

# Musculoskeletal Medicine: An Assessment of the Attitudes and Knowledge of Medical Students at Harvard Medical School

Charles S. Day, MD, Albert C. Yeh, Orrin Franko, Miguel Ramirez, and Edward Krupat, PhD

## Abstract

### Purpose

To assess medical students' knowledge and clinical confidence in musculoskeletal medicine as well as their attitudes toward the education they receive in this specialty.

### Method

A cross-sectional survey of students in all four years of Harvard Medical School was conducted during the 2005–2006 academic year. Participants were asked to fill out a 30-question survey and a nationally validated basic competency exam in musculoskeletal medicine.

### Results

The response rate was 74% (449/608). Medical students rated musculoskeletal education to be of major importance

(3.8/5) but rated the amount of curriculum time spent on musculoskeletal medicine as poor (2.1/5). Third-year students felt a low to adequate level of confidence in performing a musculoskeletal physical examination (2.7/5) and failed to demonstrate cognitive mastery in musculoskeletal medicine (passing rate on competency exam: 7%), whereas fourth-year students reported a similar level of confidence (2.7/5) and exhibited a higher passing rate (26%). Increasing exposure to the subject by taking clinical electives resulted in greater clinical confidence and enhanced performance on the exam ( $P < .001$ ). Students' feedback suggested that musculoskeletal education can be better integrated into

the preclinical curriculum, more time should be spent in the field, and more focus should be placed on common clinical conditions.

### Conclusions

These findings, which are consistent with those from other schools, suggest that medical students do not feel adequately prepared in musculoskeletal medicine and lack both clinical confidence and cognitive mastery in the field. Implementing a four-year integrated musculoskeletal curriculum is one way that medical schools can address this concern.

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The discrepancy between the widespread impact of musculoskeletal diseases on society and the relative inattention devoted to this subject in the undergraduate medical curriculum has been a subject of increasing concern during the past five years.<sup>1–8</sup> In data reported over the past 15 years, musculoskeletal complaints and injuries

have comprised approximately 15% to 30% of primary care visits in the United States and Canada,<sup>4</sup> 20% of emergency room visits in the United States,<sup>9</sup> and 20% of nonroutine pediatric visits in Europe.<sup>10</sup> In 2004, the National Ambulatory Medical Care Survey indicated that musculoskeletal conditions were the number-one reason across the United States for visits to physicians' offices, with approximately 92.1 million cases reported annually.<sup>11</sup> As part of the global initiative aimed at increasing awareness and reducing societal burden arising from these conditions, the World Health Organization designated the years 2000 to 2010 as The Bone and Joint Decade.<sup>12</sup> The United States later reemphasized this effort by adopting the National Bone and Joint Decade in 2002.<sup>13</sup>

In light of these initiatives, there has been much focus recently on the responsibilities of undergraduate medical institutions in providing adequate musculoskeletal education. In 2005, the Association of American Medical Colleges (AAMC) brought to attention that despite the increasing prevalence of

musculoskeletal conditions spread across a broad spectrum of clinical practice, it is not clear that medical schools are effectively educating future physicians in this field.<sup>1</sup> Furthermore, recent studies suggest that the discrepancy between the magnitude of musculoskeletal problems and physician competency in musculoskeletal medicine likely stems from educational deficiencies at the medical school level.<sup>2–8</sup>

Various metrics have been employed to evaluate the adequacy of musculoskeletal training. In 2001, a comprehensive study reviewing the curricula of all Canadian medical schools indicated that directors of undergraduate musculoskeletal programs felt dissatisfied with the curricular time devoted to musculoskeletal education.<sup>4</sup> In the same year, survey responses by over 1,900 second-year residents in United States residency programs revealed that residents felt poorly or very poorly prepared in their training when conducting a musculoskeletal examination on various parts of the body.<sup>5</sup> In 2003, Freedman and Bernstein<sup>2</sup> reported first-year residents' performance on a validated

**Dr. Day** is assistant professor in orthopedic surgery and director, Musculoskeletal Curriculum, Harvard Medical School, and chief, Orthopedic Hand Surgery, Beth Israel Deaconess Medical Center, Boston, Massachusetts.

**Mr. Yeh** is a fourth-year undergraduate, Harvard College, Cambridge, Massachusetts.

**Mr. Franko** is a second-year medical student, Harvard Medical School, Boston, Massachusetts.

**Mr. Ramirez** is a third-year medical student, Harvard Medical School, Boston, Massachusetts.

**Dr. Krupat** is director of evaluation and associate professor of psychology, Center for Evaluation, Department of Psychiatry, Harvard Medical School, Boston, Massachusetts.

Correspondence should be addressed to Dr. Day, Harvard Medical School, Beth Israel Deaconess Medical Center, Department of Orthopedic Surgery, 330 Brookline Avenue, Boston, MA 02215; telephone: (617) 667-2848; fax: (617) 667-2464; e-mail: (cday1@bidmc.harvard.edu).

basic competency exam in musculoskeletal medicine. According to a passing standard set by 240 internal medicine residency program directors in the United States, 78% of these first-year residents failed to meet the passing criterion expected from medical school graduates.

In an effort to gain a more comprehensive assessment of students' overall attitudes toward and knowledge of musculoskeletal medicine, we combined the various approaches from the literature by evaluating medical students' clinical confidence, cognitive mastery, and perception of education in musculoskeletal medicine.

## Method

We offered an anonymous questionnaire to 608 medical students at Harvard Medical School (HMS) during the 2005–2006 academic year. For the first- and second-year classes, we surveyed students from the New Pathway curriculum, which enrolls 135 students each year, and we excluded students from the more research-oriented Health Sciences and Technology curriculum. We did not exclude any students in the third- and fourth-year classes, because the two curriculums merge after the preclinical years. We recruited first-year students through the human body course, second-year students at the end of the musculoskeletal pathophysiology block, third-year students at the end of their mandatory general surgery rotation, and fourth-year students through a combination of clinical electives, USMLE Step 2 review sessions, and personal contacts. All participating students completed a 30-question survey that addressed their perception of the importance of musculoskeletal education, their confidence in performing musculoskeletal physical examinations, and their satisfaction with the undergraduate medical curriculum. To assess students' cognitive mastery in musculoskeletal medicine, second-, third-, and fourth-year students also took a nationally validated musculoskeletal basic competency exam consisting of 25 short answer questions as developed by Freedman and Bernstein. Freedman and Bernstein's basic competency exam assesses only students' knowledge base in musculoskeletal medicine and does not reflect their clinical performance or

Table 1

### Attitudes of 449 Students Towards Musculoskeletal Medicine at Harvard Medical School, Boston, Massachusetts, 2005 to 2006

Question	Year	Mean	95% Confidence Interval of Mean
"About what percentage of the time do you think musculoskeletal symptoms are the reason for visits by patients to a primary care physician's office?"	1	44	40–47
	2	41	37–45
	3	44	41–47
	4	45	41–49
"How important do you think musculoskeletal education is towards your future medical career?"*	1	3.9	3.8–4.1
	2	3.6	3.4–3.7
	3	3.9	3.7–4.0
	4	3.9	3.7–4.1
"How would you rate the amount of curricular time spent on musculoskeletal medicine at Harvard Medical School?"†	2	2.2	2.1–2.4
	3	2.0	1.8–2.1
	4	1.9	1.8–2.1
	4	1.9	1.8–2.1

\* 1 = no importance, 2 = minor importance, 3 = average importance, 4 = major importance, 5 = critical importance.

† 1 = inadequate, 2 = poor, 3 = adequate, 4 = good, 5 = excellent.

confidence. A total of 37 students reported prior exposure to the exam, most commonly from reading Freedman and Bernstein's original article, which includes the correct responses. We excluded the exam scores of these students from the cognitive mastery analysis.

### Population subgroup

To assess the impact of students' exposure to musculoskeletal issues on their cognitive mastery of the subject, we divided third- and fourth-year participants into two groups: those who had taken one or more musculoskeletal electives, and those who had not. Third-year musculoskeletal electives include two weeks of orthopedics during the general surgery rotation and a course on advanced clinical anatomy. Fourth-year musculoskeletal electives include advanced clinical anatomy, advanced musculoskeletal physical diagnosis, and one month of adult or pediatric orthopedics.

### Attitudes questionnaire

The questionnaire asked students to indicate the importance they placed on musculoskeletal education in terms of their future medical career using a five-point scale (ranging from 1 = "no importance" to 5 = "critical importance"). For comparison, the same scale was used to measure the perceived importance of pulmonary education, because musculoskeletal and respiratory

symptoms comprise the top two reasons that patients seek medical attention.<sup>2,14,15</sup>

To assess the perceived *r* relative value of musculoskeletal medicine, we asked second-, third-, and fourth-year students to rank the importance of musculoskeletal medicine to their future career in comparison with seven other topics: cardiovascular, pulmonary, neurology, renal pathophysiology, genetics, cell biology, and clinical epidemiology. Clinical confidence was noted by student responses to a five-point scale (ranging from "none" to "complete" confidence) regarding (1) the performance of a musculoskeletal physical examination, and (2) the generation of a differential diagnosis for musculoskeletal pain. For comparison, we used the same scale to measure confidence in performing a respiratory examination. Student participants also rated the amount of time spent on musculoskeletal pathophysiology and medicine using a five-point scale (ranging from "inadequate" to "excellent") and were given the option of recommending changes (if any) to the curriculum.

### Statistical analysis

We conducted all analyses using SPSS version 13.0 (SPSS Inc, Chicago, Ill). We used paired *t* tests to compare the reported importance ratings of musculoskeletal education to those of pulmonary education. We used Student *t* tests to compare self-reported clinical confidence between elective and

nonelective takers, self-reported clinical confidence between the musculoskeletal and pulmonary systems, and cognitive mastery exam scores between elective and nonelective takers. Statistical significance was assessed at  $P < .05$  throughout.

**Results**

**Response rates**

Response rates were 101/135 (75%) and 98/136 (72%) of first- and second-year students in the New Pathway curriculum and 163/184 (89%) and 87/153 (57%) of all third- and fourth-year students, respectively. The overall response rate was 449/608 (74%). We divided third- and fourth-year student participants into elective takers and nonelective takers; 79 third-year students (48%) and 25 fourth-year students (29%) had taken clinical electives related to musculoskeletal medicine. Thirty-four third-year students and three fourth-year students were already familiar with Freedman and Bernstein's exam, so only their responses

to the attitudes questionnaire were included in analysis.

**Importance of musculoskeletal medicine**

On average, participants estimated that musculoskeletal problems comprise between 40% and 45% of all primary care visits (Table 1). This is moderately higher than the 15% to 30% of U.S. visits that are actually related to musculoskeletal problems as previously reported in the literature.<sup>4</sup> The students considered musculoskeletal education to be of major importance (Table 1). When asked to rank eight different preclinical curriculum topics in the order of importance, third- and fourth-year students ranked musculoskeletal medicine as the third-most important topic to their future medical career, behind only cardiovascular and pulmonary medicine (Figure 1). We obtained average rankings for each topic by summing the students' ranking of that topic by year and dividing accordingly by

the number of responses. Second-, third-, and fourth-year students ranked the amount of curriculum time spent on musculoskeletal medicine as poor (Table 1).

**Clinical confidence**

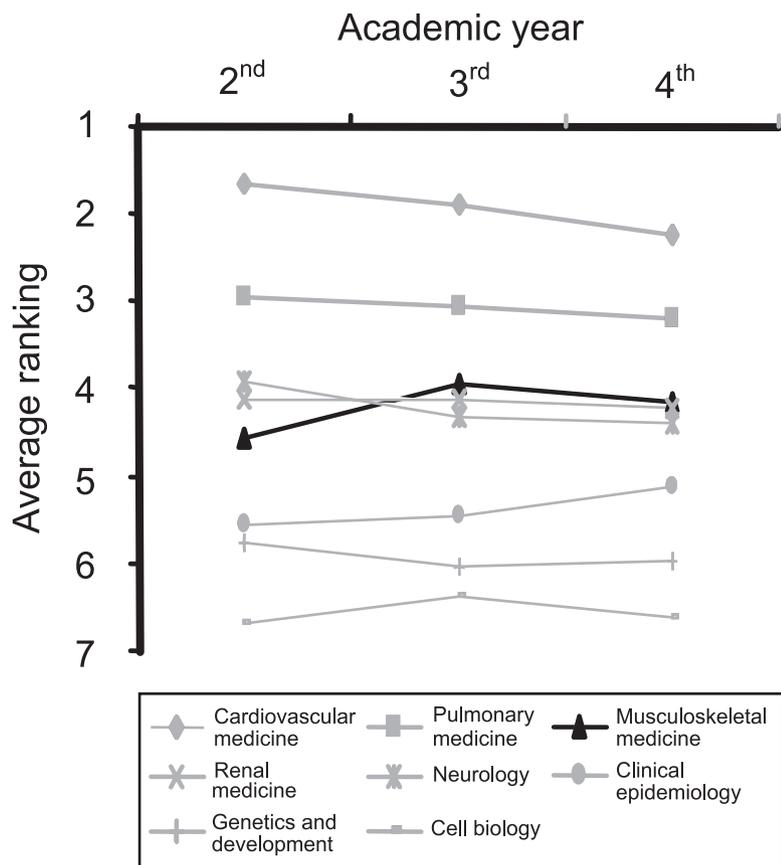
A comparison between participants' confidence levels in examining the musculoskeletal and pulmonary systems demonstrates that although students generally felt a high level of confidence in examining the pulmonary system, the same students felt a low to average level of confidence in examining the musculoskeletal system ( $P < .001$  for all years, Figure 2). Likewise, the students' confidence levels were significantly higher in generating a differential diagnosis for pain for the pulmonary system ( $P < .001$  for both years, Figure 2). Third- and fourth-year medical students who had taken clinical electives in musculoskeletal medicine felt significantly more confident in performing a musculoskeletal physical examination ( $P < .05$ ) and in generating a differential diagnosis ( $P < .005$ ) than those who had not taken any electives (Figure 3).

**Cognitive mastery exam scores**

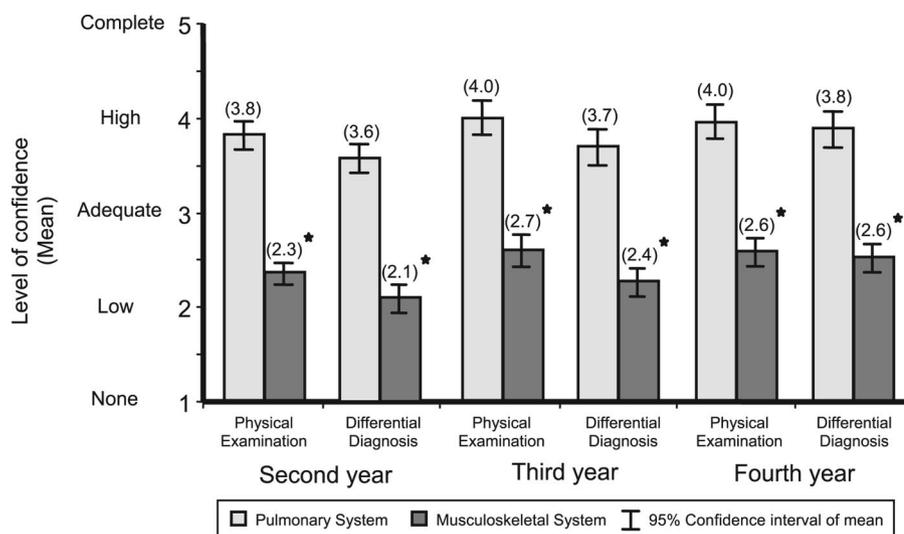
Exam results of second-, third-, and fourth-year students showed an increase in exam score by year (Figure 4). The average score for each year was below the passing mark of 70% as set by the internal medicine program directors surveyed in Freedman and Bernstein's<sup>2</sup> study (Figure 4). In our study, the overall passing rate on the validated exam was 2% (2/98), 7% (9/129), and 26% (22/84) for second-, third-, and fourth-year students respectively. Both third- and fourth-year students who had taken musculoskeletal-related electives performed significantly better on the test than those who had only taken the required musculoskeletal curriculum ( $P \leq .001$  for both groups, Figure 4). Only fourth-year elective takers exhibited an average score above the suggested passing benchmark (Figure 4).

**Student recommendations**

Sixty-one (86%) fourth-year students recommended more time as a way to change the current musculoskeletal curriculum, and only seven (10%) did not recommend any modifications. We only report results from the fourth-year



**Figure 1** Assessed importance of eight topics on future medical career by second-, third-, and fourth-year students at Harvard Medical School, Boston, Massachusetts, 2005 to 2006. Average rankings were obtained for each topic by summing the students' ranking of that topic by year and dividing accordingly by the number of responses.

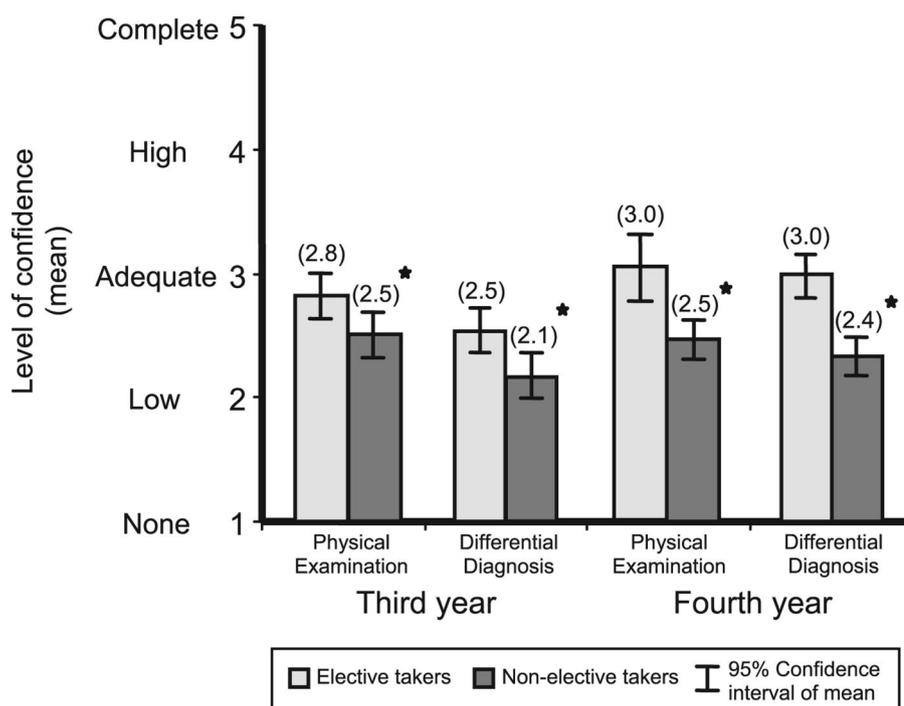


**Figure 2** Self-reported confidence in examining the musculoskeletal and pulmonary systems among 345 second-, third-, and fourth-year medical students at Harvard Medical School, Boston, Mass, 2005 to 2006.

\*Indicates significant difference between pulmonary and musculoskeletal systems as determined by Student *t* test.

class because these students have experienced the curriculum in its entirety. Among the students who suggested that more time be devoted to musculoskeletal medicine, many indicated a need for better integration of material during the preclinical years or a better structured curriculum during

surgical rotations. Commenting on the time, one student wrote: "Addressing this topic so briefly implies that it is not as important as the other systems." Commenting on the content, a student remarked: "More focus should be placed on common musculoskeletal complaints such as back pain, osteoarthritis, injuries,



**Figure 3** Self-reported confidence in performing physical examinations and generating differential diagnoses in the musculoskeletal system among 247 third- and fourth-year elective and nonelective takers at Harvard Medical School, Boston, Mass, 2005 to 2006.

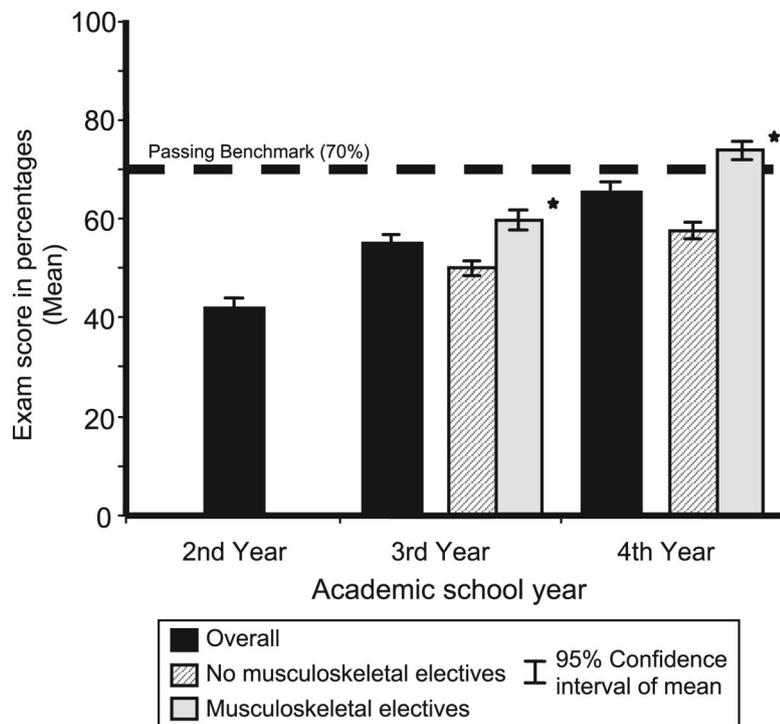
\*Indicates significant difference between elective and nonelective takers as determined by Student *t* test.

and carpal tunnel, etc. . . ." Commenting on the integration, one student mentioned: "In general, lectures in the Human Systems block have been very good. However, as the block comes so long after anatomy, the integration between those two units is lacking . . . there could be optional anatomy / integration reviews incorporated into the course or as supplemental lectures." Another student wrote: "I think that the musculoskeletal system was covered well in the Human Systems block, but it needs to be better integrated into the patient-doctor class."

## Discussion

As stated earlier, the high prevalence of musculoskeletal conditions and the impact they have on patients across a broad spectrum of medical practice, including pediatrics, emergency medicine, family practice, and internal medicine, justifies the need for all medical students to have a basic understanding of musculoskeletal medicine. Our study demonstrates that medical students realize both the importance of and the need for effective musculoskeletal education. They considered musculoskeletal conditions to account for nearly 45% of reasons for visits to a primary care office and ranked the field as being of "major importance" to their future medical career. However, the students felt that there was insufficient curriculum time devoted to musculoskeletal medicine.

The students' concerns about the inadequacy of musculoskeletal education are consistent with both their lack of clinical confidence in examining the musculoskeletal system as well as their lack of cognitive mastery in basic musculoskeletal medicine. An effective way to address both of these deficiencies is through increased exposure to information about this area of medicine. Results demonstrated that both third- and fourth-year students who had taken musculoskeletal electives in their clinical years performed significantly better on the competency exam ( $P < .001$ ) and were significantly more confident in examining the musculoskeletal system ( $P < .05$ ) than those who had taken just the required musculoskeletal curriculum. Furthermore, only fourth-year elective takers exhibited an average score above the suggested passing criterion set by the



**Figure 4** Cognitive mastery exam results for 302 second-, third-, and fourth-year medical students at Harvard Medical School, 2005–06. Note that first year-students took a shortened version of the exam (data not shown in graph).

\*Indicates significant difference between elective and nonelective takers as determined by Student *t* test. Both *P* values < .001.

internal medicine residency program directors.

Relying on clinical electives, however, is not an effective solution. Despite the fact that most students from our study seem to be aware of the importance and prevalence of musculoskeletal conditions, only 79 (48%) of third-year students and 25 (29%) of fourth-year students chose to take electives in the field. One way to guarantee greater exposure would be for medical institutions to increase the amount of mandatory musculoskeletal education in their curricula. Although every academic department could benefit from more curricular time, our study adds to the literature that provides direct evidence that such a need exists for musculoskeletal medicine.

Better integration of musculoskeletal education throughout the preclinical and clinical years is just as important. As the AAMC recommended, fragmentation of musculoskeletal content in the curriculum should be addressed through curriculum design and instructional implementation.<sup>1</sup> Student feedback from our study supports these recommendations. We received a wide

range of suggestions for improving the musculoskeletal curriculum, including better integration of musculoskeletal education in human anatomy, human systems, and patient–doctor tutorials; increased coordination with neurology; more focus on common clinical complaints; and a more structured musculoskeletal curriculum in orthopedic surgery rotations. Many of these suggestions do not entail increasing curricular time but, rather, better organization and coordination between courses. Another potential way of integrating musculoskeletal medicine into the clinical years that was not mentioned in student responses is emphasizing the musculoskeletal exam across relevant clerkships, such as family medicine, geriatrics, internal medicine, and pediatrics.

#### Limitations

Results from our study should be interpreted within the context of several limitations. First, musculoskeletal elective-takers may have performed better on the exam not because they took musculoskeletal electives, but because they have a higher level of interest in

musculoskeletal medicine. To address this issue, we looked at the top residency choice for all 25 fourth-year elective takers and found that 7 out of the 25 medical students listed orthopedics as their first residency choice. The remaining 18 students selected their top residencies as follows: internal medicine (6), obstetrics–gynecology (2), general surgery (2), plastic surgery (2), radiology (2), urology (1), radiation oncology (1), neurology (1), and emergency medicine (1), reflecting a wide variety of interest not necessarily biased towards musculoskeletal medicine. When we compared exam scores of the seven students interested in orthopedics with those of the other 18 students, we found no statistical difference between the two groups' scores. These data suggest that the increase in cognitive mastery of musculoskeletal medicine is more strongly associated with taking musculoskeletal electives than with interest alone.

Second, our assessment was performed at only one medical school. Our study population may not be representative of other medical institutions, and the musculoskeletal medicine curriculum certainly varies from school to school. It could be argued that our institution promotes a disproportionate share of future specialists and researchers and does not focus as much on primary care medicine. Nonetheless, the required two weeks of preclinical instruction focused on musculoskeletal medicine at HMS is consistent with the national average of curricular time devoted to this field.<sup>3</sup> Out of all medical schools in the United States, 47% require neither preclinical nor clinical instruction in musculoskeletal medicine, and 44% require either preclinical or clinical instruction but not both.<sup>3</sup> Out of all Canadian medical schools, 68% do not require musculoskeletal education in the clinical setting.<sup>4</sup> Thus, the amount of time devoted to musculoskeletal medicine at our institution is not atypical. Although individual institutions' curricula vary in effectiveness, it may still be reasonable to infer that a large portion of U.S. and Canadian medical schools face a similar challenge in effectively addressing musculoskeletal medicine in their curricula.

#### Future direction

As the AAMC suggests in its Medical School Objectives Project report guidelines, medical schools can and

should better address musculoskeletal education by striving to “integrate learning experiences relevant to musculoskeletal medicine throughout the curriculum in ways that explicitly identify the material as part of a coherent curriculum component.”<sup>1</sup> HMS is currently in the midst of a major undergraduate medical education reform. In response to the AAMC’s recommendations and to the findings from this study, HMS is in the process of designing a four-year musculoskeletal curriculum. Preliminary changes have already been implemented for the 2006–2007 academic school year.

Our study adds to the previous literature not only by providing direct measurement of the effectiveness of the undergraduate musculoskeletal education, but also by presenting the medical students’ perspectives towards musculoskeletal medicine and the musculoskeletal curriculum. To our knowledge, this is the largest study so far that has used Freedman and Bernstein’s nationally validated basic competency exam, and the results are consistent with other medical institutions’ findings.<sup>2,7,8</sup>

The increasing burden of musculoskeletal problems on individuals and society dictates more focus on musculoskeletal medicine, and medical schools bear

a large share of the responsibility in adequately preparing future physicians to deal with these conditions. Implementing a four-year integrated musculoskeletal curriculum with dedicated time spent in both preclinical and clinical years is one way that medical schools can contribute to The Bone and Joint Decade, the global initiative aimed at addressing the impact that musculoskeletal disorders have on society.<sup>12</sup>

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### References

- 1 Association of American Medical Colleges. Contemporary Issues in Medicine: Musculoskeletal Medicine Education. Washington, DC: Association of American Medical Colleges; 2005.
- 2 Freedman KB, Bernstein J. Educational deficiencies in musculoskeletal medicine. *J Bone Joint Surg Am.* 2002;84:604–608.
- 3 DiCaprio MR, Covey A, Bernstein J. Curricular requirements for musculoskeletal medicine in American medical schools. *J Bone Joint Surg Am.* 2003;85:565–567.
- 4 Pinney SJ, Regan WD. Educating medical students about musculoskeletal problems: are community needs reflected in the curricula of Canadian medical schools? *J Bone Joint Surg Am.* 2001;83:1317–1320.
- 5 Clawson DK, Jackson DW, Ostergaard DJ. It’s past time to reform the musculoskeletal curriculum. *Acad Med.* 2001;76:709–710.
- 6 Bernstein J, Alonso DR, DiCaprio M, et al. Curricular reform in musculoskeletal medicine: needs, opportunities, and solutions. *Clin Orthop Relat Res.* 2003;415:302–308.
- 7 Schmale GA. More evidence of educational inadequacies in musculoskeletal medicine. *Clin Orthop Relat Res.* 2005;437:251–259.
- 8 Jones JK. An evaluation of medical school education in musculoskeletal medicine at the University of the West Indies, Barbados. *West Indian Med J.* 2001;50:66–68.
- 9 De Lorenzo RA, Mayer D, Geehr EC. Analyzing clinical case distributions to improve an emergency medicine clerkship. *Ann Emerg Med.* 1990;19:746–751.
- 10 De Innocencio J. Epidemiology of musculoskeletal pain in primary care. *Arch Dis Child.* 2004;89:431–434.
- 11 Hing E, Cherry DK, Woodwell DA, et al. National Ambulatory Medical Care Survey: 2004 summary. *Adv Data.* 2006;374:1–33.
- 12 Lidgren L. The bone and joint decade 2000–2010. *Bull World Health Organ.* 2003;81:629.
- 13 Bush GW. National bone and joint decade: 2002–2011. A proclamation by the President of the United States of America. *J Bone Joint Surg Am.* 2002;84-A:1297.
- 14 Rosenblatt RA, Cherkin DC, Schneeweiss R, et al. The structure and content of family practice: current status and future trends. *J Fam Pract.* 1982;14:681–722.
- 15 Kelsey JL. *Epidemiology of Musculoskeletal Disorders.* New York, NY: Oxford University Press; 1982.