-hour reform is urgently needed in Japan, where spine-surgery caseloads are rising (5). A classic randomized trial by Huddleston *et al*. tested a hospitalist–orthopedic ecomanagement team-based physician system for hip and knee arthroplasty (12). Although conceived for patient care rather than duty limits, the model is instructive. Minor postoperative complications fell from 44% to 30%, and the adjusted length of stay shortened by 12 hours without extra cost. In addition, 62% of patients were discharged uneventfully compared with 50% under the conventional single-surgeon model. Such data reassure departments that distributing care among a team need not harm—and may in fact improve—outcomes.

Additionally, night-float systems address the after-hours burden. In Canada, Mann *et al*. replaced 24-h call with a 1-week night-float block (13). In their pilot study, 89% of orthopedic residents said the change improved quality of life and 100% felt that daytime educational value increased ; objective SF-36 scores matched age-matched Canadian norms. In Israel, a 2022 national survey by Apt *et al*. found that residents rated 16-h shifts as better for work–life balance compared with night-float but viewed both models as educationally safe ; 74% were unwilling to accept lower pay and 56% rejected adding more shifts, underlining the need for fiscal planning (14).

Taken together, team-based day coverage plus a structured night-float (or shortened-shift) roster can redistribute emergency workload, provide guaranteed off-days, and reduce fatigue. Successful adoption will, however, require additional staffing and budget. The experience from Canada and Israel suggests that once these systems are in place, improved morale can attract more junior doctors, creating a positive spiral of personnel growth that partly offsets the initial resource demand. Governmental or institutional subsidies will be essential to bridge the start-up phase.

The fourth barrier is gender-imbalanced environment (including lack of mentors/role models).

Respondents agreed that ergonomic tools and humane duty rosters will achieve little unless women can see someone like themselves succeeding at the spine table. A strong champion in spine surgery—whether a senior female surgeon or an actively supportive male ally—offers three essential benefits : (1) clear guidance for skill acquisition and career milestones, (2) practical advice on flexible scheduling and life-event planning, and (3) daily proof that modern technology can make physically demanding tasks manageable. International studies describe a "leaky pipeline" where female representation is robust in medical school but declines at each career rung within the fields of orthopedics and spine surgery, largely because mentors are scarce and women are under-represented on conference speaker panels (15, 16). Therefore, expanding structured mentorship—through national societies, online communities, and funded fellowships—remains the single most effective strategy for retaining talent and preventing further leakage.

Limitations

This preliminary study has several limitations. First, not all students and residents who received the survey responded, and those who did might have been more positively inclined toward orthopedic surgery, introducing selection bias. Second, the sample came from a single university and the investigators' personal networks, so other regional or institutional cultures that influence specialty choice were not captured. Third, the modest sample size limited the statistical power, preventing multivariable analyses and reducing our ability to detect small between-group differences. However, this study also has some notable strengths. It is the first to pair quantitative survey data with direct, written testimony from female trainees in Japan, providing a "real-voice" perspective that numbers alone cannot capture. The sequential mixed-methods design enabled the provision of qualitative insights to explain the quantitative trends, yielding actionable targets—mentorship, technology adoption, and work-practice reform—that can be tested in future interventions. Finally, the complete dataset spans the full early-training spectrum, from fifth-year medical students to spine fellows, offering a rare, end-to-end snapshot of the pipeline into orthopedic

and spine surgery.

CONCLUSION

This study examined attitudes in the current "neo-generation" of trainees and found that orthopedics is a specialty many women actively wish to choose, indicating clear potential to increase the number of women orthopedic surgeons. At the same time, progression from orthopedics into spine subspecialization is impeded by modifiable barriers. These findings suggest that early, structured mentorship and ergonomic/technology supports, together with schedule redesign, may help convert existing interest into sustained participation in spine surgery. Future multi-institutional, longitudinal studies should test these measures and quantify their impact on recruitment and retention.

CONFLICT OF INTEREST

All authors declare no conflict of interest.

ACKNOWLEDGEMENTS

The authors would like to thank the medical students, residents, and spine surgeons who responded to the questionnaire.

REFERENCES

1. Ministry of Health, Labour and Welfare : Annual Health, Labour and Welfare Report 2022, 2022
2. International Orthopaedic Diversity Alliance : Diversity in orthopaedics and traumatology : A global perspective. EFORT Open Rev 5(10) : 743-752, 2020
3. Morimoto T, Kobayashi T, Fukuda M, Hirata H, Otani K, Sekiguchi M, Yamauchi K, Tsukamoto M, Nagamine S, Haro H : Comparison of gender diversity among spine surgeons in the Japanese Society for Spine Surgery and Related Research and the Neurospinal Society of Japan : A descriptive study through secondary analysis of aggregated data. Cureus 16(5) : e61152, 2024
4. Kinoshita S, Kishimoto T : Increase in the number of female doctors and the challenges that Japan's medical system must face. Glob Health Med 6(6) : 433-435, 2024
5. Tanaka T, Sasaki M, Katayanagi J, Hirakawa A, Fushimi K, Yoshii T, Jinno T, Inose H : Trends, costs, and complications associated with after-hours surgery and unscheduled hospitalization in spinal surgery. Bone Jt Open 5(8) : 662-670, 2024
6. Beck JJ, West N, Jackson N, Willimon SC, Busch MT, Christino MA : Gender and socioeconomic factors affect adolescent patient and guardian preferences in sports medicine physician characteristics and medical decision making. J Am Acad Orthop Surg Glob Res Rev 5(5) : e21.00069, 2021
7. Bratescu RA, Berger J, Härtl R : Where are the women in spine surgery? A demographic study of the range of gender disparity in academic spine hospitals in the United States. Spine J S1529-9430(24) : 00939-2, 2024
8. Winfrey SR, Parameswaran P, Gerull KM, LaPorte D, Cipriano CA : Effective mentorship of women and underrepresented minorities in orthopaedic surgery : A mixed-methods investigation. JB JS Open Access 7(4) : e22.00053, 2022
9. Barzilay Y, Schroeder JE, Hiller N, Singer G, Hasharoni A, Safran O, Liebergall M, Itshayek E, Kaplan L : Robot-assisted vertebral body augmentation : a radiation reduction tool. Spine (Phila Pa 1976) 39(2) : 153-7, 2014
10. Morse KW, Subramanian T, Zhao E, Maayan O, Oquendo Y, Gang CH, Dowdell J, Qureshi S, Iyer S : Robotic-assisted navigation in single-level transforaminal lumbar interbody fusion reduces surgeons' mental workload compared with fluoroscopic and computed tomographic techniques : A nonrandomized prospective controlled trial. HSS J 6 : 15563316241281064, 2024
11. Maleki-Ghahfarokhi A, Yeow P, Keir PJ : Enlarged and triangular instrument handles reduce hand-force requirements in simulated orthopaedic tasks. Ergonomics 66 : 1521-1530, 2023
12. Huddleston JM, Long KH, Naessens JM, Vanness D, Larson D, Trousdale R, Plevak M, Cabanela M, Ilstrup D, Wachter RM ; Hospitalist-Orthopedic Team Trial Investigators : Medical and surgical comanagement after elective hip and knee arthroplasty : A randomized, controlled trial. Ann Intern Med 141(1) : 28-38, 2004
13. Mann SM, Borschneck DP, Harrison MM : Implementation of a novel night float call system : resident satisfaction and quality of life. Can J Surg 57(1) : 15-20, 2014
14. Apt E, Regev T, Shapira J, Haberfeld O, Duek OS, Bar-Yoseph R : Residents' perspective on duty hours at an Israeli tertiary hospital. Isr J Health Policy Res 11(1) : 11, 2022
15. Sarsour R, Guirgus M, Balen M, Kyan K, Le V, Carlson B, Jain R : Assessing students' perception of gender as a barrier in orthopedic residency matching : A pilot survey study. Am J Surg 239 : 116015, 2025
16. Nwosu C, Wittstein JR, Erickson MM, Schroeder N, Santiesteban L, Klifto C, Jiang Y, Shapiro L : Representation of female speakers at the American Academy of Orthopaedic Surgeons annual meetings over time. J Am Acad Orthop Surg 31(6) : 283-291, 2023