

Implementation of a novel musculoskeletal physical exam curriculum in an internal medicine residency

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Abstract

Background

Internal medicine residents receive little formal training on musculoskeletal complaints despite their commonality in primary care. Few musculoskeletal physical exam curricula have been reported.

Approach

We developed and delivered a musculoskeletal physical exam curriculum to increase residents' confidence and competence in assessing shoulder, knee, and lumbar spine symptoms offered during the 2023-2024 academic year. Student outcomes were assessed using pre- and post-workshop self-assessments of confidence level and direct observation of physical exam skill in each anatomical area.

Evaluation

Thirty-eight residents completed the pre- and post-assessments of both the confidence survey and the standardized checklist assessment. Shoulder workshop attendees exhibited a statistically significant increase in confidence in evaluating shoulder-related symptoms (3.00 of 5 vs. 2.24 of 5, $p=0.001$) and increased their checklist scores by 23% (71% vs 48% $p < 0.001$). Lumbar spine workshop attendees similarly exhibited increases in confidence (3.40 vs. 2.47, $p < 0.001$) and checklist scores (76% vs 59%, $p=0.015$). Knee workshop attendees showed increased confidence (3.31 vs. 2.57, $p=0.001$), but failed to show a statistically significant increase in checklist scores (82% vs. 77%, $p=0.103$).

Implications

All three workshops were associated with increases in resident confidence in evaluating associated musculoskeletal symptoms. Residents who attended the shoulder and lumbar spine physical exam workshops improved their physical exam competence as measured by direct observation. More data is needed to examine the effect of our curriculum on resident behaviors in clinical work settings.

Background

Musculoskeletal (MSK) complaints are among the most common reasons for ambulatory care visits in the United States, accounting for approximately 20% of primary care and emergency department encounters annually.¹ Primary care providers (PCPs) perform the initial assessment in up to 70% of MSK-related visits, making competence in MSK evaluation essential.² Despite this prevalence, PCPs frequently report low confidence in performing MSK physical examinations, a deficit that has been linked to inconsistent and often inadequate MSK training in undergraduate medical education.^{3–5}

Internal medicine-trained PCPs are particularly affected by this educational gap. Although internists comprise approximately one-third of the primary care workforce,⁶ MSK physical examination training during internal medicine residency remains limited. Few MSK-focused curricula in internal medicine

graduate medical education have been described. Among those that have evaluated outcomes, interventions have demonstrated improvements in self-reported confidence and objective physical examination performance, typically measured using observed structured clinical examinations.^{7,8}

To address this gap, we developed a targeted MSK physical examination curriculum for internal medicine residents focusing on three high-yield anatomical regions: the shoulder, lumbar spine, and knee. Curriculum development was guided by Kern's six-step approach, a widely accepted framework for systematic and needs-based curriculum design.⁹

The aim of this study was to evaluate the effectiveness of this curriculum in improving residents' confidence in assessing MSK complaints and their competence in performing MSK physical examinations, as measured by direct observation. Our evaluation was informed by Kirkpatrick's Four-Level Training Evaluation Model, which uses a four-level approach to assess the impact of training on learners and the organization. Our study focuses on Level 1 (reaction) and Level 2 (learning).¹⁰

Innovation

The educational innovation consisted of a longitudinal, hands-on MSK physical examination curriculum embedded within a protected internal medicine residency didactic schedule. The curriculum comprised three recurring two-hour workshops addressing the shoulder, lumbar spine, and knee. Unlike many previously described interventions that rely on specialty clinics or prolonged immersive experiences, this curriculum was designed to be feasible within existing residency structures and delivered by chief residents with faculty oversight.

Each workshop followed a standardized format: (1) an interactive large-group review of relevant anatomy, physiology, and common pathology; (2) live demonstration of physical examination maneuvers by instructors; and (3) supervised small-group practice, allowing learners to perform complete examinations with real-time feedback. Workshops were repeated twice during the academic year to ensure access for residents on night float or intensive care unit rotations.

Implementation

Setting and Participants

Participants were internal medicine residents at a single mid-sized academic institution across all postgraduate year (PGY) levels during the 2023–2024 academic year. Six chief residents delivered MSK content approximately once monthly during protected two-hour didactic sessions. Residents on inpatient, ambulatory, or elective rotations were expected to attend, with cross-coverage provided for clinical responsibilities. Residents on night float or intensive care unit rotations were excused.

Assessment Strategy

Residents completed pre- and post-intervention confidence surveys assessing their perceived ability to evaluate shoulder, lumbar spine, and knee complaints using a 5-point Likert scale. Survey development followed AMEE Guide No. 87, with item refinement informed by cognitive interviews.¹¹

Competence was assessed using direct observation checklists aligned with workshop learning objectives (see Supplemental files). Residents rotated through three stations, performing complete physical examinations of each anatomical region on healthy volunteer models while being evaluated by trained faculty scorers. Checklist items were scored as 2 (performed correctly), 1 (performed incorrectly), or 0 (not performed). Maneuvers not included on the checklist were not scored.

The intended use of the checklists was formative and low-stakes, without pass/fail implications. Validity evidence was established following the APA Standards for Educational and Psychological Testing.¹² Content validity was supported through derivation from standard physical examination texts and review by experienced clinical educators. Response process validity was addressed through standardized scorer training and scripts. Reliability was assessed by calculating inter-rater reliability for a subset of encounters scored simultaneously by two evaluators.

Timeline

Baseline confidence surveys and direct observation assessments were conducted in July 2023. The first iteration of each workshop occurred from August through October 2023, with post-intervention data collection in November. Residents who had not attended any workshops during this period completed a second baseline assessment, followed by workshops from January through March 2024 and post-intervention assessment in April 2024.

Institutional Review Board

The study (protocol #: FWP20230013E) was reviewed by an Exemption Determination Official of the Wright-Patterson Medical Center Human Research Protection Program (HRPP) Institutional Review Board and determined to constitute exempt research involving human subjects in accordance with 32 CFR 219.104(d). Participation by the human subjects in this research was entirely voluntary with their informed consent. The purpose, risks, confidentiality, and voluntariness of the study were presented to the subjects at the beginning of the study. Our study followed the ethical principles outlined in the Declaration of Helsinki.

Evaluation

Analysis

Paired two-tailed t-tests were used to compare pre- and post-intervention confidence scores and direct observation checklist scores for each anatomical region. Data analysis was performed using IBM SPSS Statistics Version 29.0.2.0. Residents who did not attend any workshops or who lacked paired pre- and post-intervention data were excluded.

Outcomes

Fifty-two residents representing all PGY levels participated in the curriculum (Table 1). Fourteen residents (27%) were excluded due to incomplete participation or missing follow-up data, leaving 38 residents (73%) with paired data for analysis. Of these, 20 attended the shoulder workshop, 21 attended the knee workshop, and 15 attended the lumbar spine workshop.

Table 1. Characteristics of participants

Characteristic	n (%)
Total residents enrolled	52 (100)
Residents excluded (incomplete participation or missing follow-up data)	14 (27)
Residents included in final analysis (paired data)	38 (73)
Workshop attendance among analyzed residents*	
Shoulder workshop	20
Knee workshop	21
Lumbar spine workshop	15

Residents demonstrated significant increases in self-reported confidence across all three anatomical regions. Mean confidence scores increased from 2.24 to 3.00 for the shoulder ($p = 0.001$), from 2.47 to 3.40 for the lumbar spine ($p < 0.001$), and from 2.57 to 3.31 for the knee ($p = 0.001$).

Table 2. Changes in Resident Self-Reported Confidence by Anatomical Region

Anatomical Region	Mean Confidence (Pre)	Mean Confidence (Post)	Mean Change	p Value
Shoulder	2.24	3.00	+0.76	0.001
Lumbar spine	2.47	3.40	+0.93	< 0.001
Knee	2.57	3.31	+0.74	0.001

Observed physical examination performance improved significantly for the shoulder and lumbar spine. Mean checklist scores for the shoulder increased from 48% at baseline to 71% post-intervention ($p < 0.001$), and lumbar spine scores increased from 59% to 76% ($p = 0.015$). Knee examination scores did not show a statistically significant improvement (77% vs. 82%, $p = 0.103$).

Table 3. Observed Physical Examination Performance Before and After Intervention

Anatomical Region	Mean Checklist Score (Pre)	Mean Checklist Score (Post)	Absolute Change	p Value
Shoulder	48%	71%	+23%	< 0.001
Lumbar spine	59%	76%	+17%	0.015
Knee	77%	82%	+5%	0.103

To establish interrater reliability for each direct observation checklist, a subset of participants were scored by two raters simultaneously. Interclass correlation coefficients for the knee (0.95), low back (0.99), and shoulder (0.99) were consistent with excellent interrater reliability.

Improvement and Implications

This MSK physical examination curriculum was associated with improved resident confidence across all anatomical regions studied and measurable gains in observed examination performance for the shoulder and lumbar spine. These findings align with prior literature demonstrating low baseline MSK confidence among internal medicine residents and the responsiveness of these skills to targeted educational interventions.^{3,7,8}

The lack of significant improvement in knee examination performance may reflect higher baseline competence, ceiling effects of the assessment tool, or differences in the complexity of knee examination maneuvers compared with the shoulder and lumbar spine. Notably, confidence improved despite the absence of statistically significant gains in observed knee performance, highlighting the importance of pairing self-assessment with objective measures.

Compared with previously described interventions that incorporate residents into specialty MSK clinics,^{8,13–16} the confidence gains observed in this study were more modest. This suggests that while workshop-based instruction is effective and feasible, integration of supervised clinical exposure may further enhance learning outcomes.

Limitations

This study has several limitations. First, no validated instrument exists to comprehensively assess MSK physical examination competence. The direct observation checklists were locally developed and not intended to represent an exhaustive set of maneuvers. Second, assessments were formative and low-stakes, with no established performance benchmarks. Finally, the single-institution design and one-year study period limit generalisability.

Future Directions

This curriculum has been incorporated into the residency's longitudinal educational programme. Future evaluation should focus on Kirkpatrick Level 3 outcomes, including changes in clinical behaviours such

as frequency of MSK examinations, diagnostic test utilisation, and referral patterns. Prior studies suggest that dedicated MSK clinics may be particularly beneficial for residents pursuing primary care or MSK-focused career paths.^{7,16}

Conclusion

A longitudinal, workshop-based MSK physical examination curriculum embedded within an internal medicine residency was associated with increased resident confidence and improved observed examination performance for selected joints. This feasible educational model may help address persistent gaps in MSK training within internal medicine graduate medical education.

Declarations

Author contributions:

MG conceived the study, led curriculum design, delivered instructional sessions, oversaw data collection and maintenance, performed data analysis, and drafted the manuscript. EW contributed to curriculum design, instruction, data collection, and scoring, and critically reviewed the manuscript. AP, TL, AK, and NZ contributed to curriculum design, instruction, data collection, and scoring, and reviewed the manuscript. KRW served as faculty advisor, contributed to curriculum design and evaluation, and assisted with manuscript revision. KMB served as senior faculty advisor, provided oversight of study design and evaluation, and critically revised the manuscript for important intellectual content. All authors approved the final manuscript.

Disclaimer:

The views expressed in this article are those of the authors and do not necessarily reflect the official policy or position of the Department of Defense, the United States Air Force, the Uniformed Services University of the Health Sciences, or the US Government.

ChatGPT 5.2 and Grammarly were used to consolidate the text, convert it to active voice, and copyedit the manuscript.

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Ethical approval: The study (protocol #: FWP20230013E) was reviewed by an Exemption Determination Official of the Wright-Patterson Medical Center Human Research Protection Program (HRPP) Institutional Review Board and determined to constitute exempt research involving human subjects in accordance with 32 CFR 219.104(d)

Informed Consent/Consent to Participate: Participation by the human subjects in this research was entirely voluntary with their informed consent. The purpose, risks, confidentiality, and voluntariness of

the study were presented to the subjects at the beginning of the study. Our study followed the ethical principles outlined in the Declaration of Helsinki.

Consent to Publish: Not applicable.

Data availability statement: The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Clinical trial number: Not Applicable

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