



Effect of Shortened Preclinical Curriculum on Medical Student Musculoskeletal Knowledge and Confidence: An Institutional Survey

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PURPOSE: Musculoskeletal education is underrepresented in American medical school curricula, and many medical schools have recently shifted toward a condensed preclinical period. Given that musculoskeletal diseases represent a large and growing social and economic burden, it is imperative that medical students be properly prepared to care for patients with musculoskeletal disorders, regardless of intended specialty.

METHODS: A survey was sent to all medical students enrolled full-time at our institution during the 2018 to 2019 academic year. First year students had not yet received musculoskeletal instruction, second-year students had completed a shortened musculoskeletal curriculum of 49 total hours, and third- and fourth-year respondents had completed a longer 78 hour musculoskeletal curriculum. Respondents were asked to rank their confidence in their musculoskeletal knowledge, their interest in orthopaedics, followed by the well-validated Freedman and Bernstein musculoskeletal knowledge assessment and a demographics section asking had respondents completed an orthopaedic surgery clinical rotation, if they had other clinical orthopaedic experience, class year, intended clinical specialty, and gender.

RESULTS: There were 179 responses to the survey, comprising 53 first-year, 54 second-year, and 72 third- and fourth-year students. The longer musculoskeletal curriculum was associated with significantly improved performance compared to the shorter musculoskeletal curriculum ($p < 0.0001$). Completion of a clinical orthopedics rotation was associated with significantly

improved performance than not completing a rotation ($p < 0.001$), regardless of if non-rotators had other orthopedic experience ($p = 0.001$) or if they did not ($p < 0.001$). There was no difference in score ($p = 0.94$) or musculoskeletal knowledge confidence ($p = 0.09$) between males and females. Intending to pursue orthopedics was associated with significantly higher scores ($p < 0.001$) and significantly higher confidence ($p = 0.02$).

CONCLUSIONS: As shortening preclinical musculoskeletal curricula worsens musculoskeletal performance, medical schools should consider requiring orthopedic clinical rotations to maintain musculoskeletal competency of graduates. (J Surg Ed 77:1414–1421. © 2020 Association of Program Directors in Surgery. Published by Elsevier Inc. All rights reserved.)

KEY WORDS: Orthopaedic surgery, medical Student, education, preclinical curriculum, medical student confidence

COMPETENCIES: Medical Knowledge

INTRODUCTION

The allopathic medical school curriculum since the 1910 Flexner Report has traditionally consisted of a 2-year period devoted to preclinical studies of anatomy, physiology, pathology, and pharmacology and a 2-year period for clinical rotations.¹ However, many medical schools have recently shifted towards a condensed preclinical period.^{2,3} While most schools following a shortened curriculum commonly devote 18 months to preclinical courses, some devote just 12 months.^{3,4}

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Musculoskeletal education, even in schools with traditional, longer preclinical durations, is underrepresented in American medical school curricula⁵. While more than 80% of US allopathic medical schools include required musculoskeletal education, only 15% of allopathic medical schools require musculoskeletal education during the clinical years.^{5,6}

The WHO Global Disease Burden report indicated that up to 33% of people across the globe live with a painful musculoskeletal condition.⁷ For the United States, it is estimated that approximately 50% of adults live with a musculoskeletal condition⁵. Healthcare expenditure on these conditions is estimated to be \$213 billion per year, which accounts for 1.4% of the United States' gross domestic product (GDP).⁵ Given this large social and economic burden, it is imperative that medical students be properly prepared to care for patients with musculoskeletal disorders, regardless of intended specialty.

However, it has been well-established that students and residents are not confident in their musculoskeletal knowledge. Medical students across all years at Johns Hopkins and at Harvard both ranked their confidence in ability to diagnose and treat musculoskeletal disorders as low to moderate.^{8,9} Similarly, graduating family medicine residents also ranked their confidence in diagnosis and treatment of musculoskeletal conditions as low, although this increased significantly if residents completed a rotation in orthopaedics.¹⁰

In an effort to move beyond subjective confidence assessments and instead quantify musculoskeletal knowledge, Freedman and Bernstein created a competency assessment consisting of written-answer questions such as "What common problem must all newborns be examined for?" and "What is a compartment syndrome?"¹¹ It has been well-validated and is widely used to assess musculoskeletal competency in both the medical student and postgraduate levels.¹² Previous studies have shown high rates of failure across all levels of training with 1 study of medical students at Johns Hopkins University demonstrating a 19.3% passing rate and the original Freedman and Bernstein study demonstrating an 18% passing rate for orthopedic surgery residents.^{8,11} Studies have indicated that improved performance is correlated with more advanced years in medical school and increased exposure to clinical orthopaedics.^{8,11,13}

However, previous studies of musculoskeletal education length have had mixed results, with some showing that increasing exposure to musculoskeletal topics improves students' performance,¹⁴ while others have shown no improvement in performance with increasing education length.¹⁵ There have been no studies exploring effect of a reduction in education length on performance in musculoskeletal topics.

Given the national shift among allopathic medical schools towards a shortened preclinical duration, our primary goal with this survey was to assess within our institution whether shortening the curriculum had an impact on musculoskeletal knowledge.

Further, we sought to expand upon previous studies that had stratified performance on the Friedman and Bernstein assessment based on year in medical school by examining the potential effect of intended medical specialty, interest in orthopedics, and clinical exposure to orthopedics. We hypothesized that students who had undergone the shortened preclinical curriculum would perform significantly worse than those with the traditional curriculum. We also hypothesized that students who participated in a clinical rotation in orthopedics, as well as those students with a career-interest in orthopedics would perform significantly better than their counterparts.

METHODS

The survey was sent via email to the 764 medical students enrolled full-time during the 2018 to 2019 school year. IRB approval was secured for administration of the survey, and students gave informed consent to participate. The survey consisted of a preliminary 10-point Likert scale asking students to assess their confidence in their musculoskeletal knowledge ranging from "Not at all confident" to "Very confident", followed by the Freedman and Bernstein musculoskeletal knowledge assessment. Additionally, orthopedics interest was assessed by a 5-point Likert scale ranging from "Not at all interested" to "Very interested," and students were asked if they had completed the established orthopedic surgery clinical rotations or if they had other clinical orthopedic experience. A brief demographics section followed asking students to list their class year, intended clinical specialty, and gender. The survey was created and responses compiled using the online survey tool Qualtrics, and is available in Supplemental Digital Appendix 1.

Our Curriculum

During the preclinical years, the musculoskeletal system is addressed through anatomic dissection as well as lectures on physiology, pathology, and pharmacology. Concurrently, students are taught the physical diagnosis and radiographic assessment of musculoskeletal disorders through "doctoring" courses which teach essential professional skills.

The preclinical curriculum at our medical school was recently changed to an 18-month "Journeys" curriculum after a multiyear review. Seeking to integrate the theory and practice of medicine, this new curriculum was first introduced for the current second year class. This

condensed preclinical curriculum has 49 hours of musculoskeletal education all taking place during the second year. Prior to modification of the preclinical curriculum, all students had a total of 78 hours dedicated musculoskeletal education during the preclinical years, with 55 hours taking place during the first year and 23 hours during the second year.

During the clinical years, students rotate for 2-week blocks through 3 of a possible 6 surgical subspecialties, specifically orthopedic surgery, urology, neurosurgery, otolaryngology, plastic surgery, and ophthalmology. Approximately 60% to 70% of all students participate in this 2-week orthopedic surgery rotation during their third year due. Those students applying for orthopedic surgery residency complete a further 4-week rotation at our home institution during their fourth year. Over the past 5 academic years, an average of 15.4 students per year have matched into an orthopedic surgery residency from our institution.

Data Analysis

Students were broken down into 3 groups: first-year students who had not received formal medical education on musculoskeletal topics, second-year students who had completed the shortened curriculum for musculoskeletal education, and third- and fourth-year students who had completed the longer curriculum for musculoskeletal education.

Survey responses were assessed by a single author using grading criteria established by Freedman and Bernstein. A passing score was set as 70%, as validated in previous studies. All survey responses were summarized by mean, standard deviation, median, and range for continuous variables or frequency and percentage for categorical variables.

The total score and confidence in musculoskeletal knowledge were visualized by box plots, and compared against length of education using the Kruskal-Wallis test. Dunn's test was used for pairwise analysis. False discovery rate approach by Benjamini and Hochberg was used to control multiple testing problems.¹⁶

The Wilcoxon rank-sum test was used to compare the total score and the confidence in musculoskeletal knowledge based on exposure to an orthopedic clinical rotation, intended specialty, and gender.

The Kruskal-Wallis test was used to compare total score and musculoskeletal knowledge confidence among students who had completed an orthopedic clinical rotation and those who had other clinical orthopedic experience. Follow-up pairwise analysis and false discovery rate were also implemented.

All tests were 2-sided at a significance level of 0.05, and all analysis was performed in RStudio (Version 0.99.902).

RESULTS

There were a total of 179 responses (23.4% response rate) to the survey. Overall, the mean score on the questionnaire was 51.7% (SD 30.6%), and median score was 55.0% (IQR 30.0%-75.0%). With the established passing score of 70% or greater, 54 respondents (30.2%) achieved a passing score.

There were 53 first-year respondents with no musculoskeletal education, with a mean questionnaire score of 22.5% (SD 21.5%) and a reported confidence in musculoskeletal knowledge of 2.55 out of 10 (SD 1.68). There were 54 second-year respondents who had experienced the shortened musculoskeletal curriculum, with a mean questionnaire score of 45.3% (SD 19.8%) and a reported confidence in musculoskeletal knowledge of 5.74 out of 10 (SD 1.67). There were 72 third- and fourth-year respondents who had experienced the longer musculoskeletal curriculum, with a mean questionnaire score of 78.1% (SD 18.5%) and a reported confidence in musculoskeletal knowledge of 6.08 out of 10 (SD 1.81).

Impact of Musculoskeletal Curriculum Length

Pairwise comparisons of the 3 groups indicated that the total score of students without musculoskeletal education was significantly lower than respondents who had undergone the shortened curriculum ($p < 0.001$) and respondents who had undergone the longer curriculum ($p < 0.001$). Respondents who had undergone the shortened curriculum scored significantly lower than those who underwent the longer curriculum ($p < 0.001$) (Fig. 1).

Impact of Orthopedics Clinical Rotation & Other Experiences

Only 45 (25.1%) total respondents had completed an orthopedic clinical rotation, with 134 (74.9%) indicating that they had not completed a clinical rotation in orthopedics. However, 15.9% of total respondents indicated that they had experience in orthopedics other than a clinical rotation. Among third- and fourth-year students, 61.1% had completed a clinical rotation in orthopedics. Of the third- and fourth-year students who had not completed a clinical rotation in orthopedics, 21.4% had experience in orthopedics other than a clinical rotation.

For third- and fourth-year students, total score was significantly higher among students who had completed an orthopedics clinical rotation (85.8%, SD 15.9%) than those who had not completed an orthopedics clinical rotation (65.9%, SD 15.6%, $p < 0.001$) (Fig. 2). Students who had completed a clinical rotation scored significantly higher regardless of if nonrotators had other

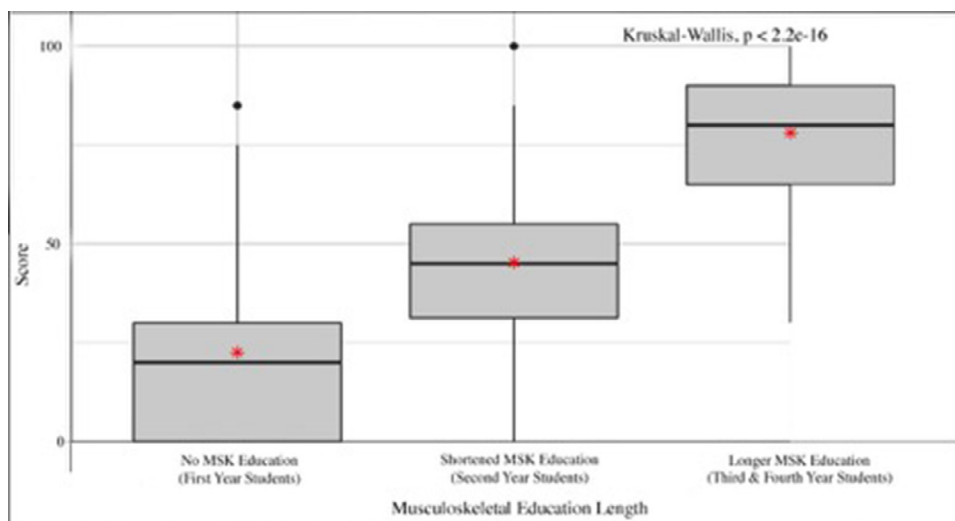


FIGURE 1. Boxplot of student performance stratified by musculoskeletal education length showing significant improvement in performance with increasing length of musculoskeletal education.

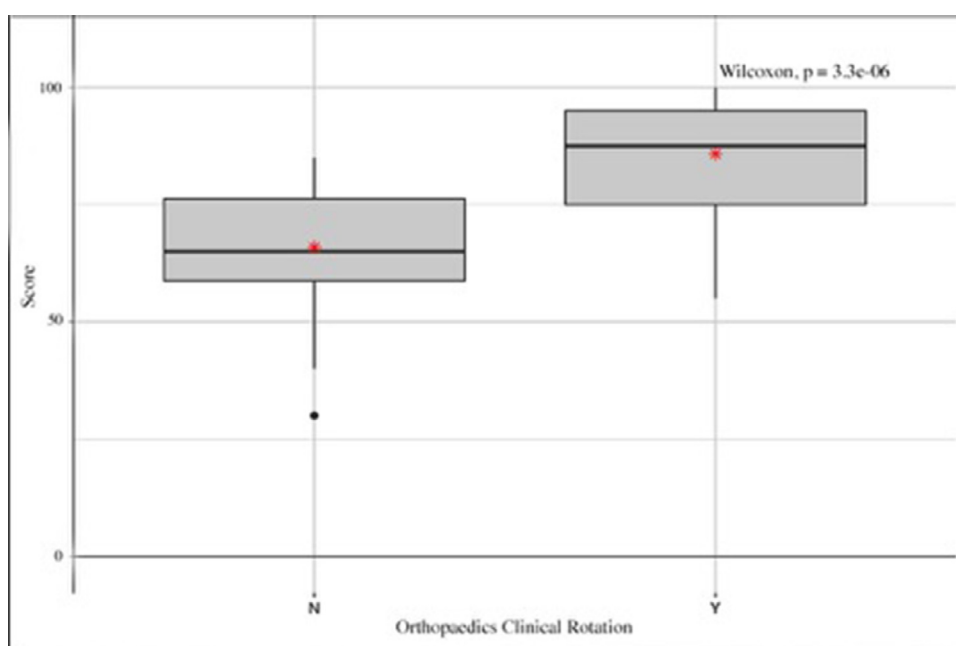


FIGURE 2. Boxplot of student performance stratified by orthopedic clinical rotation showing significantly improved performance with clinical rotation in orthopedics.

orthopedic experience (60.8%, SD 15.9%, $p = 0.001$) or if they did not (67.3%, SD 15.6%, $p < 0.001$) (Fig. 3).

Controlling for clinical rotation in orthopedics, students who had experienced the longer curriculum but did not have a clinical orthopedic rotation had significantly higher scores (65.9%, SD 15.6%) than students who underwent the shortened clinical curriculum (45.3%, SD 19.8%, $p < 0.001$) (Fig. 4).

Gender Impact

There were 95 women and 84 men who completed the survey, representing 52.8% and 47.2% of respondents respectively. The mean score for women was 51.3% (SD 30.7%), and the median score for women was 50.0% (IQR 30%-78.8%). The mean score for men was 51.7% (SD 30.4%), and the median score for men was 55.0%

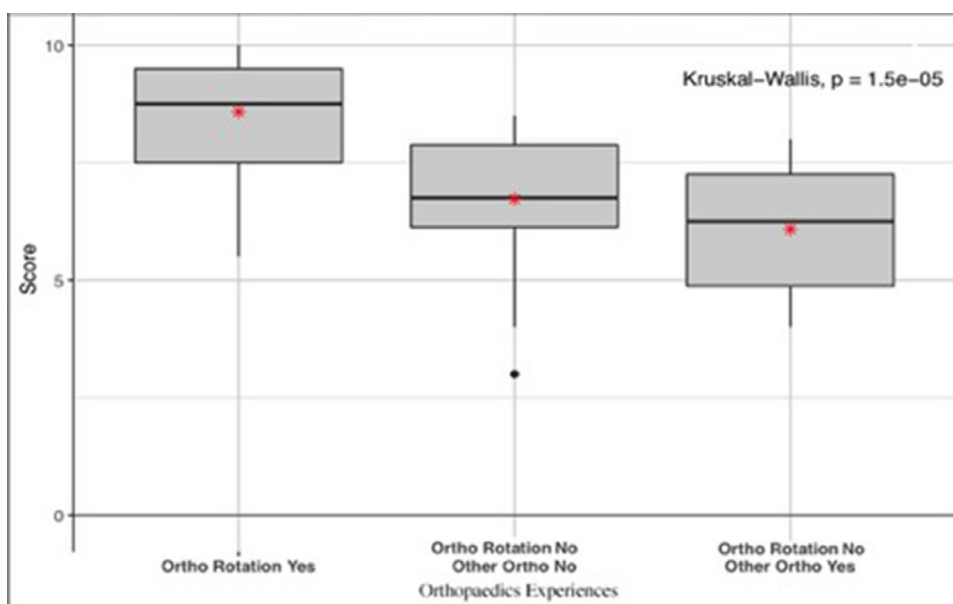


FIGURE 3. Boxplot of third- and fourth-year student performance stratified by orthopedic experience showing significant improvement in performance with completion of orthopedic clinical rotation regardless of other orthopedic experience.

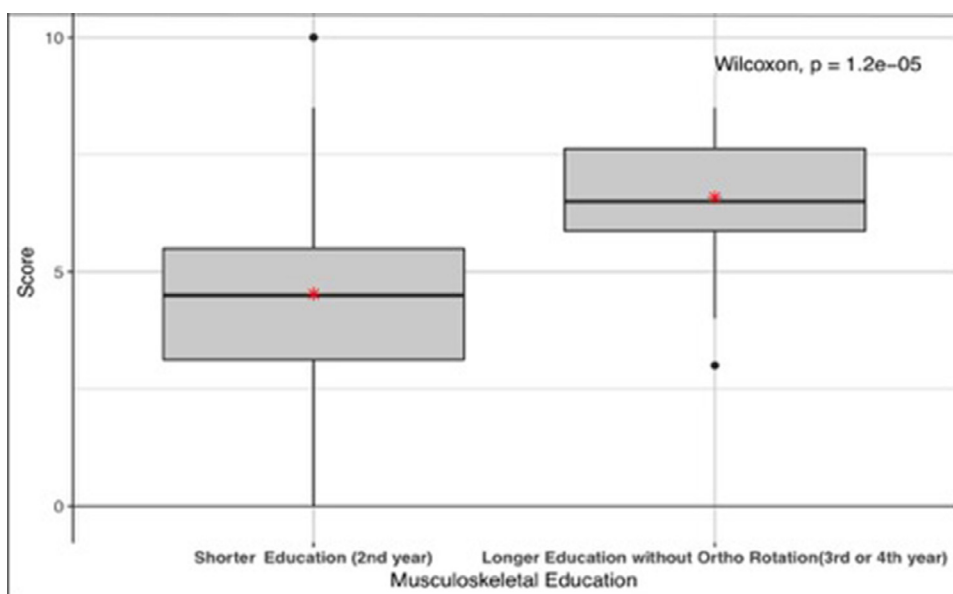


FIGURE 4. Boxplot comparing performance of shorter curriculum to longer curriculum without clinical rotation showing that in the absence of a clinical orthopedics rotation, performance is significantly improved with longer curriculum.

(IQR 30.0%-75.0%). There was no significant difference in total score between genders ($p = 0.94$).

Intended Specialty Impact

Orthopedics was the intended specialty for 21.3% of respondents. The most frequently chosen option for intended specialty was “unsure” ($n = 48$, 27.0%).

Respondents who indicated orthopedics was their intended specialty had a significantly higher total score (66.3%, SD 29.6%) than all other respondents (47.5%, SD 29.5%, $p < 0.001$) (Fig. 5). Similarly, respondents who indicated that orthopedics was their intended specialty had a significantly higher confidence in their musculoskeletal knowledge (5.68, SD 2.79) than all other respondents (4.73, SD 2.15, $p = 0.02$).

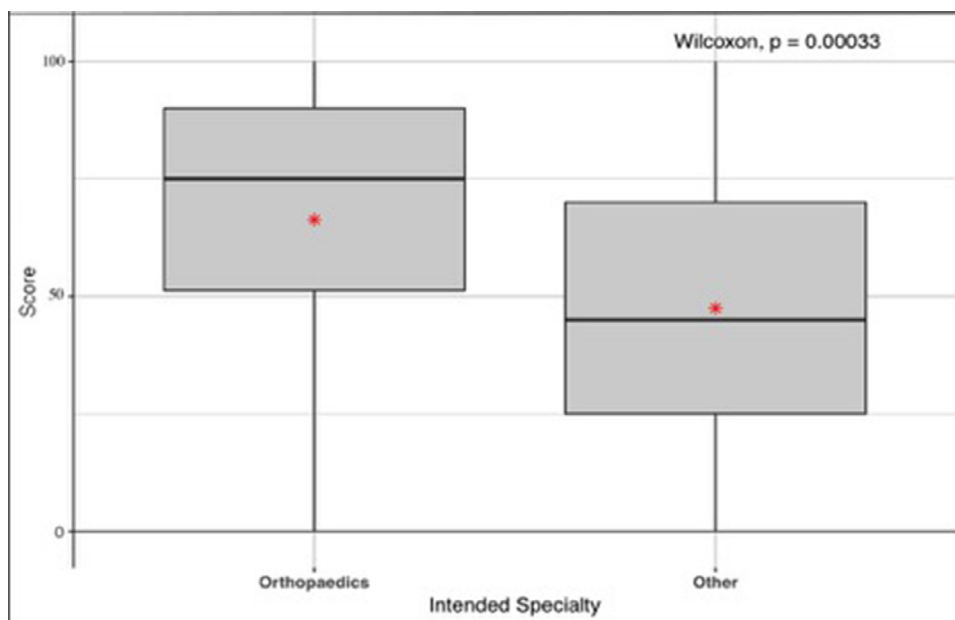


FIGURE 5. Boxplot of all respondents' performance stratified by intended specialty indicating that intending to pursue orthopedic surgery is associated with significant improved performance.

Confidence in Musculoskeletal Knowledge

Confidence in musculoskeletal knowledge was significantly lower in students without musculoskeletal education compared to students who had undergone the shortened curriculum ($p < 0.001$) or compared to students who had undergone the longer curriculum ($p < 0.001$). There was no significant difference in confidence in musculoskeletal knowledge between students who had completed the shortened curriculum and students who had completed the longer curriculum ($p = 0.19$).

Among third- and fourth-year students, confidence in musculoskeletal knowledge was significantly higher for students who had completed an orthopedics clinical rotation (6.61, SD 1.53) than those who had not completed an orthopedics rotation and did not have other orthopedic experience (4.86, SD 1.78) ($p = 0.029$). However, there was no significant difference in confidence in musculoskeletal knowledge between students who had completed a clinical orthopedics rotation and students who had not completed a clinical rotation but had other orthopedic experience (6.67, SD 1.86, $p = 0.456$).

The mean confidence in musculoskeletal knowledge was 4.67 (SD 2.13) for women, and 5.23 (SD 2.51) for men. There was no significant difference in confidence in musculoskeletal knowledge between genders ($p = 0.09$).

DISCUSSION

Increased length of musculoskeletal education is associated with significantly improved performance on a

quantitative musculoskeletal knowledge assessment. The longer musculoskeletal curriculum at our institution represented a 59% increase in time devoted to anatomy, physiology, and clinical diagnosis and treatment as compared to the shortened curriculum, and likely contributed to the improved performance.

Additionally, having a clinical rotation in orthopedics also significantly improves performance on the Freedman and Bernstein assessment. This was understood to be a possible confounding variable when comparing longer and shorter curricula. However, when controlling for clinical rotation in orthopedics, students who had done the longer curriculum but had not rotated in orthopedics still performed significantly better than those in the shorter curriculum.

With respect to confidence in musculoskeletal knowledge, there was no difference between the longer and shorter curricula. This is possibly due to the administration of the survey within 1 to 2 months of the second year students completing their musculoskeletal preclinical instruction. Nonetheless, confidence was significantly higher in students who had either completed an orthopedic clinical rotation or other orthopedic experience.

Students who indicated that they intended to pursue orthopedics as a specialty performed significantly better, and were significantly more confident in their musculoskeletal knowledge. There was no significant difference in performance or confidence between males and females.

If medical schools are to continue this educational shift towards shortened preclinical curricula, it is evident that requiring an orthopedic clinical experience

will be an effective mechanism to prevent poor musculoskeletal clinical competency in graduates. Interestingly, having other orthopedic experience, such as formal shadowing or research, did not improve students' scores on the musculoskeletal knowledge assessment, thus these pathways are not effective in improving musculoskeletal competency.

Required exposure to musculoskeletal topics increases the probability that students apply into an orthopedic surgery residency by 12% for all students. Critically, this probability increases for applicant groups that are underrepresented in orthopedics, including a 75% increased probability of applying for women, and a 35% increased probability of applying for racial minorities.¹⁷ Beyond encouraging students to pursue orthopedics as a specialty, requiring clinical rotations in orthopedics will increase confidence in musculoskeletal topics, which can be beneficial across many specialties.

Comparisons between previous studies are limited as education length is frequently reported in days or weeks, without specifying hours of instruction. A potential limitation of the present investigation is the risk for participation bias, as 23.4% (179/764) of full-time medical students responded to the survey. However, to avoid the potential impact of this limitation, the survey was sent on multiple occasions to all students via email. Future studies should include careful analysis of clinical orthopedic rotations in order to identify which aspects of the rotation are most beneficial in increasing musculoskeletal clinical competency.

ETHICAL APPROVAL

Exemption from review was obtained from the Georgetown University Institutional Review Board on 9/11/2018, IRB#: 2018-0890.

OTHER DISCLAIMERS

None.

PREVIOUS PRESENTATIONS

None.

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