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■ SYSTEMATIC REVIEW

Undergraduate education of trauma and orthopaedic surgery in the UK

A SYSTEMATIC REVIEW

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Aims

Evidence exists of a consistent decline in the value and time that medical schools place upon their undergraduate orthopaedic placements. This limited exposure to trauma and orthopaedics (T&O) during medical school will be the only experience in the speciality for the majority of doctors. This review aims to provide an overview of undergraduate orthopaedic training in the UK.

Methods

This review summarizes the relevant literature from the last 20 years in the UK. Articles were selected from database searches using MEDLINE, EMBASE, ERIC, Cochrane, and Web of Science. A total of 16 papers met the inclusion criteria.

Results

The length of exposure to T&O is declining; the mean total placement duration of two to three weeks is significantly less than the four- to six-week minimum advised by most relevant sources. The main teaching methods described in the literature included didactic lectures, bedside teaching, and small group case-based discussions. Students preferred interactive, blended learning teaching styles over didactic methods. This improvement in satisfaction was reflected in improvements in student assessment scores. However, studies failed to assess competencies in clinical skills and examinations, which is consistent with the opinions of UK foundation year doctors, approximately 40% of whom report a “poor” understanding of orthopaedics. Furthermore, the majority of UK doctors are not exposed to orthopaedics at the postgraduate level, which only serves to amplify the disparity between junior and generalist knowledge, and the standards expected by senior colleagues and professional bodies.

Conclusion

There is a deficit in undergraduate orthopaedic training within the UK which has only worsened in the last 20 years, leaving medical students and foundation doctors with a potentially significant lack of orthopaedic knowledge.

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Introduction

Musculoskeletal conditions place a significant burden on individuals, healthcare systems, and the economy. In 2018, Arthritis Research UK estimated that just under a third of the UK population live with a musculoskeletal condition.¹ Musculoskeletal conditions are the leading cause of chronic pain and absence from work, and are the most

significant contributor to comorbidity, which in turn accounts for 78% of all GP appointments.¹ Musculoskeletal conditions are managed by a multitude of different specialities including general practice, emergency medicine, rheumatology, and paediatric, geriatric, and general medicine specialists. Given the likelihood that almost all doctors will encounter musculoskeletal disease

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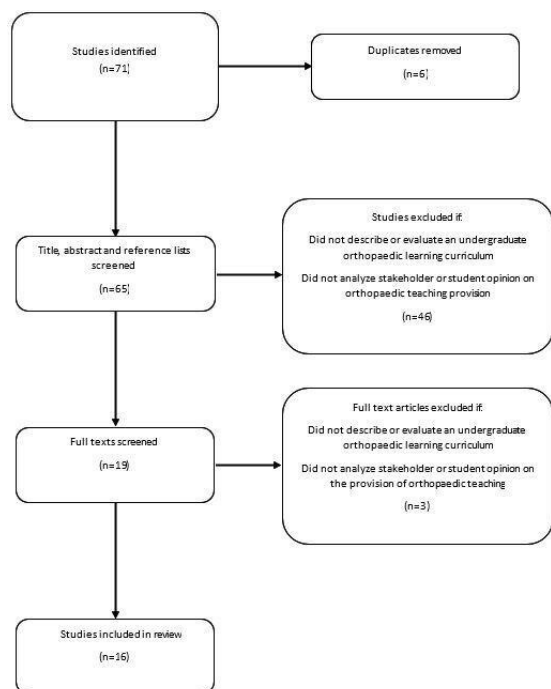


Fig. 1

Preferred Reporting Items for Systematic Reviews and Meta-Analyses flow diagram demonstrating literature search and study selection.

management, it is vital that medical students gain a basic understanding of common and serious musculoskeletal conditions, to ensure that patient care is of the highest possible standard.

In 2014, the British Orthopaedic Association (BOA) published guidance via an undergraduate medical trauma and orthopaedic (T&O) syllabus,² in an attempt to direct and standardize the teaching of musculoskeletal medicine. This response followed previous criticism of T&O education in UK medical schools as the widespread reduction in the quantity, and potentially the quality, of musculoskeletal medicine resulted in the average UK medical student receiving only 2.65 weeks of orthopaedic placement, compared to 4.5 weeks 30 years ago.³⁻⁵

Therefore, this review seeks to establish the views of stakeholders, including undergraduate students, foundation year doctors, senior clinicians, and educators, to reach a consensus regarding the rigour of content and delivery of T&O education. Where standards are not met, we will attempt to evaluate potential mechanisms for optimizing and improving current undergraduate T&O education.

Methods

Review protocols. This study was guided by the following literature review protocols: the Preferred Reporting Items for Systematic Reviews and Meta-Analyses

(PRISMA) statement,⁶ the PRISMA checklist,⁷ the PRISMA Explanation and Elaboration Document 10,⁸ and the Best Evidence Medical Education (BEME) Guide No. 13, 'Conducting a Best Evidence Systematic Review.'⁹ Ethical approval was not required for this study, as it was a systematic review of published literature.

Search strategy and data sources. We searched the MEDLINE, EMBASE, ERIC, Cochrane, and Web of Science databases for literature sources. Google Scholar was used to conduct a manual search. Primary search terms were: (Medical Student* or Phase II Student* or Undergraduate) and (Orthopaedic* or Trauma and Orthopaedic*) and (Undergraduate Medical Education or Medical School or Curriculum or Teaching or Clinical Confidence) and (UK or UK or Great Britain) and (Prepared* or Readiness* or Knowledge* or Understanding* or Competence or Attitude or Deficiencies).

Searches were limited to peer-reviewed English language articles focusing on undergraduate medicine published between 1 January 2001 and 30 March 2021. We included studies undertaken with UK medical schools or using UK practitioners. An updated search was completed on 30 March 2021. All reference lists of articles selected for inclusion were hand-searched for additional articles not discovered in the initial database search (Figure 1). Literature search identified 16 studies that matched our inclusion criteria (Supplementary Table i).

Inclusion and exclusion criteria. We considered articles that included medical students at any point in their MBBS/MBBCh programme. The focus of this review was understanding stakeholder opinion on the provision of orthopaedic undergraduate education. Therefore, studies analyzing student opinion and understanding of the importance of leadership or student existing knowledge, skills, or attitudes about leadership were included, even if they lacked an intervention (Table I). However, to be included in the evaluation and comparison of teaching styles, a study had to describe or evaluate an undergraduate orthopaedic learning curriculum that included one or more interventions where developing new orthopaedic skills, attributes, or competencies were undertaken as the primary outcome. Full details of the inclusion and exclusion criteria are detailed in Table I.

Title and abstract review. Following exclusion of duplicates, two authors (ATP, HB) independently reviewed the titles and abstracts of all articles. Articles for full-text review were selected and placed on a shared Microsoft Excel spreadsheet (v. 14.1.0; Microsoft, USA) if the inclusion criteria were satisfied. If there was a discrepancy, the abstract was discussed, and a consensus reached. All abstracts without consensus on initial eligibility were independently reviewed by two other authors (KS, JW) to determine if they met the inclusion criteria.

Full-text review and data extraction. A data extraction tool was created using the BEME guidelines. Each article

Table 1. Inclusion/exclusion criteria of the review.

Criteria	Inclusion	Exclusion
Research participant	Research relating to orthopaedic undergraduate training in the UK	Research relating to a research participant other than orthopaedic undergraduate training in the UK
Participants	Studies involving medical students who have directly experienced orthopaedic undergraduate training in the UK and or clinicians working in the UK who gave opinion on or made reference to orthopaedic undergraduate training	Studies involving participants other than those outlined in the inclusion criteria
Location	UK studies only	Studies outside the UK (rest of the world)
Type of study	Primary research or studies that report findings relevant to the research question	Studies that report on the provision of undergraduate education for preparedness but did not undertake an intervention or did not explore the perceptions of participants outlined above
Methodology	Research involving quantitative, qualitative, or mixed methodology	Commentaries, editorial comments
Timescale	Research published from the year 2001 onwards (within the past 20 years)	Research published before the year 2001

was independently read by two reviewers (JW, KS) using the data extraction tool. Where discrepancies arose, a third reviewer (ATP) read the full-text article, and a consensus was reached. Extracted data were placed in a spreadsheet. Fields included: 'description of orthopaedic programme', 'leadership skills taught', 'educational setting', 'data collection methods and evaluation tools', and 'significance/implications and limitations'. We classified educational settings as clinical, classroom, simulation, online, project-based, or mixed. Workshops and seminars were considered to be part of the classroom setting. Curricula taught in clinical settings took place in patient-care environments, whereas curricula in project-based settings were conducted in the context of community activities or other initiatives beyond classroom or clinical settings. Curricula with mixed settings were those that used multiple settings, such as didactic education delivered in a classroom, combined with project-based learning occurring outside the classroom.

Results

The length and quality of T&O clinical placements are declining. Malik-Tabassum et al¹⁰ assessed opinions from 200 medical students relating to undergraduate training across 13 UK medical schools, in which the majority of respondents considered their undergraduate training to be "Poor" (37.4%). This lack of exposure is reflected in the mean placement duration, which was just 2.5 weeks, and almost one-fifth (19.3%) of students had no previous clinical placement. Al-Nammari et al⁵ built upon these results and demonstrated a similar mean duration of 2.65 weeks, in which only 68% of participants felt they received "adequate mandatory exposure" to the speciality. Furthermore, Ghani et al¹¹ asked junior doctors, core trainees in a variety of specialities, GPs, GP trainees, and specialist registrars in the UK to comment on their musculoskeletal education during undergraduate training. Two-thirds (66%) of respondents had four or less weeks of orthopaedic undergraduate placement,

and a majority (37%) reported that their undergraduate placement did not prepare them for foundation training. One-third (33%) of respondents cited six weeks as the optimal duration of an attachment to prepare them for a T&O-related foundation post, further highlighting the need for more T&O exposure. This is in keeping with the dissatisfaction experienced by UK medical students and junior doctors with their undergraduate orthopaedic training.^{3-5,12} This dissatisfaction appears to transcend hierarchy, with concerns relating to undergraduate orthopaedic education also shared by senior healthcare professionals. Ali and Bulstrode¹³ questioned 60 senior healthcare professionals on their opinions relating to undergraduate T&O placements. Among these physicians, anaesthetists, surgeons, and GPs, perhaps unsurprisingly, there was a significant disparity ($p = 0.003$) between the professions as to the median optimal time of an undergraduate placement. Surgeons thought a median length of eight weeks was sufficient, followed by GPs and anaesthetists (six weeks), and finally physicians (four weeks). Most notably, 58 respondents (97%) felt that undergraduate T&O placements should be at least four weeks in length. The support of both specialist and non-specialist senior practitioners for increased minimum orthopaedic teaching further reinforces the concerns of their junior and medical student counterparts, and calls into question the efficacy and even safety of the current undergraduate orthopaedic training.

Queally et al¹⁴ used the Freedman and Bernstein exam¹⁵ to assess the knowledge of a group of 303 medical students, GPs, GP trainees, and orthopaedic registrars in an attempt to evaluate the effectiveness of their training. The Freedman and Bernstein examination is a well-recognized 25 short question examination that is widely used in the literature and is the currently gold standard evaluation of orthopaedic knowledge. However, it is unclear whether poor performance on a Freedman and Bernstein knowledge test is predictive

Table II. A table summarizing the impact of various interactive teaching methods and their assessment on undergraduate learning.

Study	New teaching implemented	Assessment	Exam	Average control mark	Average mark post-teaching intervention	Significance
Bulstrode et al ¹⁸	“Donut teaching” (small group sessions) for four weeks	Immediate, short-term (2 months post-course) and long-term (17 months post-course) retention	MCQ exam	Immediate: 40.1/50 Short term: 37.3/50 Long term: 38.1/50	Immediate: 41.1/50 Short term: 36.3/50 Long term: 38.7/50	Immediate: no significance Short term: no significance Long term: no significance
Williams et al ¹⁹	Seven-week T&O curriculum	Exam performance	200 MCQ exam	69%	74.2%	p < 0.001
Queally et al ²⁰	Two-week T&O module	Exam performance	Freedman and Bernstein exam	54.3%	62.3%	p < 0.001
Vioreanu et al ²¹	Two-week intensive programme	Exam performance	35-question exam	Pre-course: 136/280	Post-course: 201/280	Undisclosed
Costa et al ²²	Interactive discussion vs lectures	Exam performance	Ten-question short answer test	Written paper: 7.8/10 Oral exam: 3.8/10	Written paper: 8.3/10 Oral exam: 3.7/10	Written paper: p < 0.05 Oral exam: no significance
Kelly et al ²³	One-week intensive programme	Long-term retention	Freedman and Bernstein assessment, 55-question end of year exam and OSCE	Pre-course pass rate: 3.3%	Post-course pass rate: 61% End of year exam pass rate: 69.9% OSCE pass rate: 96.7%	Post-course: p < 0.001 Significance between control and end of year and OSCE pass rate not measured.

of poor clinical performance.¹⁶ There were two sub-groups of final year medical students: one group had completed an intensive one-week course in musculoskeletal medicine (n = 72), and the other group (n = 60) had not taken the course prior to assessment. Prior to the course, 100% of students failed this examination and yet even after exposure to the one-week course, 63 (87.5%) of medical students failed the examination, suggesting a need for more lengthy undergraduate exposure. Given these results, in the conclusion of this study, the authors called for urgent reform of orthopaedic education in the UK. The concern relating to the lack of knowledge in this cohort is compounded given the steadily reducing time spent on undergraduate orthopaedic education since the completion of this study.¹⁷

Debate still surrounds optimal teaching styles. Bulstrode et al¹⁸ examined musculoskeletal knowledge discrepancies between medical students receiving traditional lectures compared with ‘donut teaching’. This consisted of regular and interactive small group discussions based on reading material given to students in advance. Medical knowledge was assessed via multiple-choice question exams (MCQs) given immediately, then two months after the programme, as well as a final assessment at the end of the students’ clinical course. This study failed to prove any significant superiority of donut teaching compared to didactic lectures. However, interactive teaching methods have been demonstrated to improve the learning of orthopaedics. Williams et al¹⁹ evaluated undergraduate student knowledge following

the implementation of a seven-week structured T&O curriculum. This new programme featured case-based discussions, lectures, a task-based workbook, and supervised group work. Performance was gauged via a 200-question multiple-choice examination, which demonstrated a 6% improvement in mean multiple-choice question score of those who had received the new interactive curriculum over a control group (p < 0.001). Improvement in knowledge was also seen in all ten individual domains, which were all statistically significant with the exception of the non-clinical stations of upper limb anatomy and metabolic bone disorders.

These findings were mirrored in a further study which built upon Queally et al,²⁰ which compared the integration of a new two-week T&O module against a pre-existing control module. The new module consisted of didactic teaching, problem-based learning, real-time assessment, bedside demonstration, demonstration models, and self-directed learning. Knowledge was assessed using the Freedman and Bernstein exam, with a pass mark of 70%. The mean score of the group taking the new module was significantly greater than the historical control (62.3% and 54.3% respectively, p < 0.001). In addition, the new course demonstrated greater student satisfaction: 63% were “satisfied” compared to 15% on the old course (p < 0.001). Student confidence in their ability to perform musculoskeletal examinations also improved 49.1% on the new, more varied course (p < 0.001), which may benefit their future practice. This improvement in learning and satisfaction with increased interactivity of teaching has been replicated by multiple

studies which demonstrate significant improvements in soft skills enjoyment,²¹ exam performance,^{19,22} and long-term retention of knowledge (Table II).²³

Blake²⁴ explored senior views on the teaching of musculoskeletal examinations via questionnaires sent to 76 senior rheumatology and T&O clinicians based in the West Midlands. Current teaching methods at the time of appraisal included practice on real patients (75.9%) and practising on peers (72.4%). The top preferred methods among consultant orthopaedic surgeons included practising on real patients (79.3%), followed by simulation patients (51.7%), suggesting that a hands-on practical learning environment is the most beneficial to student learning. The preference for interactive learning is also described in undergraduate medical students by Boutefnouchet and Budair,²⁵ who surveyed 157 fourth-year medical students and found consultant bedside teaching to be the most useful teaching modality, with 57.8% of participants rating it as “extremely useful”. Small group teaching seminars and bedside teaching with junior doctors or trainees were also well received by students, with 54.5% and 51.6%, respectively, rating these methods as extremely useful. Baker et al²⁶ assessed the opinions of fourth- and fifth-year medical students on blended teaching, while participating in a new interactive programme for orthopaedic learning. Students rated overall course satisfaction, approval of innovative teaching methods, and satisfaction with the clarity of course information as significantly improved when compared to traditional didactic teaching controls ($p < 0.001$).

Thus, we have described a robust body of evidence that both student and teacher prefer more interactive learning styles which consistently demonstrate improved satisfaction, enjoyment, and learning in both the short and long term.

Final-year undergraduates lack the confidence to perform T&O related competencies. Undergraduate orthopaedic education should ideally prepare graduates with the knowledge and understanding of orthopaedics to attain competencies set out by the BOA.² Malik-Tabassum et al¹⁰ asked final year students to rate their self-perceived competency for such skills, recorded using a ten-point scale, where 1 = incompetent (respondents were unable to complete any aspect of the skill) and 10 = fully competent (students could efficiently complete the skill as expected by a qualified doctor). Skills with the greatest average student competency were reported in knee examination (5.76), T&O history taking (5.61), and hip examination (5.48). Conversely, the lowest mean competency scores were found in the management of T&O emergencies (4.45) and fracture management (4.73). Overall, students reported a low competency in all orthopaedic skills, coinciding with the reduced length of orthopaedic exposure at the undergraduate level. However, it was

found that students with prior T&O exposure, ranging between 1 to 5 weeks of placement, on average, had a significantly increased perceived competency of all skills compared to their peers who had no formal T&O placement ($p < 0.01$). Furthermore, the mean competency for students with prior T&O experience scored below 7.5 for all skills, which suggests the need to further optimize student learning to boost confidence and performance among newly qualified doctors.

The lack of undergraduate training is not rectified at a postgraduate level. Al-Nammari et al²⁷ demonstrated that only 15% of foundation year doctors have any formal exposure to musculoskeletal medicine during their foundation posts and just 13% felt that they had received “adequate” exposure to the field. This is reflected in the poor musculoskeletal knowledge demonstrated by Queally et al¹⁴ with only 8.9% of junior doctors and 30% of GPs passing the Freedman and Bernstein examination and the cohort performing most poorly on questions relating to red flag symptoms of disease. In addition, Queally et al¹⁴ demonstrated that 85% of GP trainees were not satisfied with their postgraduate musculoskeletal knowledge, with the primary reason sighted as inadequate undergraduate orthopaedic training.

However, potential solutions to this lack of knowledge within our healthcare professionals have been suggested. For example, Atrey et al¹² assessed the benefit of a postgraduate teaching programme in improving competency and knowledge of musculoskeletal medicine in final year medical students and foundation doctors. Individuals participated in a two-week case-based learning programme, before retaking an exam set by a large multispeciality group of surgeons. Before exposure to the learning programme, only 35% of foundation year one doctors at the district general hospital passed the exam, along with 54% at the teaching hospital and 45% of medical students. Upon completion of the programme, the average pass was 88%, with significant improvements in the score of junior doctors. Additionally, upon completion of the teaching programmes, the affirmative response to the question ‘do you feel confident being an orthopaedic doctor-on-call?’, rose from 42% to 79%.

Discussion

Throughout this review, multiple studies have demonstrated the continuing decline in both the length and quality of T&O placements. The reasons for this are likely complex and multifactorial and are currently not fully understood, or at least not described in the literature. However, the reduction in orthopaedic training has coincided with the increasing complexity of the medical curriculum, the introduction of problem-based learning programmes, and the shift in the primary aim of the General Medical Council to training doctors as effective service providers.^{28,29} However, this is simply highlighting

longitudinal trends, and further research is needed on the topic to evaluate different reasons for the decline in undergraduate orthopaedic education. For example, answering the question of how senior educators in a position of developing and maintaining the undergraduate curriculum view the topic of orthopaedics, and its importance relative to specialities, may be a useful step towards understanding the origins of the current situation.

This view of inadequacy in training is shared between medical undergraduates, junior doctors, senior orthopaedic clinicians, non-orthopaedic specialists, GPs, and academic stakeholders. Queally et al¹⁴ made clear the urgent need to improve undergraduate orthopaedic education in the UK, given the clear deficit in orthopaedic knowledge in both generalist doctors and medical students, secondary to the inadequacy of musculoskeletal education at undergraduate level. Since then, there has been considerable development of the evidence base to support the pressing need to increase placement quality and quantity within the UK, with the aim of better equipping UK doctors with the necessary orthopaedic skills and knowledge, to ensure safe and effective care of our population's musculoskeletal health. However, as demonstrated by this review, this has not yet been put into practice. Nevertheless, the question of how we can optimally improve the quality of our undergraduate education is difficult to accurately answer at this time, in part due to significant heterogeneity in study design and outcome measures.

Furthermore, the absence of true controls, the use of non-clinical assessments, and a lack of clarity and description of the teaching programmes assessed by studies make drawing conclusions from the literature difficult. Despite these limitations, there is a clear trend demonstrating that more interactive teaching components are perceived by undergraduate students and junior doctors as more useful and enjoyable than their didactic and traditional counterparts. These key outcomes could be implemented effectively by those designing undergraduate and postgraduate orthopaedic resources. Future research should aim to provide standardised, clinically relevant, and comparable measures of the efficacy of teaching interventions that will allow comparison between studies and teaching styles.

Investigation into the clinical aspect of T&O education found that inadequate bedside teaching and insufficient teaching from senior clinicians were the seminal complaints of undergraduate medical students, indicating a need to facilitate or simulate this exposure to improve the efficacy of placements. These teaching methods were consistently reported as being the preferred method of learning by students, and correlated with an increase in orthopaedic knowledge. Future placements that rely more heavily on these teaching styles could improve student engagement, improve knowledge, and increase

interest in the orthopaedic field. This would also serve to address the primary concerns of junior doctors: that they felt they did not have enough experience or teaching regarding musculoskeletal examinations during undergraduate training.

The number of foundation programme doctors pursuing higher training in orthopaedics has steadily declined, with the experience of foundation doctors and medical students having a significant impact on career path after completion of their foundation training.³⁰⁻³² The reforms to undergraduate orthopaedic training, along with appropriate supplementation at the post-graduate stage, will be vital in enticing graduates into a career in this field to ensure the maintenance of adequate musculoskeletal care provision in the future.

We present a robust evaluation of recent and relevant literature that provides an overview of the current state of undergraduate trauma and orthopaedic education, while also attempting to unpick and evaluate longitudinal trends. However, there are limitations to our review. For example, there is much heterogeneity within the topic area, especially concerning the assessment of new teaching methods. There is often not a great deal of transparency presented by studies relating to the constitution and structure of their novel teaching intervention, making outcome validation and evaluation of methodology difficult. Furthermore, the vast majority of studies use only multiple-choice questions to evaluate efficacy of interventions or establish participant knowledge of the topic area, however, this may not be the most appropriate marker of true clinical competence. Given these limitations, we have not attempted to evaluate or reach conclusions relating to the rigour of T&O education, but rather set the scene and provide an overview and potential directions for future research to drive improvement.

There has been a consistent decline in the provision of undergraduate orthopaedic training over the last 20 years, despite the rising pressure of musculoskeletal complaints to GPs,³³⁻³⁵ and rapidly increasing waiting lists for arthroplasty.³⁶ This has coincided with a reduction in the rates of speciality application and reduced satisfaction, and knowledge of medical students and doctors with their orthopaedic training. Therefore, improvement is needed: firstly, by increasing the time medical schools commit to orthopaedic education. We would suggest at least four weeks, in line with stakeholder opinion as presented by a number of sources in this review.^{11,13} Furthermore, as undergraduate medical curriculums continue to expand and the aims and objectives of medical schools shift, traditional teaching methods appear to have become insufficient to deliver an increasingly complex topic to undergraduate students. Therefore, future research should aim to identify and validate optimal and accessible teaching methods to improve the efficacy of student learning, to combat

the steadily reducing length of placement. However, change in policy and the generation and validation of future research may take some time. Therefore, in the short term, members of the T&O community should be active and collaborative in the generation and distribution of online resources, and we must ensure that time spent on orthopaedic placements is as valuable as possible. Potentially, looking forward to how higher orthopaedic training is adapting to reduced working hours and increased training demands, using methods such as simulation may provide useful suggestions for undergraduate teaching.^{30,31} The current evidence base suggests that interactive, patient- or case-focused, senior-led bedside and small group teaching provides students with the most educational value for the time invested.

In conclusion, there is inadequate teaching of T&O within the UK undergraduate curriculum. Furthermore, this learning deficit is not rectified at a postgraduate level, indicating the potential presence of a significant number of UK doctors without adequate orthopaedic training required to be competent and safe professionals.



Take home message

- The mean time spent on an orthopaedic placement within the UK is between two and three weeks, significantly less than the four- to six-week minimum advised by relevant sources.
- Final year medical students do not have adequate knowledge of trauma and orthopaedics, and these deficiencies in competence are not rectified at a postgraduate level.
- To address this deficit, there is a clear and urgent need for standardised novel research to define how the quality of trauma and orthopaedic education can be improved in the UK.

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Supplementary material



A table summarising the key study findings from all papers that met the inclusion criteria.

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