Factors Affecting Interest in Orthopedics Among Female Medical Students: A Prospective Analysis

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abstract

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The field of orthopedics has a limited ability to recruit high-quality female applicants. The purpose of this study was to determine whether early exposure to the field affects a woman's decision to pursue orthopedics. We performed a prospective, nonrandomized cohort study between academic years 2005 and 2009 and compared interest in orthopedic surgery among female (n=271) and male (n=71) medical students at 2 urban teaching institutions. Elective lectures and orthopedic literature were distributed via e-mail to the study participants. These materials included articles published in the medical literature, materials produced and distributed by the American Academy of Orthopaedic Surgeons, and Web sites providing educational materials. The primary outcome was the likelihood of application for orthopedic residency.

We studied the influence of demographics, exposure, and attitudes on interest in pursuing an orthopedic career. Men had a significantly higher baseline level of interest in orthopedic surgery than women ($P=.005$). Younger age ($P<.001$) and personal ($P<.001$), independent ($P<.001$), and school ($P=.023$) exposures to orthopedics were significantly related to interest among women. At final follow-up, total personal exposures ($P=.003$) and total independent exposures ($P<.001$) in the form of our literature and lectures were correlated with final interest in women. Female interest was decreased by the long hours, physical demands, and predominantly male nature of the field. Early exposure to orthopedic educational resources may be useful in generating female interest. Perceptions and attitudes regarding orthopedic surgery must to be changed to attract the best and brightest minds, regardless of sex.

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Sex parity among medical students has increased to such a degree that half of current students are now women. However, surgical fields have not achieved this degree of parity. Orthopedic surgery has experienced the least growth of all of the primary surgical fields in attracting female residency candidates.[1] The relative rate of increase of women in orthopedic training, when adjusted for the increase in female medical school graduates, has decreased in the United States since the 1970s.[2] The change in the percentage of women in orthopedics over the past 30 years has been significantly lower than that in every other primary surgical field, except neurosurgery.[2] Therefore, the study of female student recruitment in orthopedics provides an opportunity to increase sex parity in surgical fields.

Because of an apparent plateau in the recruitment rate over the past 2 decades, our current strategies will not be sufficient to improve sex representation in orthopedic surgery training, despite higher numbers of women entering medicine.[2] As previously noted in the literature, the failure to attract women to the field likely represents several factors, including minimal exposure to musculoskeletal topics during medical school, lack of mentoring or role modeling, differential recruitment by current orthopedic faculty and residents, the perception of physical labor, and perceptions about the incompatibility of career with family life.[2-4]

A recent retrospective study indicated that participation in a musculoskeletal medicine course was associated with a higher application rate to orthopedic surgery by minority and female medical students.[5] Currently, no report in the literature examines the recruitability of female medical students in orthopedic surgery in a prospective fashion. We sought to evaluate factors that influenced interest and the effect of exposure on a candidate's decision to pursue orthopedics. Our study questions were:

1. What personal and demographic factors affect the likelihood of high interest in orthopedic surgery among women relative to men?

2. What attitudes do women have about orthopedic surgery compared with men?

3. What characteristics make orthopedic surgery more or less appealing to women, and how do these characteristics affect interest in orthopedics as a career?

4. Can educational resources be used to increase interest in orthopedic surgery among female medical students?

Table 1

High School and Intramural Baseline Demographics[a]

Pre-med Baseline Demographics	Total Cohort (N=345)	Female Subgroup (n=271)	Male Subgroup (n=74)	*P*[b]
Sex				
Women, %	78.6	–	–	–
Men, %	21.4	–	–	–
Mean age, y	25.0	25.0	25.2	.292
Marital status, %				
Single	83.5	–	–	.422
Married	16.5	15.5 (42)	20.3 (15)	
Have children, %	2.6	3.3 (9)	0 (0)	.214
Indebtedness, % (No.)				
None	18.0	18.1 (49)	17.6 (13)	.403
$0-$50K	10.7	9.2 (25)	16.2 (12)	
$50-$100K	11.3	10.7 (29)	13.5 (10)	
>$100K	60	62.0 (168)	52.7 (39)	
Athletic participation, % (No.)				
None	13.9	14.4 (39)	12.2 (9)	.825
HS/IM	61.2	**66.8 (181)**	62.2 (46)	
College	23.2	22.5 (61)	25.7 (19)	
Professional	1.7	**2.1 (6)**	0 (0)	

Abbreviations: HS/IM, high school/intramural.
[a]*Bolded data indicate a statistically significant result.*
[b]*Men vs women.*

Materials and Methods

The effect of exposure on interest in orthopedics was studied prospectively for 3 years. Institutional review board approval was obtained prior to data collection. Based on a chi-square test, 107 participants were needed to detect a standardized medium-sized difference with a type I error rate of 0.05 and a power of 0.80.[6] Multiple types of outcomes were assessed. However, our power analysis was based on the chi-square test because this required the greatest number of participants. The final follow-up cohort consisted of 154 participants.

Two hundred seventy-one female participants and 71 male controls from 2 participating private urban medical schools were recruited via e-mail during the 2005-2006 academic year. We recruited students from the first-, second-, and third-year classes and obtained interval data at 6-month increments, with the final time point being just prior to graduation. The study was completed in 2009 when the fi-

Table 2

Baseline Exposures[a]

Variable	% (No.)[b] Total Cohort	Female Subgroup (n=271)	Male Subgroup (n=74)	*P*
Personal experience (as a patient)	47.6	44.3 (120)	55.4 (41)	.117
Vicarious experience (knew a patient)	58.8	58.7 (159)	59.5 (44)	.999
Work experience (in ortho-related field)	11.9	12.9 (35)	8.1 (6)	.352
Observed OR as pre-med	29.6	**25.8 (70)**	**43.2 (32)**	**.006**
Basic science ortho research as pre-med	3.5	3.2 (9)	4.1 (3)	.725
Clinical ortho research as pre-med	6.8	4.8 (13)	6.8 (5)	.706
Published in ortho surgery	2.9	2.2 (6)	5.4 (4)	.231
Ortho surgeon as close friend or family	9.0	58.7 (159)	59.5 (44)	.999
Basic required science course at baseline	48.7	44.6 (121)	54.1 (40)	.192
Required clinical course at baseline	29.6	*23.2 (63)*	*54.1 (40)*	*<.001*
Elective nonop sports	2.6	2.6 (7)	2.7 (2)	.999
Elective ortho surgery course	3.5	2.6 (7)	6.8 (5)	.142
Read ortho literature				
Never	68.4	*70.8 (192)*	*59.5 (44)*	*.004*
Once	16.5	*15.1 (41)*	*21.6 (16)*	
Multiple times	15.1	*14.0 (38)*	*18.9 (14)*	
Attended ortho lectures				
Never	44.6	45.0 (122)	43.8 (32)	.073
Once	22.6	25.1 (68)	13.7 (10)	
Multiple times	32.8	29.9 (81)	42.4 (31)	
Attended ortho discussions				
Never	64.1	66.4 (180)	55.4 (41)	.237
Once	14.8	14.4 (39)	16.2 (12)	
Multiple times	21.2	19.2 (52)	28.4 (21)	
Read Web material				
Never	68.1	69.7 (189)	62.2 (46)	.415
Once	12.2	12.2 (33)	12.2 (9)	
Multiple times	19.7	18.1 (49)	25.7 (19)	
Total personal exposure[c]	1.7	1.6	1.9	.40
Total baseline school exposure[d]	**0.8**	**0.7**	**1.3**	**<.001**
Total baseline independent exposure[e]	2.4	2.5	2.7	.097

Abbreviations: Nonop, nonoperative; OR, operating room; ortho, orthopedic.
[a]*Bolded data indicate a statistically significant result.*
[b]*Fisher's exact test numbers in parentheses are raw numbers of participants with the relevant answer.*
[c]*Personal exposures include experience as a patient (vicarious or personal), work experience, observation in the OR, research, or orthopedic surgeon as a friend or family member.*
[d]*School exposures: number of types of baseline courses taken (required basic science, required clinical, elective nonoperative, and elective operative).*
[e]*Independent exposures were scored 0, 1, or 2 for each read ortho literature, attended ortho lectures, attended ortho discussions, read Web material.*

Table 3

Continuous or Ordinal Variables and Outcome of Interest in Orthopedic Residency[a]

	P (Spearman *r*)					
Variable	**Baseline Interest**	**Male Subgroup Baseline Interest**	**Female Subgroup Baseline Interest**	**Final Interest**	**Male Subgroup Final Interest**	**Female Subgroup Final Interest**
Age	**<.001 (−.231)**	**.002 (−.347)**	**<.001 (−.211)**	.558 (−.48)	.679 (.085)	.584 (−.049)
Total personal exposure	**<.001 (.317)**	**.016 (.279)**	**<.001 (.318)**	**.008 (.213)**	.943 (.015)	**.003 (.264)**
Total baseline school exposure	.116 (−.085)	.345 (−.111)	**.023 (2.138)**	–	–	–
Total baseline independent exposure	**<.001 (.317)**	**<.001 (.511)**	**<.001 (.264)**	–	–	–
Total final school exposure	**.001 (.263)**	**.044 (.398)**	**.035 (.187)**	**.046 (.161)**	.211 (.254)	.131 (.134)
Total final independent exposure	**<.001 (.429)**	**.036 (.413)**	**<.001 (.432)**	**<.001 (.355)**	**.016 (.466)**	**<.001 (.323)**

[a]*Bolded data indicate a statistically significant result.*

Table 4

Categorical Variables Effect on Baseline Interest[a,b]

		Mean Baseline Interest (95% Confidence Interval)				
Variable	**Overall (n=345)**	**Category 1**	**Category 2**	**Category 3**	**Category 4**	***P***
Sex[c]	3.2 (3.0, 3.4)	**3.0 (2.8, 3.3)**	**3.9 (3.3, 4.5)**	–	–	**.005**
Married[d]	3.2 (3.0, 3.4)	3.2 (2.9, 3.4)	3.4 (2.8, 4.1)	–	–	.578
Children[e]	3.2 (3.0, 3.4)	2.8 (1.8, 4.0)	3.2 (3.0, 3.4)	–	–	.923
Indebtedness[f]	3.2 (3.0, 3.4)	3.1 (2.5, 3.6)	2.9 (2.5, 3.4)	3.3 (2.7, 4.0)	3.3 (3.0, 3.6)	.879
Athletic participation[g]	3.2 (3.0, 3.4)	**2.4 (2.1, 2.7)**	**3.1 (2.8, 3.4)**	**3.8 (3.2, 4.3)**	**5.3 (1.4, 9.2)**	**.003**
Personal experience (as a patient)[e]	3.2 (3.0, 3.4)	**3.7 (3.3, 4.1)**	**2.8 (2.5, 3.0)**	–	–	**<.001**
Vicarious experience (knew a patient)[e]	3.2 (3.0, 3.4)	**3.5 (3.2, 3.8)**	**2.8 (2.5, 3.0)**	–	–	**.002**
Work experience (in ortho-related field)[e]	3.2 (3.0, 3.4)	**4.4 (3.6, 5.3)**	**3.0 (2.8, 3.3)**	–	–	**<.001**
OR experience as pre-med[e]	3.2 (3.0, 3.4)	**3.8 (3.3, 4.3)**	**2.9 (2.7, 3.2)**	–	–	**.004**
Basic science ortho research pre-med[e]	3.2 (3.0, 3.4)	**5.0 (3.1, 6.9)**	**3.1 (2.9, 3.4)**	–	–	**.005**
Pre-med clinical ortho research[e]	3.2 (3.0, 3.4)	**5.9 (4.2, 7.6)**	**3.1 (2.9, 3.3)**	–	–	**<.001**
Published in ortho surgery[e]	3.2 (3.0, 3.4)	**7.0 (4.6, 9.4)**	**3.1 (2.9, 3.3)**	–	–	**<.001**
Ortho surgeon as close friend or family[e]	3.2 (3.0, 3.4)	**4.7 (3.7, 5.6)**	**3.1 (2.8, 3.2)**	–	–	**<.001**

Abbreviations: OR, operating room; ortho, orthopedic.
[a]*Mann–Whitney* U *test used for entire cohort for variables with 2 categories. Kruskal–Wallis test was used for variables with ⩾3.*
[b]*Bolded data indicate a statistically significant result.*
[c]*Category 1, female; Category 2, male.*
[d]*Category 1, no; Category 2, yes.*
[e]*Category 1, yes; Category 2, no.*
[f]*Category 1, none; Categtory 2, <$50K; Category 3, $50-$100K; Category 4, >$100K.*
[g]*Category 1, none; Category 2, high school/intramural; Category 3, college; Category 4, professional.*

Table 5

Categorical Variables Effect on Baseline Interest for the Female Cohort[a,b]

	Mean Baseline Interest (95% Confidence Interval)				
Variable	**Category 1**	**Category 2**	**Category 3**	**Category 4**	***P***
Married[c]	3.0 (2.7, 3.2)	3.3 (2.6, 4.0)	–	–	.340
Children[d]	2.9 (1.8, 4.0)	3.0 (2.8, 3.3)	–	–	.862
Indebtedness[e]	2.9 (2.4, 3.5)	2.7 (2.3, 3.2)	3.0 (2.3, 3.6)	3.2 (2.8, 3.4)	.844
Athletic participation[f]	**2.5 (2.1, 2.8)**	**2.8 (2.6,3.1)**	**3.7 (3.1, 4.3)**	**5.3 (1.4, 9.2)**	**.003**
Personal experience (as a patient)[g]	**3.6 (3.2, 4.0)**	**2.6 (2.4, 2.8)**	–	–	**<.001**
Vicarious experience (knew a patient)[g]	**3.3 (3.0, 3.7)**	**3.6 (2.3, 2.9)**	–	–	**.002**
Work experience (in ortho-related field)[g]	**4.5 (3.5, 5.4)**	**2.8 (2.6, 3.0)**	–	–	**<.001**
OR experience as pre-med[g]	**3.6 (3.0, 4.2)**	**2.8 (2.6, 3.0)**	–	–	**.034**
Basic science ortho research pre-med[g]	**5.1 (3.1, 7.2)**	**3.0 (2.7, 3.2)**	–	–	**.001**
Pre-med clinical ortho research[g]	**5.1 (3.2, 7.0)**	**2.9 (2.7, 3.1)**	–	–	**.002**
Published in ortho surgery[g]	**5.3 (1.9, 8.8)**	**3.0 (2.8, 3.2)**	–	–	**.016**
Ortho surgeon as close friend or family[g]	**4.3 (3.1, 5.4)**	**2.9 (2.7, 3.1)**	–	–	**.002**

Abbreviations: OR, operating room; ortho, orthopedic.
[a]*Mann–Whitney* U *test used for variables with 2 categories. Kruskal–Wallis test used for variables ⩾3.*
[b]*Bolded data indicate a statistically significant result.*
[c]*Category 1, no; Category 2, yes.*
[d]*Category 1, +; Category 2, −.*
[e]*Category 1, none; Category 2, <$50K; Category 3, $50-$100K; Category 4, >$100K.*
[f]*Category 1, none; Category 2, high school/intramural; Category 3, college; Category 4, professional.*
[g]*Category 1, yes; Category 2, no.*

nal participants graduated. We described our study as aiming to evaluate general factors that influenced residency selection to minimize selection bias for students interested in surgery. Enrollment data regarding student demographics, interest, and exposure to orthopedic, general, or other surgical subspecialties were obtained. Baseline demographics included age, sex, marital status, whether the student had children, indebtedness, and participation in athletics prior to medical school (Table 1). Exposure to orthopedics predating entrance to medical school was defined as any personal experience introducing the subject to the field of orthopedics: personal or vicarious encounters as an orthopedic patient, work or research experience in an orthopedic or rehabilitation setting, or having an orthopedic surgeon as a friend or family member. Potential exposures during medical school included course work in orthopedic basic science, a required orthopedic rotation, an elective orthopedic surgical or nonsurgical rotation, or independent exposure (reading orthopedic or sports medicine literature, using Web-based resources, or voluntarily attending lectures or discussions). Students were surveyed regarding their opinions on the influence of sex on the practicality of a career in orthopedic surgery.

At 6-month intervals, students were offered elective lectures as well as electronically based orthopedic literature selected by the principal investigator (J.A.). This material was distributed via e-mail–based Web links or attached documents. These materials included articles published in the medical literature, materials produced and distributed by professional societies (including the American Academy of Orthopaedic Surgeons) and Web sites providing educational materials on orthopedics. The content included, but was not limited to, the burden of musculoskeletal disease and the anticipated growth of career opportunities in orthopedics, changes in orthopedic education, and resident diversity.

In addition, lectures and discussions were advertised via e-mail prior to their occurrence. Interest level in orthopedics and the likelihood of application for orthopedic residency (along with general surgery and surgical subspecialties) were graded on a 10-point Likert scale, with 1 indicating very unlikely to apply and 10 indicating almost certain to apply. The demographics of our sample are presented in Table 1.

At 6-month intervals, participants were reassessed for their attitudes toward orthopedic surgery and other surgical subspecialties. These questionnaires included whether the student had been exposed to orthopedic subinternships, orthopedic nonoperative sports medicine clinical courses, musculoskeletal medicine courses, orthopedic literature, and orthopedic

Table 6

Effect of Baseline Factors on Final Interest for the Entire Cohort[a,b]

		Mean Final Interest (95% Confidence Interval)				
Variable	**Overall**	**Category 1**	**Category 2**	**Category 3**	**Category 4**	***P***
Sex[c]	1.8 (1.5, 2.1)	1.7 (1.4, 2.0)	2.3 (1.3, 3.3)	–	–	.188
Married[d]	1.8 (1.5, 2.1)	1.8 (1.5, 2.2)	1.7 (0.6, 2.7)	–	–	.527
Children[e]	1.8 (1.5, 2.1)	1.0 (only 1)	1.8 (1.5, 2.1)	–	–	.779
Indebtedness[f]	1.8 (1.5, 2.1)	**2.7 (1.8, 3.7)**	**2.9 (1.2, 0.9, 1.5)**	**3.3 (1.3, 0.9, 1.8)**	**1.6 (1.2,2.0)**	**.006**
Athletic participation[g]	1.8 (1.5, 2.1)	1.5 (0.8, 2.2)	(1.7 (1.3, 2.1)	2.0 (1.2, 2.8)	3.4 (0.0, 8.1)	.245
Personal experience (as a patient)[h]	1.8 (1.5, 2.1)	**2.3 (1.7, 2.9)**	**1.3 (1.1, 1.5)**	–	–	**.009**
Vicarious experience (knew a patient)[h]	1.8 (1.5, 2.1)	2.0 (1.5, 2.5)	1.5 (1.1, 1.9)	–	–	.266
Work experience (in ortho related field)[h]	1.8 (1.5, 2.1)	2.5 (1.1, 3.9)	1.7 (1.4, 2.0)	–	–	.333
Pre-med OR experience[h]	1.8 (1.5, 2.1)	2.2 (1.4, 2.9)	1.7 (1.3, 2.0)	–	–	.199
Basic science ortho research pre-med[h]	1.8 (1.5, 2.1)	3.3 (0.0, 10.0)	1.8 (1.5, 2.1)	–	–	.739
Pre-med clinical ortho research[h]	1.8 (1.5, 2.1)	3.3 (0.0, 7.1)	1.7 (1.4, 2.1)	–	–	.085
Published in ortho surgery[h]	1.8 (1.5, 2.1)	4.3 (0.0, 10.0)	1.7 (1.4, 2.1)	–	–	.104
Ortho surgeon as close friend or family[h]	1.8 (1.5, 2.1)	2.5 (0.8, 4.3)	1.7 (1.4, 2.1)	–	–	.572

Abbreviations: OR, operating room; ortho, orthopedic.
[a]*Mann–Whitney* U *test used for variables with 2 categories. Kruskal–Wallis test used for variables with ⩾3.*
[b]*Bolded data indicate a statistically significant result.*
[c]*Category 1, women; Category 2, men.*
[d]*Category 1, no; Category 2, yes.*
[e]*Category 1, +; Category 2, −.*
[f]*Category 1, none; Category 2, <$50K; Category 3, $50-$100K; Category 4, >$100K.*
[g]*Category 1, none; Category 2, high school/intramural; Category 3, college; Category 4, professional.*
[h]*Category 1, yes; Category 2, no.*

Web sites in the most recent 6-month interval. Interval exposure and interest level were rated in the same manner as baseline data. The primary outcome variable of interest was considered to be the likelihood to apply to an orthopedic residency program. We chose this outcome because, historically, the rates of application are too low to make meaningful comparisons.

We enrolled a total of 271 women and 74 men among first-, second-, and third-year medical school classes at 2 institutions in 2005. This represented a 31.6% response rate from the available students during that year. Our final cohort comprised 154 participants (45% retention rate). Mean age was 25 years (range, 19-50 years). Baseline demographic data regarding marital status, children, indebtedness, and participation in athletics are highlighted in Table 1. No significant differences existed between men and women in terms of demographic factors. Table 2 shows baseline personal and academic factors that could be involved in baseline interest in orthopedic surgery, as well as the differences between men and women in terms of these baseline variables. Men were more likely to have taken the required clinical course at baseline ($P<.001$) and to have observed the operating room as pre-med students ($P=.006$) and were more likely at baseline to have read the orthopedic literature provided to them ($P=.004$).

Univariate analysis, including nonparametric tests comparing groups of ordinal variables or non-normally distributed continuous variables, was performed to evaluate demographics, exposure variables, and interest levels. We used the Mann–Whitney *U* test in the case of variables with 2 groups and the Kruskal–Wallis test in the case of variables with ⩾3 groups. Contingency tables were tested with the chi-square test or the Fisher's exact test. Spearman correlation was used to compare correlation

Table 7

Effects of Baseline Factors on Final Interest (Women)[a]

	Mean Final Interest (95% Confidence Interval)				
Variable	**Category 1**	**Category 2**	**Category 3**	**Category 4**	***P***
Married[b]	1.8 (1.4, 2.1)	1.1 (0.9, 1.2)	–	–	.188
Children[c]	1.0 (only 1)	1.7 (1.4, 2.1)	–	–	.797
Indebtedness[d]	2.6 (1.5, 3.6)	1.1 (0.9, 1.3)	1.1 (0.9, 1.3)	1.5 (1.1, 1.9)	.058
Athletic participation[e]	1.6 (0.7, 2.5)	1.5 (1.1, 1.9)	1.9 (1.1, 2.6)	3.4 (0.0, 8.1)	.153
Personal experience (as a patient)[f]	**2.3 (1.6, 2.9)**	**1.1 (1.0, 1.3)**	–	–	**.003**
Vicarious experience (knew a patient)[f]	1.9 (1.4, 2.4)	1.4 (1.0, 1.9)	–	–	.145
Work experience (in ortho-related field)[f]	**2.8 (1.1, 4.4)**	**1.5 (1.2, 1.9)**	–	–	**.086**
Pre-med OR experience[f]	2.3 (1.3, 3.3)	1.5 (1.2, 1.8)	–	–	.117
Basic science ortho research pre-med[f]	3.3 (0.0, 10.0)	1.6 (1.3, 2.0)	–	–	.679
Pre-med clinical ortho research[f]	3.5 (0.0, 10.0)	1.6 (1.3, 2.0)	–	–	.134
Published in ortho surgery[f]	4.0 (0.0, 10.0)	1.7 (1.3, 2.0)	–	–	.601
Ortho surgeon as close friend or family[f]	2.9 (0.8, 5.1)	1.6 (1.3, 1.9)	–	–	.193

Abbreviations: OR, operating room; ortho, orthopedic.
[a]*Bolded data indicate a statistically significant result.*
[b]*Category 1, no; Category 2, yes.*
[c]*Category 1, +; Category 2, −.*
[d]*Category 1, none; Category 2, <$50K; Category 3, $50-$100K; Category 4, >$100K.*
[e]*Cagegory 1, none; Category 2, high school/intramural; Category 3, college; Category 4, professional.*
[f]*Category 1, yes; Category 2, no.*

between ordinal variables or non-normal continuous variables. Moment correlations were assessed at each interval to assess for exposure (classes/rotations in school) and degree of exposure to extracurricular orthopedic literature that correlated with interest in pursuing orthopedic residency at each interval. Changes in interest and exposure were noted. Fisher's exact test was used to determine whether a significant relationship existed between increased exposure and interest at 1-year intervals, and from the first interval to the last. An alpha value of .05 was considered statistically significant. All statistics were calculated with the SPSS processor version 16.0 (SPSS Inc, Chicago, Illinois)

RESULTS

Baseline Interest

At intake, mean interest in orthopedics as a topic for women was 3.6 on a 10-point scale compared with 4.4 for general surgery and 5.8 for other surgical subspecialties (urology, otolaryngology, plastics, ophthalmology, neurosurgery, and obstetrics/gynecology) ($P<.001$ for both). The reported likelihood of applying for residency in orthopedics for women was 3.0, compared with 3.6 for general surgery and 5.1 for other surgical subspecialties ($P<.001$ for both).

Younger age and more personal and independent exposures were correlated with interest in orthopedics in the entire cohort ($P<.001$ for all). Specifically for women, younger age and personal, independent, and school exposures were significantly related to interest in orthopedics ($P<.001$ for all except school exposures, $P=.023$ for school exposures) (Table 3).

At baseline, men had a significantly higher average level of interest in orthopedic surgery compared with women (3.9 and 3.0, respectively) ($P=.005$). For our overall cohort, level of athletic participation and exposure to orthopedic surgery in the workplace, as a patient, or through research or voluntary operating room observation were important factors in increasing interest in the specialty (Table 4). These same factors were statistically important in terms of our female cohort (Table 5).

Final Effects of Personal and Demographic Factors on Interest

Total personal exposures ($P=.008$), total school exposures ($P=.046$), and total independent exposures ($P<.001$), were significant predictors of interest in orthopedics at final follow-up, but age and sex were not. For women, total personal and independent exposures were significant predictors ($P=.003$ and $P<.001$, respectively). Total independent and school exposures were strongly correlated with baseline interest in orthopedics in every subgroup (Table 3). At final follow-up, different subgroups of indebtedness were re-

Table 8

Attitudes of Men Vs Women About Orthopedic Surgery at Baseline and Final[a]

	Baseline, % (No.)			Final, % (No.)		
Opinion Question	**Men**	**Women**	***P*[b]**	**Men**	**Women**	***P*[b]**
Does the number of female orthopedic surgeons need to increase?	78.4 (40/51)	89.0 (170/191)	.081	**66.7 (12/18)**	**90.7 (88/97)**	**.016**
Does the percent of female orthopedic surgeons need to increase?	78.4 (40/51)	88.9 (169/190)	.083	**60.0 (12/20)**	**91.6 (87/95)**	**.001**
Is it more difficult for women to match in orthopedics?	**52.1 (25/48)**	**67.9 (114/168)**	**.066**	46.7 (7/15)	68.1 (62/91)	.186
Is it more difficult for women to complete an orthopedic residency?	49 (24/49)	60.2 (106/176)	.213	58.8 (10/17)	63.1 (53/84)	.954
Is it more difficult for a woman to be promoted in orthopedic surgery?	**63.9 (23/36)**	**82.8 (120/145)**	**.024**	**56.3 (9/16)**	**91.7 (77/84)**	**.001**
Do the physical demands of the job make it more difficult for a woman?	37.5 (18/48)	41.7 (86/206)	.707	43.8 (7/16)	46.4 (45/97)	.999
Would a career in orthopedic surgery be more difficult to balance with a family for a woman?	**64.3 (36/56)**	**84.1 (196/233)**	**.002**	78.9 (15/19)	79.1 (87/110)	.999
Is a career in orthopedic surgery incompatable with a family for a woman?	8.8 (5/57)	16.1 (29/180)	.214[c]	13.0 (3/23)	11 (11/100)	.725[c]
Is a career in orthopedic surgery incompatable with a family for a man?	8.5 (5/59)	7.8 (17/219)	.719[c]	4.3 (1/23)	5.5 (6/110)	.999[c]

[a]*Bolded data indicate a statistically significant result.*
[b]*Chi-square with Yates' correction.*
[c]*Fisher's exact test.*

lated to final interest, but no reliable pattern existed. Personal experience as a patient was strongly correlated with interest (average interest in those with personal patient experience was 2.3, compared with 1.3 in those with no such experience) (P=.009). Participants who did research in orthopedic surgery tended to have higher than average interest in orthopedic surgery, but the number of participants doing research as undergraduate students was too low to see a significant difference (Table 6). Similar observations were noted in the female cohort, but work experiences seemed to be marginally contributory to final interest as well (Table 7).

Perceptions of Orthopedics

More women felt that it was more difficult for a woman to match in orthopedics compared with a man at the initial interview (67.9% vs 52.1%, respectively) (P=.066). At final follow-up, more women felt it was more difficult for a woman to match, but this was not statistically significant. In addition, at baseline, 82.8% of women felt that it is more difficult for a woman to be promoted in orthopedics, compared with 63.9% of men (P=.024). This trend was also seen at final follow-up (91.7% of women felt it was more difficult for a woman to be promoted vs 56.2% of men) (P=.001). At baseline, 84.1% of women felt that a career in orthopedics would be difficult to manage with a family compared with 64.3% of men who felt this way (P=.002). At final follow-up, women felt that the number and percent of female orthopedic surgeons needs to increase. Table 8 contains the attitudes of women and men relative to a career in orthopedic surgery.

Effects of Characteristics of Orthopedics on Final Interest

Factors that significantly decreased baseline interest in orthopedic surgery in women compared with men were a long work week, length of residency, the procedural nature of the specialty, the physical demands of the procedures, and the fact that the field is predominantly male. Men were drawn to the field significantly more than women because of its relatively high salary (Table 9).

At final follow-up, the length of residency, physical demands of orthopedics, and male predominance of the field were significant detractors from interest in the field compared with men. Women who answered that a long work week decreased their interest had a mean interest of 1.2, compared with 2.2 in those who answered that a long work week had no effect on interest (P=.017). Women who answered that a long residency decreased their interest had an average interest of 1.1, compared with 2.4 in those who answered that it had no effect (P=.009). Women who were interested in the procedural nature of the specialty had an average interest of 2.4, compared with

Table 9

Effect of Factors of Orthopedic Surgery on Interest (Baseline)[a]

	Baseline, %			
Variable Effect on Interest	**Whole Group (N=345)**	**Women (n=271)**	**Men (n=74)**	***P*[a]**
>60-hour work week	**↓34.2**	**↓37.6 (102)**	**↓21.6 (16)**	**.035**
	=64.3	**=60.9 (165)**	**=77.0 (57)**	
	↑1.4	**↑1.5 (4)**	**↑1.4 (1)**	
Approximate 60-hour work week	↓30.7	↓31.7 (86)	↓27.0 (20)	.267
	=67.0	=66.8 (181)	=67.6 (50)	
	↑2.3	↑1.5 (4)	↑5.4 (4)	
Length of residency	**↓41.7**	**↓43.9 (119)**	**↓33.8 (25)**	**.001**
	=54.5	**=54.2 (147)**	**=55.4 (41)**	
	↑3.8	**↑1.8 (5)**	**↑10.8 (8)**	
Procedural nature	**↓21.4**	**↓24.4 (66)**	**↓10.8 (8)**	**.007**
	=43.2	**=44.3 (120)**	**=39.2 (29)**	
	↑35.4	**↑31.4 (85)**	**↑50 (37)**	
Clinical goals	↓13.3	↓14.4 (39)	↓9.5 (7)	.596
	=46.4	=46.5 (126)	=45.9 (34)	
	↑40.3	↑39.1 (106)	↑44.6 (33)	
Having to take call	↓33.6	↓33.9 (92)	↓32.4 (24)	.480
	=64.6	=64.9 (176)	=63.5 (47)	
	↑1.7	↑1.1 (3)	↑4.1 (3)	
Physical demands of procedures	**↓32.5**	**↓38.4 (104)**	**↓10.8 (8)**	**<.001**
	=61.2	**=57.9 (157)**	**=73.0 (54)**	
	↑6.4	**↑3.7 (10)**	**↑16.2 (12)**	
Low research funding	↓25.8	↓24.4 (66)	↓31.1 (23)	.163
	=68.7	=71.2 (193)	=59.5 (44)	
	↑5.5	↑4.4 (12)	↑9.5 (7)	
High salary	**↓0.9**	**↓0.7 (2)**	**↓1.4 (1)**	**.022**
	=56.8	**=60.9 (165)**	**=41.9 (31)**	
	↑42.3	**↑38.4 (104)**	**↑56.8 (42)**	
High liability	↓46.7	↓48.0 (130)	↓41.9 (31)	.525
	=51.9	=50.2 (136)	=58.1 (43)	
	↑1.4	↑1.8 (5)	↑0.0 (0)	
Patient population	↓15.1	↓15.9 (43)	↓12.2 (9)	.811
	=48.4	=48.3 (131)	=48.6 (36)	
	↑36.5	↑35.8 (97)	↑39.2 (29)	
Predominantly male field	**↓46.4**	**↓54.2 (147)**	**↓17.6 (13)**	**<.001**
	=45.8	**=38.0 (103)**	**=74.3 (55)**	
	↑7.8	**↑7.7 (21)**	**↑8.1 (6)**	

Abbreviations: ↓,decreases interest; =, no effect; ↑, increases interest.
[a]*Bolded data indicate a statistically significant result.*
[b]*Significance tested with Yate's chi-square.*

Table 10

Effect of Factors of Orthopedic Surgery on Interest (Final)[a]

Variable Effect on Interest	Exit, %			*P*[b]	Effect on Female Interest at Exit, *P*
	Whole Group (N=154)	Women (n=128)	Men (n=26)		
>60-hour work week	↓42.9	↓43.8 (56)	↓38.5 (10)	.723	**.017**
	=56.5	=55.5 (71)	=61.5 (16)		
	↑0.3	↑0.4 (1)	↑0.0 (0)		
Approximate 60-hour work week	↓42.9	↓43.0 (55)	↓42.3 (11)	.999	.058
	=56.5	=56.3 (72)	=57.7 (15)		
	↑0.3	↑0.4 (1)	↑0.0 (0)		
Length of residency	**↓47.4**	**↓52.3 (67)**	**↓23.1 (6)**	**.004**	**.009**
	=56.5	**=46.9 (60)**	**=69.2 (18)**		
	↑0.6	**↑0.4 (1)**	**↑7.7 (2)**		
Procedural nature of specialty	↓29.9	↓31.3 (40)	↓23.1 (6)	.115	**.010**
	=30.5	=32.8 (42)	=19.2 (5)		
	↑39.6	↑35.9 (46)	↑57.7 (15)		
Clinical goals	↓21.4	↓22.7 (29)	↓15.4 (4)	.232	**.013**
	=43.5	=45.3 (58)	=34.6 (9)		
	↑35.1	↑32.0 (41)	↑50.0 (13)		
Having to take call	↓35.1	↓34.4 (44)	↓38.5 (10)	.170	.751
	=64.3	=65.6 (84)	=57.7 (15)		
	↑0.6	↑0.0 (0)	↑3.8 (1)		
Physical demands of procedures	**↓38.3**	**↓42.2 (54)**	**↓19.2 (5)**	**.036**	**.022**
	=53.9	**=51.6 (66)**	**=65.4 (17)**		
	↑7.8	**↑6.3 (8)**	**↑15.4 (4)**		
Low research funding	↓30.5	↓29.7 (38)	↓34.6 (9)	.140	**.002**
	=66.9	=68.8 (88)	=57.7 (15)		
	↑2.6	↑1.6 (2)	↑7.7 (2)		
High salary	↓4.5	↓4.7 (6)	↓3.8 (1)	.999	.774
	=57.1	=59.4 (76)	=46.2 (12)		
	↑38.3	↑35.9 (46)	↑50.0 (13)		
High liability	↓15.7	↓35.2 (45)	↓34.6 (9)	.229	.060
	=28.7	=64.8 (83)	=61.5 (16)		
	↑0.3	↑0.0 (0)	↑3.8 (1)		
Patient population	↓16.9	↓19.5 (25)	↓3.8 (1)	.130	**.022**
	=48.1	=46.1 (59)	=57.7 (15)		
	↑35.1	↑34.4 (44)	↑38.5 (10)		
Predominantly male field	**↓42.2**	**↓47.7 (61)**	**↓15.4 (4)**	**.002**	.527
	=52.6	**=48.4 (62)**	**=73.1 (19)**		
	↑5.2	**↑3.9 (5)**	**↑11.5 (3)**		

Abbreviations: ↓,decreases interest; =, *no effect*; ↑, *increases interest.*
[a]*Bolded data indicate a statistically significant result.*
[b]*Significance tested with Fisher's exact test. Tests of significance of comparison of women with interest tested with the Kruskal–Wallis test.*

1.5 in those who said no difference and 1.2 in those who said it decreased their interest ($P=.010$). Women who reported that the clinical goals of restoring function increased their interest had an average interest of 2.3, compared with 1.6 in participants who reported no difference compared with 1.0 in those who reported that it decreased their interest ($P=.013$). Women who liked the physical demands of orthopedic procedures reported an interest of 4.0 on average compared with 1.9 in those who reported no difference and 1.2 in those who reported that it decreased their interest ($P=.022$). Women who liked the idea of working with a healthy population had an average interest of 2.4, compared with those who said this factor made no difference and 1.1 in those who said this decreased their interest ($P=.022$). Full details regarding characteristics of orthopedic surgery and their effects on interest in orthopedics are detailed in Table 10.

Table 11

Odds of Increased Interest With Increased Independent Exposure[a]

		Odds Ratio (95% Confidence Interval)			
Exposure Type	**Interval Span**	**Total Exposure**	***P***	**Total Exposure, Women**	***P***
Independent	**1-3**	**4.3 (1.3, 14.6)**	**.024**	**9.2 (2.2, 37.7)**	**.001**
	2-4	1.0 (0.2, 4.6)	.999[b]	0.6 (0.1, 3.4)	.676
	3-5	0.8 (0.2, 4.4)	.999[b]	0.2 (0.0, 1.8)	.310
	4-6	1.1 (0.1, 10.9)	.999	1.2 (0.1, 12.4)	.999
	1-6	0.5 (0.1, 2.4)	.412	0.6 (0.1, 2.7)	.661
School	**1-3**	**4.5 (1.3, 15.1)**	**.014**	**4.4 (1.2, 15.1)**	**.031**
	2-4	0.9 (0.2, 4.0)	.999[b]	0.5 (0.1, 2.5)	.646
	3-5	2.1 (0.4, 11.3)	.644	1.5 (0.2, 9.5)	.999
	4-6	4.2 (0.4,43.8)	.369	7.4 (0.7, 83.1)	.257
	1-6	0.2 (0.0, 1.1)	.112	0.3 (0.1, 1.4)	.165

[a]*Bolded data indicate a statistically significant result.*
[b]*Calculated with Fisher's exact test.*

Interval Exposure and Change in Interest

Our correlations at each 6-month interval showed that the increasing level of exposure to orthopedics in the form of independent exposures was associated with increased interest levels (Table 11). This relationship was consistent throughout the entire cohort and in the subgroup analysis of male and female participants. Exposure to rotations or classes at school was less consistently correlated with interest (Table 11).

Change in interest with change in exposure showed that in the year interval between the beginning of the study and the third interval (1 year), the change in exposure to orthopedics was significantly correlated with the change in interest in the students both in the female cohort and the entire cohort (Table 11). This was true both for school exposures and independent exposures. The 3-year intervals that were checked (2-4, 3-5, and 4-6) did not show this relationship. In addition, the change in exposure throughout the study period (1-6) did not show this relationship.

Effect of Final Exposure on Outcome

In our overall cohort, independent exposures in the form of attending orthopedic lectures or discussions and reading material and Web-based content were highly correlated with final interest (Table 12). In terms of academic exposure, only students who did an orthopedic surgery elective had a significantly increased interest ($P<.001$). Our female cohort had similar findings to the overall cohort. Performance of the basic science orthopedic course was also somewhat predictive of final interest ($P=.047$). The numbers in our male cohort were smaller but had numerically similar trends that were not statistically significant (Table 13).

DISCUSSION

Although half of the undergraduates in the United States are women and 49.1% of medical students are women, only 13.1% of orthopedic surgery residents are women.[2,7] Over the past 20 years, the percentage of women entering orthopedics has not changed despite relatively large increases in the percentage of women in medical schools.[2] Although orthopedic educators aim to recruit the best and the brightest students into their field and residency programs, the inability to increase recruitment of female candidates could limit the selectivity of training programs when evaluating applicants.

It is our belief that early exposure plays a role in attracting both male and female students to a specific field. Several studies demonstrated that early exposure has a positive correlation with matching into a surgical career.[8-11] However, it is clear that a lack of musculoskeletal education during medical school exists. The curriculum in many medical schools does not include a formal didactic block on musculoskeletal medicine, and clinical rotations on the orthopedic service are generally brief and elective.[12,13] Yeh et al[14] conducted a cross-sectional survey study of 337 third- and fourth-year students at a single institution using an objective examination in musculoskeletal medicine. Only students who listed orthopedic surgery as their top residency choice demonstrated cognitive mastery in musculoskeletal medicine and reported above-average clinical confidence in their ability to conduct an examination of the musculoskeletal system.[14]

Similarly, Matzkin et al[15] gave a validated musculoskeletal cognitive examination to 334 medical students, residents,

Table 12

Effect of Exposure on Interest at Final Follow-up[a]

			Mean (95% Confidence Interval)			
Variable	**Total Cohort**	***P***	**Male Cohort**	***P***	**Female Cohort**	***P***
Ortho required basic science						
Yes	1.8 (1.5, 2.3)	.148	2.2 (1.0, 3.4)	.429	**1.8 (1.4, 2.2)**	**.047**
No	1.5 (0.9, 2.2)		2.8 (0.0, 6.0)		**1.4 (0.7, 2.0)**	
Ortho required rotation						
Yes	1.9 (1.4, 2.4)	.740	2.7 (1.2, 3.6)	.864	1.7 (1.2, 2.3)	.365
No	1.7 (1.3, 2.1)		1.8 (0.0, 4.1)		1.7 (1.3, 2.1)	
Elective nonoperative sports						
Yes	4.1 (1.5, 5.7)	.073	4.0 (0.0, 10.0)	.762	4.2 (1.2, 7.2)	.072
No	1.6 (1.3, 1.8)		2.1 (1.2, 3.0)		1.5 (1.2, 1.7)	
Elective ortho surgery						
Yes	**4.3 (2.5, 6.2)**	**<.001**	4.4 (0.6, 8.2)	.094	**4.3 (1.9, 6.7)**	**.007**
No	**1.4 (1.2, 1.6)**		1.1 (1.0, 2.0)		**1.4 (1.2, 1.6)**	
Read ortho literature						
Never	**1.2 (1.1, 1.3)**		**1.2 (0.0, 1.7)**		**1.2 (1.1, 1.3)**	
Once	**1.6 (1.2, 2.1)**	**<.001**	**2.0 (0.0, 3.8)**	**.029**	**1.6 (1.1, 2.1)**	**.012**
Multiple times	**3.6 (2.3, 4.9)**		**3.8 (1.3, 3.3)**		**3.4 (1.8, 4.9)**	
Attended ortho lectures						
Never	**1.0 (1.0, 1.1)**		**1.0 (1.0, 1.0)**		**1.0 (1.0, 1.1)**	
Once	**1.4 (1.1, 1.7)**	**.007**	**2.0 (0.8, 3.2)**	**.661**	**1.3 (1.1, 1.6)**	**.005**
Multiple times	**2.4 (1.7, 3.0)**		**2.6 (1.0, 4.3)**		**2.3 (1.6, 3.1)**	
Attended ortho discussions						
Never	**1.2 (1.1, 1.3)**		1.6 (0.7, 2.4)		**1.1 (1.0, 1.2)**	
Once	**1.7 (1.2, 2.3)**	**.001**	1.5 (0.0, 3.1)	.528	**1.8 (1.2, 2.4)**	**.002**
Multiple times	**3.0 (2.0, 4.0)**		3.1 (1.1, 5.1)		**3.0 (1.7, 4.3)**	
Read Web-based ortho literature						
Never	**1.2 (1.1, 1.4)**	**.001**	**1.4 (0.8, 2.0)**	**.049**	**1.2 (1.1, 1.3)**	**.026**
Once	**1.5 (1.0, 2.0)**		**1.7 (0.0, 4.5)**		**1.5 (0.9, 2.0)**	
Multiple times	**3.0 (2.0, 4.0)**		**4.3 (1.1, 7.4)**		**2.7 (1.7, 3.8)**	

Abbreviations: ortho, orthopedic.
[a]*Bolded data indicate a statistically significant result.*

and staff physicians in multiple disciplines of medicine to assess the adequacy of their musculoskeletal medicine training. They found that 79% of the participants failed the basic musculoskeletal cognitive examination. This suggests that training in musculoskeletal medicine is inadequate in medical schools and nonorthopedic residency training programs. Among the nonorthopedists, scores were significantly better if they had taken a medical school course or residency rotation in orthopedics, suggesting that a rotation in orthopedics would improve the general level of musculoskeletal knowledge.[15]

One possible explanation is that exposure to musculoskeletal medicine in medical schools is lacking, and increased exposure may increase interest. Bernstein et al[5] found that 55% of medical school graduates had mandatory exposure to musculoskeletal topics during the course of their medical education and noted a statistically significant difference in the percentage of graduating women who applied to orthopedic surgery residency between those who were required to take part in musculoskeletal educa-

Table 13

Correlation Coefficients Between Interest (in Orthopedic Residency) and Exposure

	Total School Exposure (*P*)			Total Independent Exposure (*P*)		
Interval	**All**	**Men**	**Women**	**All**	**Men**	**Women**
1	−.143 (.016)	−.056 (.679)	−.214 (.001)	.275 (<.001)	.461 (<.001)	.201 (.002)
2	−.66 (.358)	−.023 (.897)	.025 (.749)	.333 (<.001)	.386 (.022)	.315 (<.001)
3	−.001 (.987)	−.132 (.528)	−.040 (.684)	.452 (<.001)	.522 (.007)	.407 (<.001)
4	.181 (.038)	.337 (.092)	.089 (.363)	.413 (<.001)	.521 (.006)	.371 (<.001)
5	.226 (.062)	.337 (.092)	.089 (.363)	.417 (<.001)	.569 (.002)	.315 (.001)
6	.069 (.571)	.610 (.061)	.055 (.679)	.331 (.006)	.825 (.003)	.185 (.161)

tion and those without such exposure. We showed that the use of Web-based educational resources can be an easily implemented method to enhance musculoskeletal exposure for medical students who may not otherwise have mandatory exposure during medical school. We showed that this type of exposure can influence a woman's decision to apply for orthopedic residency.

Although exposure is an important variable in determining interest, interest is derived from multiple factors. One possible barrier to women being accepted into orthopedic residency could be the perception in some orthopedic programs that they do not perform as well as men. However, Pico et al[16] examined 90 residents over a 10-year span at a single residency program and used in-training examination scores, faculty evaluations, and a resident graduate survey to determine performance of male (n=73) and female (n=17) residents.[16] They observed no difference between men and women in terms of performance. Despite this study, bias in selection may exist. However, Scherl et al[13] performed a study in which applications to orthopedic surgery residency were blinded to sex. The authors found no significant difference in ranking between female and male applicants. They felt that the low number of female residents was not the result of bias against female applicants in the initial application review process.[13]

Furthermore, less easily quantifiable variables such as female students' attitudes or perception of orthopedic surgery may exist. A study in England demonstrated that 76% of women stated they would not enter into orthopedic surgery due to insufficient interest, in addition to it being a male-dominated specialty. It was noted that 34% of female students had been exposed to negative attitudes regarding female surgeons, and 62% of these students would not consider surgery.[17] Our findings demonstrated that many women carry the perception that it is more difficult for a woman to match a man in orthopedics than a man. Many women also felt that it would be more difficult to be promoted in orthopedic surgery as a woman. These perceptions did not appear to change significantly after exposure to musculoskeletal education. In addition, concerns regarding the physically demanding nature and length of training remained variables that were associated with lack of interest in an orthopedic career. Fields with similar lengths of training and physical demands and potentially similar issues with time constraints have experienced significant growth since 1970.[2] Although our study cannot specifically address this issue, future studies could compare and contrast interest in different specialties by medical students' attitudes and what they find important in a career.

This study had limitations. Although early exposure to musculoskeletal education was associated with greater interest in orthopedics, intent to enroll in an orthopedic elective, and intent to apply to an orthopedic residency, we do not know the actual application and acceptance rates of orthopedic residency programs. In addition, this study was performed at 2 private, urban teaching institutions, and the study population and results may not be generalizable to other community-based institutions. Also, it is difficult to say with certainty that the exposures in medical school are not self-selected (ie, students with the most interest tend to seek the most exposure). Even with a prospective study design, this factor cannot be eliminated during analysis. In addition, because we used a Likert scale, the possibility of ceiling and floor effects exists in both our exposure variables and our outcome variables.

This work underscores the importance of early exposure to musculoskeletal medicine in increasing interest in orthopedic surgery. We encourage orthopedic departments to take an active role in participating in medical student education as a means of providing early education and mentorship to medical students.

Because further evaluation is needed to determine if increased exposure effects pursuit of orthopedic residency, our current data at 3 years suggest that basic

exposure may be a critical tool in recruiting more women into orthopedic surgery, an important step in meeting the anticipated demands of a growing orthopedic patient population. Early use of questionnaires and early recruitment based on the answers to questionnaires may be useful.

Perceptions and attitudes regarding orthopedic surgery as a career need to change among some students to attract a more diverse applicant pool. Whether exposure or other methods can change these perceptions is undetermined and requires further investigation.

REFERENCES

1. Brotherton SE, Rockey PH, Etzel SI. US graduate medical education, 2003-2004. *JAMA*. 2004; 292(9):1032-1037.
2. Blakemore LC, Hall JM, Biermann JS. Women in surgical residency training programs. *J Bone Joint Surg Am*. 2003; 85(12):2477-2480.
3. Stickles B. Attracting female candidates to the field of orthopaedic surgery. *J Bone Joint Surg Am*. 2001; 83(6):954-955.
4. Templeton K, Wood VJ, Haynes R. Women and minorities in orthopaedic residency programs. *J Am Acad Orthop Surg*. 2007; 15 suppl 1:S37-S41.
5. Bernstein J, Dicaprio MR, Mehta S. The relationship between required medical school instruction in musculoskeletal medicine and application rates to orthopaedic surgery residency programs. *J Bone Joint Surg Am*. 2004; 86(10):2335-2358.
6. Cohen J. *Statistical Power Analysis for the Behavioral Sciences*. 2nd ed. Hillsdale, NJ: Lawrence Erlbaum Associates; 1988.
7. Brotherton SE, Etzel SI. Graduate medical education, 2008-2009. *JAMA*. 2009; 302(12):1357-1372.
8. O'Herrin JK, Lewis BJ, Rikkers LF, Chen H. Medical student operative experience correlates with a match to a categorical surgical program. *Am J Surg*. 2003; 186(2):125-128.
9. Reilly CW, Stothers KA, Broudo M, Perdios A, Tredwell SJ. An orthopedic career fair: a novel recruitment event. *Can J Surg*. 2007; 50(3):168-170.
10. Gauvin JM. How to promote medical student interest in surgery. *Surgery*. 2003; 134(3):407-408.
11. Kirkham JC, Widmann WD, Leddy D, et al. Medical student entry into general surgery increases with early exposure to surgery and to surgeons. *Curr Surg*. 2006; 63(6):397-400.
12. Freedman KB, Bernstein J. The adequacy of medical school education in musculoskeletal medicine. *J Bone Joint Surg Am*. 1998; 80(10):1421-1427.
13. Scherl SA, Lively N, Simon MA. Initial review of Electronic Residency Application Service charts by orthopaedic residency faculty members. Does applicant gender matter? *J Bone Joint Surg Am*. 2001; 83(1):65-70.
14. Yeh AC, Franko O, Day CS. Impact of clinical electives and residency interest on medical students' education in musculoskeletal medicine. *J Bone Joint Surg Am*. 2008; 90(2):307-315.
15. Matzkin E, Smith EL, Freccero D, Richardson AB. Adequacy of education in musculoskeletal medicine. *J Bone Joint Surg Am*. 2005; 87(2):310-314.
16. Pico K, Gioe TJ, Vanheest A, Tatman PJ. Do men outperform women during orthopaedic residency training? *Clin Orthop Relat Res*. 2010; 468(7):1804-1808.
17. Bucknall V, Pynsent PB. Sex and the orthopaedic surgeon: a survey of patient, medical student and male orthopaedic surgeon attitudes towards female orthopaedic surgeons. *Surgeon*. 2009; 7(2):89-95.