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Changes in medical student attendance at in-person teaching sessions: a systematic review

Palaniappan Ganesh Nagappan ,[1,2] Sapphire Rou Xi Tan,[2,3] Shazia Absar,[2,3] Samuel Brown,[3] Sarah Sayers ,[3] Alex McManus,[3] Anmol Arora ,[1,2,4] Isla Kuhn,[5] Faris Khan,[2,3] Edward Lau,[2,3] Charlotte Tulinius [6]

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PGN and SRXT are joint first authors.

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[1]School of Clinical Medicine, University of Cambridge, Cambridge, UK
[2]Department of Public Health and Primary Care, University of Cambridge, Cambridge, UK
[3]University of Cambridge, Cambridge, UK
[4]Department of Oncology, University College London, London, UK
[5]Medical Library, School of Clinical Medicine, University of Cambridge, Cambridge, UK
[6]Department of Public Health and Primary Care, Clinical School of Medicine, University of Cambridge, Cambridge, UK

Correspondence to
Dr Palaniappan Ganesh Nagappan; pgn25@cam.ac.uk

ABSTRACT

Introduction The COVID-19 pandemic has had a significant impact on medical education, with many institutions shifting to online learning to ensure the safety of students and staff. However, there appears to be a decline in in-person attendance at medical schools across the UK and worldwide following the relaxation of social distancing rules and the reinstatement of in-person teaching. Importantly, this trend was also observed before the pandemic. While reflected within the literature, there is currently no systematic review describing these changes. We aim to find out how medical students' attendance is changing as documented within the literature and its impact on their educational outcomes.

Methods This systematic review followed the guidelines of the Centre of Research and Dissemination, Moose and Preferred Reporting Items for Systematic Reviews and Meta-Analyses. We searched the major databases of Medline via Ovid, Embase via Ovid, Scopus, Web of Science, British Education Index via EBSCOhost and ERIC via EBSCOhost in September 2023. Two reviewers independently screened each paper and extracted the data, with a third reviewer for dispute resolution. All studies reporting on medical students from various universities, both graduate and undergraduate, and describing changes in attendance and/or students' educational outcomes were included. Risk of bias in individual studies was assessed using the Agency for Healthcare Research and Quality tool. A narrative synthesis of the findings from all included studies was done.

Results 12 papers were included in the analysis. Primary aim: Of the eight papers that measured attendance data over more than one academic year, only one paper demonstrated a statistically significant decrease while one paper demonstrated a statistically significant increase in attendance over the observational period. Other papers either did not perform statistical tests or did not demonstrate statistical significance. Secondary aims: Most papers showed a general positive correlation between attendance and educational outcomes. No studies explicitly explored reasons for changes in attendance seen. Only one paper outlined a possible strategy to address changes in attendance, a mandatory attendance policy, which has mixed outcomes.

Discussion Despite widespread anecdotally reported attendance decline post-COVID-19, overall, there was no consistent change in attendance noted. However, there was a large heterogeneity in the studies included. Further research is required to elucidate trends in attendance and its impact on medical education.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ The study's adherence to comprehensive methodology, following established guidelines like Centre of Research and Dissemination, Moose and Preferred Reporting Items for Systematic Reviews and Meta-Analyses, ensures a systematic and rigorous approach, enhancing credibility and reliability.
⇒ Independent data management and extraction by two pairs of reviewers reduce biases and enhance objectivity, leading to more robust and credible research outcomes.
⇒ Variable data quality, heterogeneous study designs and potential bias from self-reported attendance data were possible limitations.
⇒ Attendance data, though regularly collected by medical schools, are seldom published and vary in collection methodology.
⇒ The Hawthorne effect may influence observed improvements in student attendance when monitoring is introduced, potentially leading to unsustainable changes.

INTRODUCTION

Historically, universities have served as hubs of academic excellence, fostering environments conducive to research, collaboration and education. In-person teaching, particularly lectures, emerged as a popular and effective method for disseminating vast amounts of information in a structured format. Effective teaching is fundamental in medical schools, where the scope and complexity of the curriculum are extensive, leading to societal implications if not achieved.

Following the COVID-19 pandemic, with a shift back to in-person teaching, medical student attendance at many higher education institutions including medical schools across the UK appeared to have fallen dramatically.

At our institution, teachers and leads across all subjects reported low and decreasing attendance rates at small and large group teaching and whole cohort lectures. A similar observation has been anecdotally reported to us across other medical schools in the UK. Although the literature is still limited on this development, this appears to be an observation seen in several settings across the world.[1–4] The question, therefore, remains whether medical student attendance rates at in-person teaching sessions are truly decreasing.

The pandemic necessitated a transition from in-person education to innovative remote learning methods,[5] catalysing the rapid development of online learning. As in-person teaching resumed, studies have suggested that some students are actively choosing not to attend.[6] Self-determination theory may be the driver for this shift due to the realisation that in-person teaching sessions may not be essential for successful curriculum completion after experiencing the autonomy of remote learning.[1] Attendance rates may, therefore, reflect the relative utility of teaching sessions compared with the utility of online material and other available resources.[7] However, as attendance changes have been noted in some areas prior to the COVID-19 pandemic,[8] there are likely other explanations for these changes.

A deeper understanding of these changes in attendance could help identify more and less effective sessions. Longitudinally measured attendance rates offer a more accurate gauge of session utility, as students would have had the opportunity to compare it against other competing information sources.

Institutional support is crucial to adapt teaching strategies that ensure comprehensive education and address changes in medical student attendance at in-person sessions. Evaluating past approaches and their outcomes[9] can guide innovative models for maintaining high-quality, accessible learning experiences.

To date, no systematic reviews have been published that describe changes in attendance at in-person teaching sessions and their subsequent influence on student educational outcomes. This systematic review aims to investigate and elucidate any changes in medical student attendance at in-person teaching sessions, describe the potential impacts on student educational outcomes and identify any potential strategies that have enhanced the relative utility of in-person teaching sessions in light of any attendance changes.

RESEARCH QUESTIONS

Primary objective

- To describe the changes in medical student attendance at in-person teaching sessions.

Secondary objectives

- To explain the changes to medical student attendance at in-person teaching sessions.
- To describe the impact of the changes in attendance on medical student educational outcomes.
- To describe strategies adopted by educators in light of these changes to medical student attendance at in-person teaching sessions.

METHODS

Definitions

Due to the wide variety of terms used to describe the various categories, we have standardised a set of terms that will be used in this paper.

Cohort—Each unique group of participants being observed (or exposed to interventions)

Academic period—This is taken to describe a phase of education (eg, medical student year 3 or clinical student year 2) or course (eg, dermatology course).

Calendar period—This is taken to describe a time period (eg, 2016/2017 or 2019/2020) or course period (eg, a course lasting a semester).

Search strategy and source of papers

This systematic review was conducted based on a previously published protocol.[10] Deviations from the protocol will be highlighted. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) reporting guidelines were used here,[11] with the checklist included in online supplemental materials 1.

A wide literature search was conducted in September 2023 of six electronic databases: EMBASE via OVID, MEDLINE via OVID, Scopus, Web of Science Core Collection, British Education Index via EBSCOhost, ERIC via EBSCOhost.

The search strategies implemented are included in online supplemental materials 2.

All research articles were retrieved for examination, and a bibliography management programme (EndNote V.21, Clarivate) was used to create a search library.

Inclusion and exclusion criteria

Inclusion criteria:

- Medical students studying in medical schools accredited by their country's governing body.
- Language of publication: all languages.
- Settings: hospitals, medical schools.
- At least one of the following outcomes: (1) attendance rates; (2) educational outcomes and (3) solutions.

Exclusion criteria:

- Grey literature.
- Secondary research.

Eligibility criteria

Sample: Medical students in both graduate and undergraduate medical curriculums across all types of universities (private and public).

(PI) The phenomenon of interest: Changes in attendance, educational outcomes or both.

1. Design: Primary studies excluding grey literature and secondary studies.

2. Evaluation: (1) Recorded or anecdotal evidence of longitudinal changes in attendance and (2) comparison between two or more sets of examination scores or any other performance-based measures (including interest, satisfaction and confidence rates).
3. Research type: Primary studies of qualitative, quantitative and mixed-methods research could be searched for, not including systematic reviews, literature reviews or meta-analysis.

The inclusion and exclusion criteria with the eligibility criteria were used to preliminarily select papers that looked at longitudinal changes in medical student attendance in in-person teaching sessions. We looked at longitudinal changes rather than comparative cross-sectional studies that do not involve any temporal component.

Data management techniques

Data screening

Title-abstract screening was conducted to select papers for full-text review. Each paper was screened by at least two independent reviewers (SS/SA/SB/AM/FK), with a third reviewer (AA/SRXT/PGN) resolving any conflicts between any decision. Screening was conducted in Rayyan (online).

Data extraction

The full text of each paper that passed the title-abstract screening was reviewed by at least two independent reviewers (SS/SA/SB/AM/FK) who then extracted the data from the included papers, with a third reviewer (AA/SRXT/PGN) independently checking the data for consistency and clarity as well as resolving any discrepancies.

A standardised data extraction template was used to include the following summary data. Data extraction was performed in Microsoft Excel. This was designed from the data list in the predefined protocol and was adjusted after a pilot data extraction and internal discussion:

- Sample characteristics (author, year, title, country).
- Study type.
- Cohort types (teachers and students).
- Sample sizes.
- Attendance rates.
- Types of teaching.
- Topics taught.
- Strategies adopted.
- Educational outcomes (before and after an intervention or exposure if any)—this would include confidence, interest and satisfaction levels as well as perceptions.
- Reasons for changes.
- Suggestions for possible strategies.

We replaced academic outcome/performance scores, as defined in the protocol, with educational outcomes achieved to capture the wide variety of outcome metrics used by the various papers.

We employed an iterative approach throughout this process. Calibration meetings were held periodically to discuss any discrepancies and refine the screening and data extraction procedures, ensuring consistency and accuracy. Any disagreements were resolved through discussion or consultation with a third reviewer.

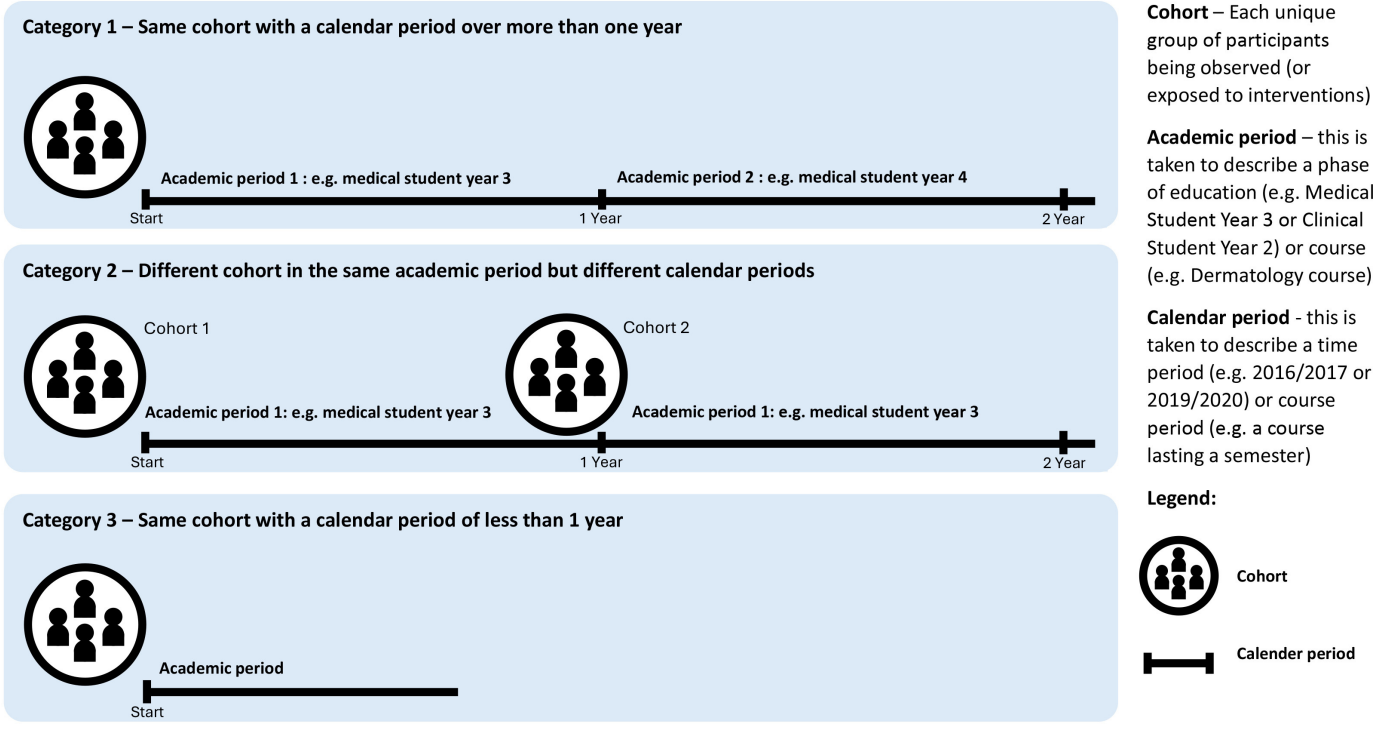

Figure 1 Classification of studies.

Data analysis

The data collected underwent narrative synthesis. This was conducted by two reviewers independently (SRXT/AA/PGN) with a discussion following this.

A meta-analysis was not done due to the heterogeneity of the quantitative data. There were no papers that had suitable data that could undergo qualitative data analysis.

Studies were divided into three categories based on how the participants were followed during the study: (1) attendance in one cohort over multiple academic periods with a calendar period longer than 1 year; (2) attendance in multiple cohorts in the same academic period but different calendar periods and (3) attendance in the same cohort over one academic period with a calendar period of less than 1 year (figure 1).

Risk of bias in individual studies

Two reviewers independently assessed the risk of bias for each included study. The third reviewer mediated in situations of disagreement. Cohen's κ was used to assess agreement between reviewers. All tools and processes were piloted before use.

The Agency for Healthcare Research and Quality (AHRQ) tool[12] was used to assess risk of bias (online supplemental materials 3). This was a deviation from the initially planned use of the Newcastle-Ottawa Scale in the study protocol.[13 14] The Newcastle-Ottawa Scale was strictly applicable for only cohort and case–control studies; however, we elected to include a wider array of study types.

Patient and public involvement

None.

Reflexivity

The authors of this study comprise a diverse range of expertise, including senior medical educators, clinicians and medical students. Diversity of specialty and career stage permitted a wide scope of viewpoints regarding the study design and enriched data analysis. Future research could benefit from incorporating even broader viewpoints, including an international author group to perhaps enable input from non-English-speaking researchers.

RESULTS

Search summary

A total of 10 746 records were identified based on the search strategy, and 12 studies were ultimately included in the analysis (tables 1–3[1 2 15–24]). Details of the selection procedure are outlined in the PRISMA flow chart (figure 2). There were no qualitative studies included.

Table 1 Narrative synthesis of data extracted from included studies—same cohort with a calendar period over more than 1 year

Same cohort with a calendar period over more than 1 year					
Author, location	**Study design, sample size, study years**	**Cohort and teaching characteristics**	**Changes that occurred during the study**	**Results—primary aim**	**Results—secondary aim(s)**
Riaz *et al*,[15] Pakistan	Observational, partly retrospective partly prospective (n=152), 2020–2021	A single cohort of third-year then fourth-year medical students (same cohort followed for 2 years) enrolled in the subject of ophthalmology, involving lectures, small-group classes and clinical ward rotations.	There were no changes reported.	The mean attendance was 55.73% in their third year and 77.25% in their fourth year (no statistical tests performed).	Educational outcomes—Academic performance was based on pass rates on a class test and ward test which both included multiple-choice questions and short essay questions. Pearson correlation test showed a significant positive relationship between attendance and pass rate on exams (p<0.01).
Gupta and Saks,[16] USA	Cross-sectional (n=95 in second year), survey sent in April 2012	Second-year medical students enrolled in 'Patient-Centred Medicine' courses. Self-reported attendance data were obtained via a survey.	There were no changes reported.	Second-year students report attending 50% of live lectures. 58% of second-year students reported their attendance at live lectures decreased between first and second year.	

Table 2 Narrative synthesis of data extracted from included studies—different cohort in the same academic period but different calendar periods

Different cohort in the same academic period but different calendar periods					
Author, location	**Study design, sample size, study years**	**Cohort and teaching characteristics**	**Changes that occurred during the study**	**Results—primary aim**	**Results—secondary aim(s)**
Alamer and Alharbi,[17] Saudi Arabia	Observational, prospective (1st semester: n=66, 2nd semester: n=67), Academic year 2019/2020 (2 semesters)	Fourth-year medical students on a radiology clerkship (lasting 1 semester) which includes on-campus lectures using a mixed didactic and case-based approach.	Teaching was entirely face-to-face in the first semester but transitioned to a mixture of face-to-face sessions and online synchronous sessions in the second semester.	The mean attendance of face-to-face teaching was 85.9% in the first semester and 93.5% in the second semester (no statistical tests performed).	Educational outcomes—Academic performance was based on homework assignments and scores on clerkship examinations with multiple-choice questions. Within the second semester, there was a significant positive relationship between the number of attended sessions and the scores on the clerkship examinations (r=0.39, p<0.05).
Lamb *et al*, [18] USA	Observational/ anecdotal (n=not specified), 2010–2019	First-year and second-year medical students receiving a combination of lecture, small-group case-based learning, clinical skills instruction or clinic experiences, and interactive laboratory-based instruction.	In 2010, a mandatory attendance policy was introduced, which was subsequently dismantled in 2018 in favour of 'encouraged attendance'.	Student attendance waned drastically in 2010. Attendance between 2010 and 2018 was not reported (but assumed to be high due to the mandatory attendance policy). In 2018, attendance rate at case-based learning increased to nearly 100%, but attendance at lectures declined (students report attending lectures 'often' plus 'most of the time' has declined from 59% in 2016 to 48% in 2019).	Educational outcomes—Academic performance was assessed using passing rate and scores on the US Medical Licensing Examination Step 1 examination. Prior to 2018, there was a several-year decline in performance (passing rate 93%–94% vs national 95%–96%; mean score 2–4 points below national mean). In 2018, performance increased (passing rate 100% vs national rate 96%–97%, mean score 5 points above national mean), and the higher performance is sustained in 2019 (passing rate 100% vs national rate 96%–97%; mean score 5–8 points above national mean). Strategies by educators—In response to a waning attendance in 2010, a mandatory attendance policy was instituted.
Nast *et al*, [19] Germany	Observational, prospective (1: n=374, 2: n=322, 3: 325), Winter semester 2005/2006—Winter semester 2006/2007 (3 semesters)	Medical students enrolled on a dermatology course (lasting 1 semester) delivered as lectures.	During the second semester, audio from 50% of lectures was recorded and made available; during the third semester, the remaining lectures were recorded and made available.	Mean attendance of face-to-face lectures was 18% in the first semester, 19% in the second semester and 21% in the third semester (no statistical tests performed).	
Paudel *et al*,[2] USA	Observational, prospective (2017: n=92, 2018: n=90), 2017–2018	Medical students enrolled on a pharmacology course delivered using lectures only which were also recorded and made available to students.	Removal of an attendance credit policy occurred between 2017 and 2018.	The mean attendance decreased from 2017 (87%) to 2018 (61%, p<0.001).	Educational outcomes—Academic performance was measured based on scores from assessments which were single-best answers. Pearson correlation test demonstrated a linear relationship between attendance and performance in both 2017 (r=0.240, p<0.05) and 2018 (r=0.368, p<0.01).

Continued

Table 2 Continued

Author, location	Study design, sample size, study years	Cohort and teaching characteristics	Changes that occurred during the study	Results—primary aim	Results—secondary aim(s)
Different cohort in the same academic period but different calendar periods					
Popovic *et al*,[20] Montenegro	Observational, prospective (2015/2016: n=49, 2016/2017: n=42), Academic years 2015/2016–2016/2017	Second-year medical students enrolled on a Physiology course delivered using face-to-face theory lectures, practical classes and seminars.	A web-based course management system (Moodle) was introduced in 2016/2017.	The mean attendance increased from academic year 2015/2016 (79.67%) to 2016/2017 (87.77%, p=0.041).	Educational outcomes—Academic performance was based on scores on five formative term tests involving multiple-choice questions, as well as a final summative grade which is a sum of attendance, participation in classes, term test scores, a final practical exam and a final oral exam. Performance was higher in academic year 2016/2017 compared with 2015/2016, with a higher average formative test score (73.44% in 2015/2016 vs 81.31% in 2016/2017, p=0.049) and a higher summative grade (7.80 in 2015/2016 vs 9.00 in 2016/2017, p=0.004).
Saxena *et al*,[21] India	Observational, partly retrospective partly prospective (2017: n=133, 2018: n=135, 2019: n=134), 2017–2020	Medical students enrolled in an undergraduate Paediatrics course delivered using lectures.	Teaching was conducted in-person in 2017–2019 but online in 2020 (therefore data from 2020 was excluded).	The mean attendance was 84.9% in 2017, 92.6% in 2018 and 83.0% in 2019 (no statistical tests performed).	Educational outcomes—Academic performance was assessed using scores from an end-of-term summative examination, which were 66.9% in 2017, 58.6 in 2018 and 60.9 in 2019 (no statistical tests performed).

Changes in medical school attendance at in-person teaching sessions

Eight papers measured attendance data over more than one academic year. Of these, only one paper[2] demonstrated a statistically significant decrease in attendance over the observational period, where attendance of medical students enrolled on a pharmacology course decreased from 87% in 2017 to 61% in 2018 (p<0.001). Two other papers[16 18] also found a decrease in attendance, but no statistical tests were performed. Conversely, only one paper[20] demonstrated a statistically significant increase in attendance over the observational period, where attendance of medical students enrolled on a physiology course increased from 79.67% in the calendar period 2015/2016 to 87.77% in the calendar period 2016/2017 (p=0.041). Three other papers[15 17 19] also found an increase in attendance, but no statistical tests were performed. One paper[21] did find any statistically significant change in attendance.

Four papers[1 22–24] measured attendance data over one or less academic year or course duration. All four papers found a statistically significant decrease in attendance throughout the academic year.

Summary of secondary aim results

Impact of the changes in attendance on medical student educational outcomes

Nine studies also explored how academic performance changed with attendance. This was generally assessed based on scores or pass rates on examinations during or at the end of the course. Five of these studies found a statistically significant positive correlation between student academic performance and attendance. One study[1] showed mixed results, where attendance was positively related to second-year course performance but negatively related to United States Medical Licensing Examination (USMLE) step 1 score. One study[23] showed no significant correlation between performance and attendance. Two studies did not undertake statistical analyses.

Reasons for changes to medical student attendance at in-person teaching sessions

None of the included studies explored possible reasons for the changes in attendance seen. However, four studies reported changes that occurred in the curriculum during the time of attendance data collection that could have impacted on student attendance. Alamer and Alharbi found an increase in attendance at in-person teaching (no statistical tests performed) when teaching was switched from entirely face-to-face to a mixture of face-to-face and synchronous online sessions.[17] Nast *et al* also found an increase in attendance (no statistical tests performed) when audio from lectures was recorded and made available to students.[19] Popovic *et al* found a statistically significant increase in attendance which coincided with the introduction of a web-based course management system.[20] These three studies suggest that the use of electronic resources as an adjunct to in-person teaching may

Table 3 Narrative synthesis of data extracted from included studies—same cohort with a calendar period of less than 1 year

Same cohort with a calendar period of less than 1 year					
Author, location	Study design, sample size, study years	Cohort and teaching characteristics	Changes that occurred during the study	Results—primary aim	Results—secondary aim(s)
Al Khaja *et al*, [22] Bahrain	Observational, prospective (n=1404), Academic year 2013/2014	Second-year, third-year and fourth-year medical students in the preclerkship course including peer-based learning resource sessions which are non-mandatory.	There were no changes reported.	The mean attendance of resource sessions declined among second-year students from 78.7% in unit I to 50.8% in unit III (p<0.0001). The mean attendance also declined among third-year students from 53.4% in unit IV to 33.0% in unit VI (p<0.0001). The mean attendance likewise declined among fourth-year students from 32.6% in unit VII to 22.1% in unit IX (p=0.02).	Educational outcomes—Academic performance was based on the end-unit test with multiple-choice questions. Pearson correlation analysis demonstrated a significant positive correlation between attendance and academic performance (r=0.280, p<0.001) throughout all 3-year groups.
Eisen *et al*,[23] USA	Observational, prospective (n=62), Not specified	Second-year medical students enrolled in a required dermatology course consisting of 20 teaching sessions each comprised of 50% didactic material and 50% interactive material.	There were no changes reported.	Mean attendance was 38.7% overall. The highest mean attendance rate of >50% was during the first 7 classes. Thereafter, it dropped dramatically.	Educational outcomes—Academic performance was assessed based on scores on a final examination with multiple-choice questions. There was no statistically significant relationship between class attendance and academic performance (p=0.77).
Gardner *et al*,[1] USA	Cross-sectional (n=195), not specified	Second-year medical students on a preclinical curriculum where majority of lectures are non-mandatory attendance. Self-reported attendance data was obtained via a survey.	There were no changes reported.	A repeated measures ANOVA and post hoc tests showed a statistically significant main effect of semester on frequency of attendance, with reduction in frequency of attendance after each subsequent semester.	Educational outcomes—Academic performance was based on the average performance scores across all second-year courses, and the USMLE step 1 performance score on the first attempt. Linear regression analysis demonstrated that third semester attendance was positively related to second-year course performance (p=0.004), but negatively related to USMLE step 1 score (p=0.022).
Mattick *et al*,[24] UK	Observational, prospective (1st year: n=168, 2nd year: n=130), Academic year 2003/2004	First-year and second-year medical students enrolled on a series of non-compulsory plenary lectures, half of which were delivered live and half remotely.	There were no changes reported.	Attendance demonstrated a linear decrease through the first half of year 1 (R^2=97%, p=0.0024) after which attendance levels off at around 57%. Attendance was relatively constant throughout year 2.	

ANOVA, analysis of variance; USMLE, United States Medical Licensing Examination.

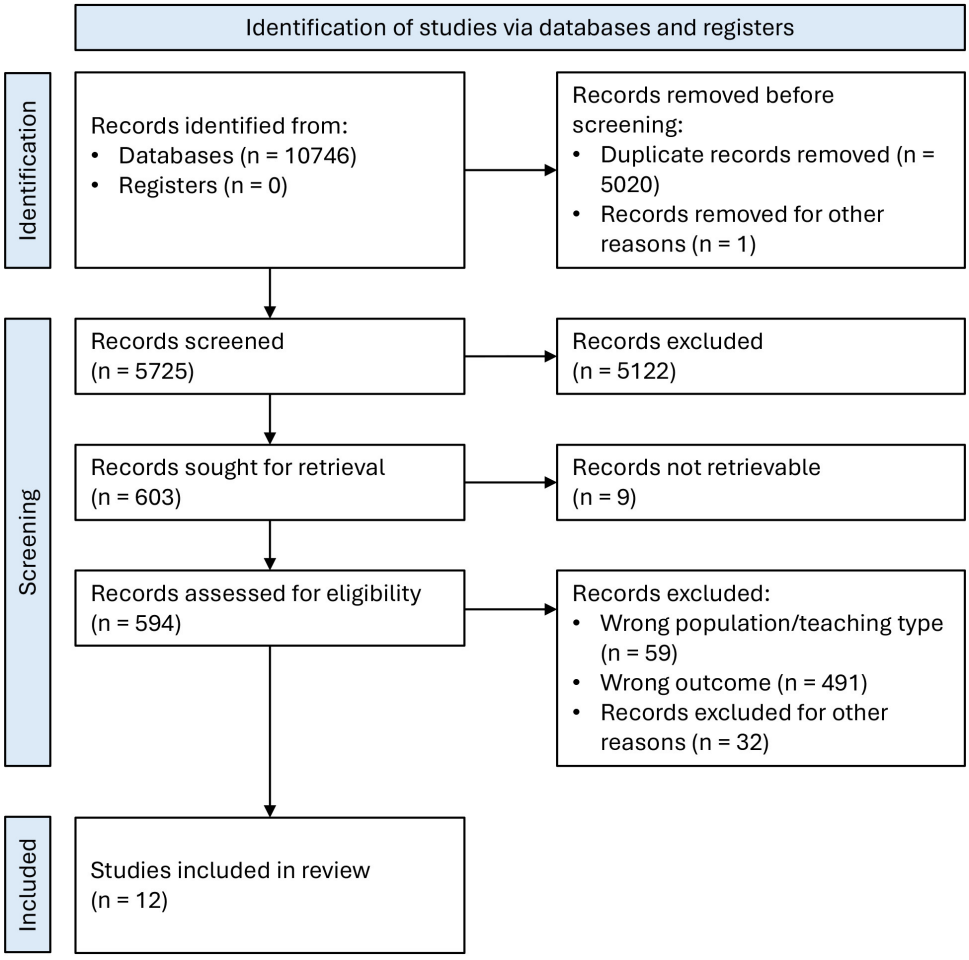

Figure 2 PRISMA flow chart. PRISMA, Preferred Reporting Items for Systematic Reviews and Meta-Analyses.

be the reason for an increase in attendance observed in these studies. Conversely, Paudel *et al* found a statistically significant decrease in attendance recorded that occurred during the removal of an attendance credit system whereby students were no longer required to meet a target number of 'credits' that were obtained on attendance to a lecture.[2]

Strategies adopted by educators in light of these changes to medical student attendance at in-person teaching sessions

Only one study proposed possible strategies to address the changes in attendance seen. Lamb *et al*[18] described an initial decline in medical student attendance in 2010, resulting in the implementation of a mandatory attendance policy. However, there was a subsequent abolishment of this policy due to increasing student and staff dissatisfaction, high administrative resources to regulate it and an observed decline in academic performance as measured by scores and pass rates on the USMLE step 1.[18]

Risk of bias

Risk of bias was evaluated using the AHRQ tool as displayed in online supplemental materials 3. Studies were generally considered high risk of bias with little concordance between study designs as seen in online supplemental materials 4.

DISCUSSION

Summary of key findings

With 12 studies across various countries, this study has highlighted an emerging body of literature reporting a mixed picture of changes in attendance over time. The majority of studies predate the pandemic, with classes mostly having been studied in-person. One study showed a statistically significant increase in class attendance over the study period, while five studies showed a decrease and six studies reported no statistically significant differences. The findings of studies exploring the relationship between attendance and academic performance were similarly mixed, although the majority of these studies did note a positive relationship. The mixed findings suggest that while attendance generally benefits educational outcomes, the extent of its impact can vary based on the nature of the course, assessment methods and possibly other context-specific factors.

This is the first systematic review, of which we are aware, to appraise and rationalise longitudinal changes in student educational outcomes over time. This review revealed no consistent change in medical student attendance when measured longitudinally, although there was some heterogeneity. Localised changes in attendance rates could be attributed to students' misperception

that in-person teaching sessions may not be essential for successful curriculum academic success. Fluctuations in attendance for specific teaching programmes may reflect the perceived utility of in-person teaching sessions in the context of novel online learning materials and other resources. Much of the research predates the pandemic, and so there is a shortage of literature evaluating whether replacement methods of education were adequate. The advent of digital learning platforms and virtual classrooms has created a novel environment for medical education. Whether the study remains representative of the emergent environment of medical education in post-COVID-19 era is debatable, and further research is required. However, the present study has revealed key themes from existing literature that may be relevant when assessing changes in attendance associated with the pandemic.[1] The COVID-19 pandemic necessitated rapid adaptations to remote learning, accelerating pre-existing trends towards digital education and hybrid attendance models.[25] There were rapid shifts towards online education and telemedicine, and there were suggestions that these could be expanded through outreach programmes in underserved rural communities.[5] During the pandemic, there was also the development of novel service-based learning approaches, which replaced conventional lectures, but the long-term outcomes of these are unclear.[26]

There were several cross-sectional studies that surveyed students to ask what factors affected their attendance, or absence, at teaching sessions. Student-related factors reported in the literature included health issues, lack of self-discipline or getting up late.[27] Curriculum-related factors included poorly defined curricula, ineffective teaching, inflexible timetabling and variable teaching quality.[28] Although this was not systematically assessed in this study, there were reports that students appeared to prefer online lectures but noted that in-person attendance helped to maintain social relationships.[1]

Implications for educational practice

Although the body of literature in this area is in its infancy, the provision of recorded lectures and the introduction of web-based course management systems appeared to positively impact attendance. The introduction of blended learning models, such as combining face-to-face sessions with online synchronous teaching, was associated with increased attendance as reported by Alamer and Alharbi. Nast *et al* and Popovic *et al* found that making lecture recordings available and using platforms like Moodle were correlated with stable or increased attendance, perhaps contrary to expectations.

Another potential policy implication for educators is the effect of mandatory attendance policies. Lamb *et al* discussed the implementation of such a policy, which initially increased attendance but was later abolished due to negative feedback and resource constraints. The study highlighted the complexity of enforcing such policies, noting dissatisfaction among students and staff, as well as increased administrative burden.

A significant caveat to these findings is dependent on whether attendance is compulsory for students to pass the course, which only some of these studies have addressed clearly as part of their methods. In the UK, the GMC mandates that students[29]: 'must engage fully with your medical course by attending educational activities, including lectures, seminars and placements, and by completing coursework'. The onus is left to the medical schools to determine a suitable attendance rate. Similarly in the USA, there is no nationally mandated minimum attendance requirement.

Using attendance as a marker of the perceived relative utility of a teaching session, compared with other learning resources, is no longer suitable if compulsory attendance is mandated. An explanation for the attendance-performance correlation could be a result of increased engagement with material relevant to the examination. However, enforcing compulsory attendance may not result in the same correlation. Keeping sessions voluntary can help to ascertain which lessons are more useful, while enforcing mandatory attendance can help to ensure crucial knowledge is imparted, which would otherwise not be part of the students' attention (table 4).

Limitations

The main limitation of this review, and the studies it includes, is the variable quality of data, scarcity of data and the heterogeneous nature of study designs, which can make summarisation difficult. Furthermore, the reliance on self-reported attendance data in some studies introduces a potential bias that could skew the results. Through a broad search strategy, efforts were made to maximise the number of relevant articles captured within the systematic review. However, there were a handful of papers that were unavailable, either due to being published solely in abstract format or due to online inaccessibility. There may be publication bias against papers which report low attendance rates as these may not be favourable statistics for the institution. While attendance is a metric that may be regularly collected by medical schools for internal use, this study indicates that such data are seldom published. Where data are published, they are heterogeneous in collection methodology. Cross-sectional studies where attendance was only noted at a single time point were not included in this study. However, there have been reports in literature from such cross-sectional studies that reduced attendance is correlated with reduced academic performance, with no causal relationship able to be elucidated due to study design.[30] There was a notable dearth of primary qualitative research performed in this area, which limited the analysis to quantitative data and limited our ability to conduct wider methodological triangulation. This is an avenue for future research. We attempted to fill this gap by triangulating sources of evidence beyond those identified in the systematic review, within the Discussion section.

In evaluating changes in medical student attendance at in-person teaching sessions, one must consider the

Table 4 Compulsory versus voluntary attendance in medical schools

	Benefits	Drawbacks
Compulsory attendance	School ► Able to demonstrate higher attendance rates	School[18] ► Logistical system required for enforcing attendance ► High administrative burden for enforcement ► Unable to identify sessions that require improvements in an accurate and timely fashion
	Students ► Important information can be imparted to students that would otherwise not be within the students' attention	Students ► Unable to discern between sessions the school determines to be more important, leading to cognitive fatigue ► Worse satisfaction levels due to lack of control
Voluntary attendance	School ► To identify which lectures, sessions or courses require more work ► To recognise those that should be commended ► To find learning points that could make other lessons better	School ► More work required to increase attendance levels ► At risk of having generally low levels of attendance, especially when there is limited support in helping to improve curriculum quality
	Students[32 33] ► To focus on sessions that matter to their learning ► To minimise time spent on less useful sessions ► Able to tailor individual learning based on own learning style ► Improved satisfaction levels as students have more control over their studies	Students ► Important information may be missed that would otherwise not be within the students' attention.

potential impact of the Hawthorne effect, wherein individuals alter their behaviour due to the awareness of being observed. When students know their attendance and participation are being monitored, they may be more inclined to attend sessions or engage more actively than they would under normal circumstances. To mitigate the influence of the Hawthorne effect in future research, studies may use hidden observations[31] or track attendance over extended periods to characterise whether initial improvements are sustained over time.

CONCLUSIONS

To summarise the principal findings of the present study, this review revealed that existing evidence in the field is generally limited to single-site studies, often with high risk of bias, and so there is a need for further high-quality research. However, in general, the adoption of innovative styles of medical education delivery, including blended learning, was associated with improvements in attendance. There was a focus on quantitative data within the existing body of literature, with a research gap in the collection of qualitative findings beyond simple attendance metrics. For example, there is a shortage of studies which attempt to characterise the reasons for changes in attendance, rather than solely measuring attendance itself.

Future directions of research include creating frameworks for measuring and evaluating attendance, that can be applied in a federated manner at medical schools. This would require studying attendance more consistently and in somehow comparable settings to enable meta-analysis.

Whether attendance is correlated with performance remains an open question and we call for studies which seek to measure engagement with scheduled teaching activities, rather than attendance itself. This could include measuring engagement with reflective logbooks, coursework, contribution to activities or measurement of clinical learning objectives. Within the UK, there is also potential scope for novel research using the UK Medical Education Database (UKMED) which tracks educational outcomes at an individual level for the UK trainees. With the development of remote medical education resources, including online lectures or virtual electives, there is a need for critical evaluation of the outcomes, in comparison to in-person attendance. Specific analysis could involve a meta-analysis of studies comparing these modes of education concerning student engagement, knowledge retention and clinical skill acquisition.

X Anmol Arora @DrAnmolArora, Isla Kuhn @ilk21 and Charlotte Tulinius @ClinEduRes_ucam

Contributors PGN: drafted the proposal, conceptualisation of topic. SRXT: conceptualisation of topic, results analysis and drafting of manuscript. SB: data collection and refining of topic. AM: data collection and refining of topic. SS: data collection and refining of topic. SA: data collection and refining of topic. FK: data collection and refining of topic. AA: conceptualisation of topic, drafting of manuscript. IK: review and critiquing to improve research methodology with the drafting of the search strategy. EL: conceptualisation of topic and supervision. CT: conceptualisation of topic and supervision. CT: guarantor.

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ORCID iDs
Palaniappan Ganesh Nagappan http://orcid.org/0000-0002-9203-8836
Sarah Sayers http://orcid.org/0009-0003-8931-7361
Anmol Arora http://orcid.org/0000-0003-4881-8293
Charlotte Tulinius http://orcid.org/0000-0002-1322-4703

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