BMJ Open

The impact of medical school on performance in the Intercollegiate Membership of the Royal College of Surgeons (MRCS) Examination: A retrospective cohort study

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2021-054616
Article Type:	Original research
Date Submitted by the Author:	19-Jun-2021
Complete List of Authors:	Ellis, Ricky; University of Aberdeen Institute of Applied Health Sciences; Nottingham University Hospitals NHS Trust, Urology Department Brennan, Peter ; Queen Alexandra Hospital, Department of Maxillo-Facial Surgery Scrimgeour, Duncan; Aberdeen Royal Infirmary, Department of Colorectal Surgery; University of Aberdeen Institute of Applied Health Sciences Lee, Amanda; University of Aberdeen Institute of Applied Health Sciences, Department of Medical Statistics Cleland, Jennifer; Lee Kong Chian School of Medicine, Medical Education Research and Scholarship Unit (MERSU)
Keywords:	MEDICAL EDUCATION & TRAINING, SURGERY, Adult surgery < SURGERY

SCHOLARONE™
Manuscripts

The impact of medical school on performance in the Intercollegiate Membership of the Royal College of Surgeons (MRCS) Examination: A retrospective cohort study

Authors

R Ellis[1,2], PA Brennan[3], DSG Scrimgeour[4], AJ Lee[1], J Cleland[5]

[1]Institute of Applied Health Sciences, University of Aberdeen, and [2]Urology Department, Nottingham University Hospitals NHS Trust, Nottingham and [3]Department of Maxillo-Facial Surgery, Queen Alexandra Hospital, Portsmouth. and [4]Department of Colorectal Surgery, Aberdeen Royal Infirmary, Aberdeen and [5]Lee Kong Chian School of Medicine, Nanyang Technological University, Singapore.

Correspondence to:

Mr Ricky Ellis

Urology Specialist Registrar and Intercollegiate Research Fellow.

Institute of Applied Health Sciences, University of Aberdeen, Aberdeen, AB25 2ZD.

Rickyellis@nhs.net

@RickJEllis1 07886102573

Co-author details

Professor Peter A Brennan, PhD

Professor of Surgery, Consultant Maxillo-Facial Surgeon and Research Lead for the Intercollegiate Committee for Basic Surgical Examinations

Department of Maxillo-Facial Surgery, Queen Alexandra Hospital, Portsmouth, PO6 3LY, United Kingdom.

Peter.brennan@porthosp.nhs.uk

@BrennanSurgeon

Mr Duncan SG Scrimgeour, PhD

Colorectal Specialist Registrar and Past Intercollegiate Research Fellow

Department of Colorectal Surgery, Aberdeen Royal Infirmary, Aberdeen, AB25 2ZN, United Kingdom.

duncan.scrimgeour@nhs.scot

@dsgscrimgeour

Professor Amanda J Lee, PhD

Chair in Medical Statistics and Director of the Institute of Applied Health Sciences

University of Aberdeen, AB25 2ZD, United Kingdom.

a.j.lee@abdn.ac.uk

Professor Jennifer Cleland, PhD

Professor of Medical Education Research and Vice-Dean of Education

Medical Education Research and Scholarship Unit, Lee Kong Chian School of Medicine, Nanyang Technological University, Singapore.

jennifer.cleland@ntu.edu.sg

Key words:

MRCS, Post-graduate examinations, Medical Education and Training, Pedagogy

Word Count: 4,277

ABSTRACT

Objectives: The knowledge, skills and behaviours required of new UK medical graduates are the same but how these are achieved differs given medical schools vary in their mission, curricula and pedagogy. Medical school seems to impact performance on some postgraduate examinations. To date, the relationship between school and Membership of the Royal College of Surgeons (MRCS) performance has not been scrutinised. Thus, we explored differences in MRCS outcomes between medical schools, course types, national (league table) ranking and candidate sociodemographic factors.

Setting: Secondary care.

Participants: A retrospective longitudinal study of all UK medical graduates who attempted MRCS Part A (n=9730) and MRCS Part B (n=4645) between 2007 and 2017, utilising the UK Medical Education Database.

Primary and Secondary outcome measures: We studied MRCS performance across all UK medical schools and examined relationships between potential predictors and MRCS performance using chi squared analysis. Multinomial logistic regression models were used to identify independent predictors of MRCS success at first attempt.

Results: MRCS pass rates differed significantly between individual medical schools (P<0.001) but not after adjusting for prior (high-school) academic performance. Candidates from courses other than those described as problem-based learning (PBL) were 53% more likely to pass MRCS Part A (Odds ratio (OR) 1.53 [95% Confidence Interval 1.25-1.87] and 54% more likely to pass Part B (OR 1.54 [1.05-2.25]) at first attempt after adjusting for prior academic performance. Attending a Standard-Entry 5-year medicine programme, having no prior degree and attending a Russell Group university were independent predictors of MRCS success in regression models (P<0.05).

Conclusions: There are significant differences in MRCS performance between medical schools, however, this variation is largely due to the innate academic ability of individuals, rather than medical school factors. This study also highlights group level attainment differences that warrant further investigation to ensure equity within medical training.

Key words

Medical Education and Training, Surgery, Adult Surgery

Strengths and Limitations of this study

- The first study to explore differences in MRCS performance between medical school course types, pedagogy and national ranking.
- A large-scale longitudinal study utilising the UKMED Database.
- Regression models were constructed with and without adjusting for prior academic attainment (A-level performance)
- Uses MRCS success as a predictor of future performance in surgical training.
- Identifies group-level attainment differences that require further exploration.

The impact of medical school on performance in the Intercollegiate Membership of the Royal College of Surgeons (MRCS) Examination

BACKGROUND

Medical schools vary significantly in their teaching methodology, curriculum, course structure, assessment methods and standards.(1–3) In the United Kingdom (UK), the General Medical Council (GMC) acknowledged that these differences between medical schools exist and that it is "inevitable" that this variation can influence a graduate's "interests, abilities and career progression" but that it is not a "cause for concern",(4) presumably because all new medical graduates must meet the same GMC standards. This can be debated given that medical school choice seems to have an influence on later career choices and success. For example, the number of graduates choosing each speciality differs significantly across medical schools.(5–8) There are also significant differences in the performance of graduates from different medical schools in high-stakes post-graduate examinations such as the FRCA,(9) MRCOG,(10) MRCGP and MRCP (11–13) (see abbreviations list).

To our knowledge, no studies have demonstrated whether success at post-graduate surgical examinations differs according to choice, type or ranking of UK medical school. This is an important area to evaluate. MRCS success is associated with success in surgical training, national selection for higher specialty training and first attempt success in the Fellowship of the Royal College of Surgeons examinations (FRCS).(14–16) Furthermore, MRCS is an indicative marker of future outcomes in a surgical career, and those who wish to pursue surgery as a specialty may want to know which medical school will "best" prepare them for a surgical career.(17)

Many students enter medicine with clear views as to which specialty they wish to pursue (18–20) and perceptions of how well one will be placed for a surgical career on graduation may be one factor taken into account at the time of application to medical school.(21) However, it will not be the only factor. Studies with senior students and junior doctors indicate that numerous factors are "traded-off" when considering a training post (e.g., location, reputation of the unit, working conditions), and these trade-offs differ for different groups (e.g., on the basis of gender, or socio-economic background).(22–24) Similarly, applicants may consider factors such as pedagogic approach (e.g., problem-based learning [PBL] versus, for example, or a lecture-based course);(25–27) course length if a graduate (graduates have the choice between a traditional five-year programme or an accelerated Graduate-Entry Medicine (GEM) course);(28) and/or the reputation and national ranking of a medical school when considering where to apply.(20,29–31) In short, choosing which medical school to attend is a major decision and factors other than career preference may be important in this process.

In this study, we evaluated a number of medical school factors in respect to MRCS success. We compare first attempt pass rates for both MRCS parts A and B across all medical schools within the UK and calculate the likelihood of passing MRCS based on university, course type and course pedagogy. Additionally, we investigated whether indicators of esteem such as Russell Group membership and institutional national ranking predict MRCS success. As individual factors are also associated with success in medical training,(23,32–35) we also studied the relationship between MRCS and graduate status on entry to medical school, gender and ethnicity.

METHODS

This was a longitudinal retrospective cohort study. Individual-level linked data was obtained from the UK Medical Education Database (UKMED) (36) and the four Royal Colleges of

Surgeons of the UK and Ireland (Edinburgh, Glasgow, England and Ireland). Anonymised data was extracted for all UK medical graduates who had attempted either the Part A (written) or the Part B (clinical) MRCS examination between 2007-2017. When storing, handling and analysing data, the highest standards of security, governance and confidentiality were ensured. No patient or public involvement was required for this study.

The following data were extracted: Place of primary medical qualification, course pedagogy and type, MRCS Part A and B first attempt result, gender, self-declared ethnicity and graduation status at the time of entry to medical school. Candidate first attempt results were used as they have been shown to be the best predictor of future performance in post-graduate examinations.(37) These variables are described in more detail below.

Except for place of primary qualification, all variables were dichotomized. Part A and B MRCS performance was categorized as "pass" or "fail" at first attempt. Graduation status was defined as "no" if candidates had not obtained a degree prior to entering medicine and "yes" if they entered as a graduate. Self-declared ethnicity was coded as "white" or "non-white" as per similar studies to enable powered analysis of smaller cohorts.(15,38) Course pedagogy was classified as "Problem Based Learning" (PBL) or "Not Problem Based Learning" (nPBL). Course type was classified as "Graduate-Entry" (GEM: four-year accelerated programmes) or "Undergraduate" which was later further classified into "Standard-Entry" program (SEM) or "Medicine with a Gateway Year" (five years plus one preparatory year). Note that foundation year students were combined with gateway students for this last category, as both approaches have the aim of widening access to medicine; that is, providing alternative ways into medicine for those who do not meet the academic criteria for SEM courses because of socio-economic or personal disadvantage.(39) Finally, there are a significant number of graduates who choose to do a SEM programme,(40) so candidates who undertook SEM courses were further defined as "Graduate on Entry" or "Not Graduate on Entry".

Medical Schools

At the time of writing, there were 35 medical schools in the United Kingdom recognised by the GMC, including a combined University of London awarding body. Most are undergraduate courses, offering a five-year programme, plus 16 accelerated graduate entry programmes. Eleven medical schools offer gateway/foundation courses. The study-specific dataset included values for 31 medical schools: newer medical schools (e.g. Lancaster, Anglia Ruskin and The University of Buckingham) were not represented in the dataset as very few, if any of their graduates had attempted MRCS within the study period. Several GEM courses included in the analysis have ceased to exist since (such as Leicester and Bristol), additionally new GEM and Gateway courses were not included if graduates of these courses had not attempted the MRCS within the study period.

Within the UK a number of Universities combine to create linked medical schools such as Leicester-Warwick Medical School (a combination of the Universities of Leicester and Warwick) and Peninsula Medical School (a combination of Plymouth and Exeter Universities). Many later end their partnership, creating two independent medical schools. To represent this in the data analysis candidates who studied at either Leicester-Warwick or Peninsula Medical Schools were categorized according to the university from which they graduated (i.e. Leicester, Warwick, Plymouth or Exeter). Graduates of Hull-York Medical School and Brighton and Sussex Medical School remain under the combined title as they were still combined institutions at the time of data analysis. Within the study period certain medical schools were also linked (e.g., Keele students were awarded degrees by the University of Manchester until 2012). To acknowledge this, students were categorised by the place of graduation for their primary medical qualification, including London graduates.

Rankings

In this study, universities were ordered according to their ranking by 'The Complete University Guide' as of August 2020. 'The Complete University Guide' is the most well recognised independent university ranking system in the UK and uses the following data annually to create an overall score (100 points being the most a university can be awarded): entry standards, student satisfaction, research quality and intensity, graduate prospects, student to staff ratio, spending, honours and degree completion. More information on how the ranking system is calculated is available on the complete university guide website.(41) This ranking system provides a quantitative comparator between universities for the purposes of this study and its use does not suggest that its value is greater than that of any other ranking systems that exist which are calculated using similar data. Note that Lancaster University (ranked 16th) was excluded having only opened in 2006 and having insufficient outcome data. St Andrews Medical School (ranked 25th) was also excluded as it offers only pre-clinical education: those who commenced their studies at St Andrews were therefore categorised by their place of graduation (e.g. Manchester University, The University of Dundee, etc.). The ranking table was adjusted accordingly, to create an ordinal variable.

Russell Group

Russell Group Institutions are a collection of self-selected research driven universities that have developed a reputation of excellence.(42) The majority of older medical schools are associated with the Russell Group. Whether these universities are truly the elite institutions within the UK is a highly debated topic (43–45) but they do graduate the majority (80%) of the UK medical students.

Pedagogy

Despite well-established definitions of what comprises problem based learning (PBL) it can be challenging to identify which medical schools run PBL courses.(46,47) We have aligned our definition with that of the British Medical Association (BMA) as well as that used in recent studies to ensure consistency within the literature, enabling comparisons to be drawn between the results of these studies.(1,11,48) PBL schools are: Liverpool, Manchester, Glasgow, Queen Mary, Cardiff, Plymouth, Exeter, Sheffield, Keele, Hull-York and East Anglia.

Markers of prior academic attainment

Individual-level linked performance data was extracted for A-Levels (high-school exit examinations) as a marker of prior academic attainment. Total A-Level scores used in data analyses are the sum of all A-Level scores achieved i.e. A=10 (being the highest score achievable for each A-Level), B=8, C=6, D=4, E=2, U=0 (being the lowest score for each A-Level). A small minority of candidates in the dataset (n=30) undertook A-Levels after A* grades were implemented in 2010. These were subsequently excluded for cohort homogeneity.

Statistical analysis

All analyses were conducted using SPSS® v22.0 (IBM, Armonk, New York, USA). Chi-squared tests were used to assess the relationship between two categorical factors such as medical school and first attempt MRCS pass/fail outcomes. All counts have been rounded to the nearest 5 for illustration according to Higher Education Statistics Agency (HESA) data standards.(49) Regression models were used to calculate the odd's ratios (OR) and 95% confidence interval (CI) for passing MRCS Parts A and B at first attempt according to place of primary medical qualification. The University of Keele was declared the reference category for construction of the logistic regression model for MRCS Part A, as the pass rate at this university (58.6%) most closely resembled the pass rate of the entire cohort of Part A candidates from all universities. The University of Birmingham was declared the reference category for Part B in the logistic regression model, as the pass rate at this university (71.1%) most closely resembled the pass rate of the entire cohort of Part B candidates from all universities.

Potential independent predictors of first attempt success at Part A and B MRCS were identified using multinomial logistic regression models. Regression models were constructed with and without adjusting for prior academic attainment (A-level performance) for direct comparison. Any variable with an association with outcome at a conservative $P<0.10$ on univariate analysis was entered into the logistic regression model. All potential predictors with $P>0.05$ in the full model were subsequently removed until only statistically significant predictors remained in the final model. Potential interactions between the remaining significant predictors were also examined.

Patient and public involvement

No patient or public involved.

RESULTS

Medical School Differences

Between 2007 to 2017 a total of 9,730 UK medical graduates from 31 medical schools attempted the MRCS Part A, with 59% passing on first attempt. A total of 4,645 candidates attempted MRCS Part B and 71% passed at their first attempt. Of all Part A exam candidates 64% were male, 59% were white and 86% had no degree level qualification prior to studying medicine. Similar demographics were seen in Part B applicants with 65% male candidates, 61% white candidates and 86% of candidates having no prior degree. Chi-squared analysis revealed a significant difference in MRCS pass rates between medical schools for Part A ($P<0.001$) and Part B ($P<0.001$) (Figures 1 and 2 respectively, raw data presented in Appendix 1). The mean (standard deviation, SD) MRCS pass rate at first attempt for candidates across all medical schools was 59% (SD 49) for Part A and 71% (SD 45) for Part B.

Figure 1 and Figure 2

Medical School ranking and position of esteem

Odds ratios for passing MRCS Part A and B at first attempt for each medical school can be found in Table 1. Oxford and Cambridge University graduates (ranked 1st and 2nd respectively) performed significantly better in MRCS Part A than the mean with resulting odds ratio 9.11 (95% CI 4.77 to 17.39) and 5.82 (3.42 to 9.90) respectively. After adjusting for prior academic attainment, Oxford University graduates were still found to be more than three times more likely to pass MRCS Part A at first attempt (OR 3.18 (95% CI 1.15 to 8.81)) and Cambridge graduates were more than twice as likely to pass (OR 2.64 (95% CI 1.03 to 6.78)). After adjusting for prior academic attainment, there was no statistically significant difference in performance between most medical schools.

Table 1. Odds ratio for pass at first attempt at Part A and Part B MRCS across all UK medical schools, ranked according to the Complete University Guide as of 2019-2020. C.I., Confidence Interval. Statistically significant odds ratios shown in bold

		Part A			Part B		
Rank	**Medical School**	**MRCS Candidates (n=9730)**	**Unadjusted Odds Ratio (95% C.I.)**	**Odds Ratio Adjusted for prior academic attainment (95% C.I.)**	**MRCS Candidates (n=4645)**	**Unadjusted Odds Ratio (95% C.I.)**	**Odds Ratio Adjusted for prior academic attainment (95% C.I.)**
1	University of Oxford	210	**9.11 (4.77 – 17.39)**	**3.18 (1.15-8.81)**	94	**2.32 (1.23 – 4.40)**	4.43 (0.51-38.58)
2	University of Cambridge	285	**5.82 (3.42 – 9.90)**	**2.64 (1.03-6.78)**	142	1.52 (0.92 – 2.50)	3.92 (0.77-19.82)
3	University of Glasgow	350	0.96 (0.62 – 1.47)	0.51 (0.18-1.39)	169	1.40 (0.88 – 2.23)	1.11 (0.20-6.09)
4	Swansea University	15	**0.28 (0.08 – 0.96)**	**0.90 (0.83-0.97)**	0	- -	- -
5	The University of Edinburgh	365	**1.76 (1.13 – 2.74)**	2.01 (0.81-5.00)	190	1.40 (0.89 – 2.19)	0.56 (0.19-1.62)
6	University of Dundee	215	**0.56 (0.35 – 0.89)**	0.73 (0.26-2.05)	105	0.95 (0.57 – 1.58)	0.42 (0.14-1.32)
7	Imperial College London	815	**2.05 (1.36 – 3.08)**	1.26 (0.58-2.75)	415	1.06 (0.73 – 1.52)	1.22 (0.47-3.20)
8	Queen Mary University of London	475	**0.44 (0.29 – 0.67)**	0.45 (0.19-1.04)	210	**0.41 (0.28 – 0.61)**	0.38 (0.14-1.01)
9	Keele University	110	- -	- -	70	1.13 (0.61 – 2.09)	0.61 (0.17-2.17)
10	University of Exeter	70	**0.52 (0.28 – 0.95)**	0.38 (0.13-1.07)	35	1.32 (0.57 – 3.08)	2.24 (0.25-20.12)
11	University of Aberdeen	230	0.68 (0.43 – 1.07)	0.39 (0.12-1.29)	105	0.94 (0.57 – 1.56)	0.28 (0.04-2.23)
12	University of Bristol	355	**1.58 (1.02 – 2.46)**	0.66 (0.28-1.52)	170	1.27 (0.80 – 2.01)	0.83 (0.24-2.86)
13	University College London	575	**1.53 (1.02 – 2.33)**	1.25 (0.55-2.82)	275	0.84 (0.57 – 1.24)	1.11 (0.37-3.31)
14	Newcastle University	390	0.81 (0.53 – 1.24)	0.59 (0.26-1.32)	200	1.01 (0.66 – 1.54)	1.44 (0.50-4.17)
15	Cardiff University	390	1.10 (0.72 – 1.69)	0.79 (0.35-1.78)	180	1.13 (0.72 – 1.75)	1.34 (0.44-4.14)
16	King's College London	665	0.94 (0.62 – 1.41)	0.63 (0.29-1.38)	305	0.97 (0.66 – 1.42)	1.31 (0.45-3.84)
17	The University of Sheffield	285	**0.62 (0.40 – 0.97)**	0.82 (0.34-2.00)	145	0.74 (0.47 – 1.16)	0.43 (0.15-1.30)
18	University of Leeds	275	0.84 (0.54 – 1.32)	0.67 (0.28-1.64)	130	**2.01 (1.17 – 3.47)**	2.63 (0.51-13.58)
19	University of Plymouth	70	**0.50 (0.27 – 0.92)**	0.63 (0.23-1.70)	35	**0.45 (0.22 – 0.93)**	0.39 (0.10-1.50)
20	University of East Anglia	110	**0.37 (0.22 – 0.64)**	0.44 (0.17-1.14)	45	0.57 (0.29 – 1.11)	1.54 (0.27-8.73)
21	Brighton and Sussex Medical School	90	0.65 (0.37 – 1.13)	1.10 (0.35-3.44)	45	0.94 (0.46 – 1.92)	0.35 (0.08-1.57)
22	Queen's University Belfast	245	0.84 (0.53 – 1.32)	0.49 (0.21-1.15)	115	0.88 (0.54 – 1.44)	0.80 (0.25-2.56)
23	University of Nottingham	465	1.44 (0.94 – 2.21)	0.92 (0.41-2.07)	235	1.40 (0.91 – 2.13)	2.03 (0.63-6.54)
24	The University of Manchester	580	0.72 (0.47 – 1.08)	0.58 (0.26-1.28)	275	0.96 (0.65 – 1.41)	0.78 (0.29-2.09)
25	Hull York Medical School	85	0.60 (0.34 – 1.06)	0.79 (0.25-2.50)	40	0.92 (0.44 – 1.92)	1.30 (0.11-16.01)
26	University of Birmingham	480	1.26 (0.83 – 1.93)	1.08 (0.48-2.41)	220	- -	- -
27	University of Warwick	160	0.78 (0.48 – 1.27)	2.08 (0.16-27.09)	70	0.66 (0.38 – 1.16)	0.80 (0.69-1.02)
28	University of Leicester	275	1.07 (0.68 – 1.67)	0.80 (0.33-1.94)	130	0.81 (0.51 – 1.30)	0.54 (0.17-1.72)
29	University of Southampton	310	0.81 (0.52 – 1.26)	0.63 (0.27-1.45)	140	0.76 (0.48 – 1.20)	0.56 (0.19-1.61)
30	University of Liverpool	365	**0.60 (0.39 – 0.92)**	0.66 (0.30-1.47)	160	1.02 (0.65 – 1.59)	1.01 (0.35-2.88)
31	St George's University of London	430	0.73 (0.48 – 1.12)	0.73 (0.32-1.62)	200	0.84 (0.55 – 1.27)	0.46 (0.18-1.13)

A significant difference in Part A pass rates between candidates from Russell Group Universities (60.7% (4970/8185)) to Non-Russell Group Universities (49.9% (770/1540)) *P*<0.001 (Table 2). Similarly, a significant difference was seen in Part B of the examination with a pass rate of 71.4% (2790/3910) for Russell Group Universities and 67.5% (495/735) for Non-Russell Group Universities *P*=0.038.

Table 2. MRCS first attempt pass rates by course type and prior degree status.

Predictor	Part A (n= 9730)	Part B (n = 4645)
Russell Group		
Yes	60.7% (4970/8185)	71.4% (2790/3910)
No	49.9% (770/1540)	67.5% (495/735)
Missing	n=0	n=0
p-value	< 0.001	0.038
Course		
Undergraduate	59.3% (5305/8950)	71.0% (3050/4300)
Graduate-Entry	54.6% (405/745)	69.3% (230/335)
Missing	n=35	n=10
p-value	0.012	0.533
Undergraduate Course Classification		
Standard-Entry Medicine	60.0% (5255/8755)	71.1% (3010/4230)
Medicine with Gateway Year	28.1% (55/190)	60.9% (40/70)
Missing	n=0	n=0
p-value	< 0.001	0.081
Prior Degree Status on Undergraduate Courses		
Not Graduate on entry	60.2% (4945/8220)	71.5% (2830/3960)
Graduate on entry	49.5% (360/730)	65.0% (220/335)
Missing	n=0	n=0
p-value	< 0.001	0.015
Graduate Student Outcomes		
Graduate on Standard-Entry Course	49.5% (360/730)	65.0% (220/335)
Graduate on Graduate-Entry Course	54.6% (405/745)	69.3% (230/335)
Missing	n=0	n=0
p-value	0.054	0.251
Teaching Methodology		
Not Problem Based Learning	63.1% (4560/7225)	72.2% (2505/3465)
Problem Based Learning	47.0% (1175/2500)	66.6% (785/1180)
Missing	n=0	n=0
p-value	< 0.001	< 0.001

Note. All p-values presented are from chi-squared analysis. MRCS, Membership of the Royal College of Surgeons.

Course Type

Univariate analysis of pass rates by course type is displayed in Table 2. The majority of all MRCS Part A candidates had studied a Standard-Entry Medicine (SEM) course (8950/9730): only 745 candidates had graduated from a Graduate-Entry Medicine (GEM) course. There was a significant difference between Part A pass rates of SEM (59.3%) and GEM graduates (54.6%) *P*=0.012. Of the 335 graduates who attempted Part B, 69.3% passed first time, and there was no statistically significant difference in MRCS Part B pass rates between SEM and GEM candidates (*P*=0.533).

A small proportion of the trainees attempting MRCS Part A who had studied a SEM course (n=8950) entered medicine as graduates (n=730). There was a significant difference in MRCS Part A success between those entering without a prior degree 60.2% (4945/8220) and graduates 49.5% (360/730) from SEM courses, *P*<0.001. Similar results were found for MRCS Part B (71.5% (2830/3960) versus 65% (220/335) respectively *P*<0.001).

Table 2 shows that of all candidates who attended a SEM, 190 entered their course via a 'Gateway year'. A statistically significant difference was seen in MRCS Part A pass rates between students who undertook a Gateway year (28.1%) and those who entered directly into a Standard-entry course (60.0%) *P*<0.001. There was a difference in MRCS Part B pass rates between Gateway students (60.9% (40/70)) and direct-entry students (71.1% (3010/4230)) but this was not statistically significant (*P*=0.081).

Of all graduates from SEM courses, 49.5% passed Part A first time compared to 54.6% of graduates from GEM courses (*P*=0.054). Similarly, 65% of SEM graduates passed Part B first time compared to 69.3% of GEM graduates (*P*=0.251).

Course pedagogy

A significant difference was observed in MRCS Part A first attempt pass rates between candidates who studied on a course described as PBL and those who studied at medical schools with other core pedagogies (47.0% (1175/2505) versus 63.1% (4560/7225) *P*<0.001 (Table 2)). A similar difference was observed in Part B of the MRCS (PBL: 66.6% (785/1180) and non-PBL: 72.2% (2505/3465) *P*<0.001).

A comparison of MRCS pass rates between GEM courses can also be found in Table 3. A significant difference in pass rates between GEM schools for MRCS Part A (*P*=0.028) but not for MRCS Part B (*P*=0.072) was seen. Drilling down further highlights that the aggregate data disguises variation. For example, graduates of KCL's GEM programmes performed above average (e.g., 76.7% Part A and 81.0% Part B pass rates; Kings College London, Table 3) but the MRCS performance of candidates from their undergraduate programme was lower than average (57% Part A (Figure 1) and 70.5% Part B (Figure 2)).

Table 3. MRCS first attempt pass rates by Graduate-Entry Medicine course.

	Part A			Part B		
Medical School	**Total Number of Candidates (n=745)**	**Pass rate (n=405)**	**95% C.I.**	**Total Number of Candidates (n=335)**	**Pass rate (n=230)**	**95% C.I.**
The University of Oxford	5	100.0%	(100.0 – 100.0)	5	100.0%	(100.0 – 100.0)
The University of Cambridge	25	80.0%	(63.1 – 96.9)	10	40.0%	(0.31 – 76.9)
The University of Swansea	15	28.6%	(1.5 – 55.6)	0	-	-
Imperial College London	25	51.9%	(31.7 – 72.0)	10	60.0%	(23.1 – 96.9)
Queen Mary University of London	75	51.3%	(39.8 – 62.8)	35	58.8%	(41.4 – 76.3)
The University of Bristol	25	60.9%	(39.3 – 82.4)	10	72.7%	(41.3 – 100.0)
University of Newcastle-upon-Tyne	35	63.6%	(46.3 – 81.0)	20	85.7%	(69.4 – 100.0)
Cardiff University	50	51.0%	(36.8 – 65.2)	20	84.2%	(66.2 – 100.0)
King's College London	30	76.7%	(60.6 – 92.7)	20	81.0%	(62.6 – 99.3)
University of Nottingham	95	56.3%	(46.1 – 66.4)	45	59.6%	(45.0 – 74.1)
The University of Birmingham	30	50.0%	(31.0 – 69.0)	15	88.2%	(71.2 – 100.0)
The University of Warwick	160	52.5%	(44.7 – 60.2)	70	62.0%	(50.4 – 73.5)
The University of Leicester	40	47.6%	(31.9 – 63.4)	15	78.6%	(54.0 – 100.0)
The University of Southampton	25	52.0%	(31.0 – 73.0)	10	77.8%	(43.9 – 100.0)
The University of Liverpool	20	45.0%	(21.1 – 68.9)	15	84.6%	(61.9 – 100.0)
St George's Medical School London	85	50.0%	(39.2 – 60.8)	35	66.7%	(49.7 – 83.6)

Note: All values presented from Chi-squared analysis; Part A 27.12 P=0.028 and Part B 23.59 P=0.72. MRCS, Membership of the Royal College of Surgeons. C.I., Confidence Intervals to 95%.

Sociodemographic Factors

Pass rates for MRCS Parts A and B by graduate on entry to medicine status, gender and ethnicity are shown in Table 4. Non-graduates, males and individuals of white ethnicity had significantly higher pass rates for MRCS Parts A and B compared to their graduate, female and non-white ethnicity counterparts.

Table 4. MRCS first attempt pass rates by gender, ethnicity and graduation status for UK medical graduates.

Predictor	Part A (n= 9730)	Part B (n = 4645)
Graduate on entry to medicine		
No	60.2% (4945/8220)	71.5% (2830/3960)
Yes	52.4% (790/1510)	66.8% (455/685)
Missing	n=0	n=0
p-value	< 0.001	0.014
Gender		
Male	62.5% (3865/6185)	72.1% (2185/3030)
Female	52.8% (1870/3545)	68.3% (1100/1615)
Missing	n=0	n=0
p-value	< 0.001	0.007
Ethnicity		
White	63.7% (3580/5615)	76.6% (2130/2780)
Non-white	52.3% (2055/3930)	62.5% (1120/1790)
Missing	n=180	n=75
p-value	< 0.001	< 0.001

Note. All p-values presented are from chi-squared analysis. MRCS, Membership of the Royal College of Surgeons.

Multivariate analysis

The multinomial logistic regression models showing independent predictors of success at MRCS Part A and MRCS Part B can be found in Table 5. After adjusting for prior academic attainment, white candidates, men and those who studied medicine without a prior degree-level qualification were all significantly more likely to pass MRCS Part A at first attempt (P<0.05). After adjusting for prior attainment, white ethnicity remains a statistically significant predictor of Part B success (P<0.05), although gender and graduate status were not independent predictors of Part B success.

Candidates who attended a non-PBL medical school were found to be 53% (OR 1.53 (95% CI 1.25 to 1.87)) more likely to pass Part A and 54% (OR 1.54 (95% CI 1.05 to 2.25)) more likely to pass Part B at first attempt after adjusting for prior academic performance, compared to those who attended a PBL school. Candidates attending a SEM course were nearly four times more likely to pass Part A at first attempt (OR 3.72 (95% CI 2.69 to 5.15)) and 67% more likely to pass Part B (OR 1.67 (95% CI 1.02 to 2.76)) when compared to those entering SEM via a Gateway Year. After adjusting for prior attainment, SEM candidates were more than twice as likely to pass Part A (OR 2.34 (95% CI 1.21 to 4.52)) but attending an SEM course was not found to be a statistically significant predictor of Part B success.

Candidates that attended a Russell Group university, were 79% more likely to pass Part A (OR 1.79 (95% CI 1.56 to 2.05)) and 24% more likely to pass Part B (OR 1.24 (95% CI 1.03 to 1.49)). However, after adjusting for prior academic attainment, attending a Russell Group university was found to predict success at MRCS Part B (OR 1.81 (95% CI 1.17 to 2.80)) but not Part A.

Table 5. Predictors of pass at first attempt at MRCS Part A (n=5735) and Part B (n=3285) for UK medical graduates. Odds ratios (95% Confidence Interval) given prior to and after adjustment for prior academic attainment.

	Part A		Part B	
Predictor	**Unadjusted OR (95% CI)**	**Adjusted OR (95% CI)**	**Unadjusted OR (95% CI)**	**Adjusted OR (95% CI)**
Graduate on entry into medicine Non-Graduates vs. Graduates	1.40 (1.19-1.64)	2.86 (1.00-8.16)	1.66 (1.24-2.24)	2.08 (0.74-5.88)
Gender Males vs. Females	1.66 (1.48-1.88)	1.62 (1.34-1.95)	1.25 (1.09-1.44)	1.23 (0.86-1.77)
Ethnicity White vs. Non-White	1.65 (1.46-1.87)	1.40 (1.17-1.68)	2.06 (1.80-2.36)	2.07 (1.46-2.93)
Russell Group Russel Group vs. Non-Russell Group	1.79 (1.56-2.05)	1.14 (0.88-1.48)	1.24 (1.03-1.49)	1.81 (1.17-2.80)
Undergraduate Course Type Standard-Entry vs. Gateway Year	3.72 (2.69-5.15)	2.34 (1.21-4.52)	1.67 (1.02-2.76)	2.53 (0.89-7.17)
Teaching Methodology Not PBL vs. PBL	1.99 (1.74-2.27)	1.53 (1.25-1.87)	1.49 (1.27-1.75)	1.54 (1.05-2.25)

MRCS, Membership of the Royal College of Surgeons; CI, Confidence Interval. OR, Odds Ratio. *P*=0.034 for interaction between Ethnicity and Gender, *P*=0.001 for Ethnicity and Teaching Methodology, *P*=0.001 for PBL and Russell group classification in unadjusted Part A regression model and *P*=0.031 for Graduate status and Russell group classification in adjusted Part A model. **P*=0.022 for interaction between Graduate Status and Teaching Methodology in unadjusted Part B regression model.

DISCUSSION

Success at the MRCS is a prerequisite for entry into higher UK surgical training and predicts future success in a surgical career.(14–16) This study, the first to examine the variation in pass rates for the MRCS examination across UK medical schools, identified significant differences in pass rates for both MRCS Part A and Part B across schools, course type and pedagogy.

Our most important finding is the lack of statistically significant difference in MRCS success between medical schools after adjusting for prior academic attainment. This indicates that prior attainment is a significant contributory factor to postgraduate performance between different schools. Prior academic performance has also been found to predict later success in other high-stakes postgraduate examinations such as the MRCP and the United States Medical Licensing Examination (USMLE).(50–52) In other words, differences in postgraduate exam performance are related to individual factors not medical school ones. However, even after adjusting for prior academic attainment and, by extension, the selection of the highest achieving applicants (see later), both Oxford and Cambridge universities performed significantly better than other academic institutions. This suggests that the training and education offered by these schools does add value to the likelihood of their student's later success, over and above the individual's innate academic ability.

Institutional prestige is a known pull-factor for medical school applicants.(20,30,31) Yet, with the exceptions of Oxford and Cambridge, we found little association between MRCS pass rates and medical school rankings. This is perhaps unsurprising given that rankings are based on amalgamated scores,(41) several of which are not relevant to vocational medical degrees with their high retention and employability rates. Indeed, earlier studies indicated that staff to student ratio and student feedback seem to have no effect on performance in medical graduates.(11,13) In contrast, Russell Group (research-intensive/focused universities) medical graduates were far more likely to pass MRCS at first attempt.

The relationship between research-intensity/focus and MRCS outcomes is unclear. However, it is likely that higher entry requirements at selection play a role in these attainment differences (53,54) given the strong message from our findings and those of the wider literature that prior academic performance is the strongest predictor of future success.(50,53,55,56) Indeed, we would suggest that educational institutions that are self-selecting as an elite group have a self-interest in selecting the very best applicants who will continue to perform at a high level after graduating in order to perpetuate their status as the leading schools.

As per McManus et al.'s (2020) MedDifs paper,(11) we found that pedagogic differences (PBL versus non-PBL) are related to variation in outcome measures on postgraduate examinations. Graduates from PBL courses perform less well on MRCS A and B. Other literature hints at possible reasons for this. PBL graduates have reported less surgical teaching than is offered at other medical schools.(11) PBL courses have also been criticised for reduced basic science content,(57) and this may be a contributing factor in the performance of PBL students at Part A of the MRCS, given that paper 1 (of 2) is dedicated to applied basic sciences.

Gateway courses provide a pathway to medicine for students from more diverse sociodemographic and academic backgrounds.(58,59) Students from Gateway courses perform less well on assessments during medical school,(58,60) at Foundation Programme Selection (61) and the MRCS. However, there are two points to note. Whilst increasing the diversity of the medical workforce is high on the workforce planning agenda,(62) the actual number of Gateway programme graduates in our analysis was small (n=190). This suggests that surgery is not a common career pathway for these students. Why this is the case may be due to high competition for surgical training posts, the need for more support at medical school and in the post-graduate environment to enable these individuals to achieve their full potential, and/or a greater preference to choose a medical career which enables them to give back to under-served communities.(63-65) Future research is required to examine this further.

Despite graduate performance being comparable to undergraduate performance throughout medical school (34,66) and on graduation,(60) there remains a significant attainment difference between these groups at a post-graduate level.(14,67,68) Our analysis suggests that this is not due to course type (GEM or SEM) and the reasons for these attainment differences remain unclear. Further work is required to ascertain whether graduates are disadvantaged in postgraduate training due to other factors, such as increased commitments on their time (e.g. family, dependants and financial obligations) (68) or whether this is a reflection of lower prior academic achievement.(54,69)

Group differences by gender and ethnicity reflect those seen in previous studies.(14,70) These attainment differences have also been identified in other high-stakes medical examinations, including FRCS, MRCP, MRCPsych and the USMLE.(14,35,71–75) The reasons for these attainment gaps are unclear but are likely to be complex and multifaceted. Other studies have identified inherently biased questions; examiner bias in clinical examinations and true group differences as causes of variation in performance.(70–72,75) Further investigation using differential item analysis would identify whether biased questioning explains some of these group-level performance differences.(76)

These findings are relevant to medical school selection. In the UK, the first and major hurdle to entry into medicine is achieving high grades on high-school exit examinations (such as A-Levels or Highers). This is usually coupled with an aptitude test and, if an applicant reaches the required standard on these measures, an interview to assess non-cognitive (personal) qualities.(77) There has been much debate in the selection literature as to the weight which should be placed on each of these selection components.(78) Our data suggest that if a medical school wants to graduate doctors who are good at passing post-graduate exams, then prior academic attainment should be heavily weighted at the point of selection. However, if their mission is to graduate doctors who will, for example, meet social accountability mandates, then a more holistic assessment may be required.(79) Moreover, there are other factors potentially influencing postgraduate success which we could not take into account: group factors (e.g. factors related to the demographics of the student group);(80) individual career preferences (13) and prior schooling;(81) mentorship and research opportunities (82) and a student's overall experience of a specialty.(8) We are unlikely to ever characterise all variables that contribute to postgraduate success but this study goes some way to identifying key patterns.

Strengths and Limitations

The UKMED dataset enabled a large-scale, multi-cohort analysis of medical school differences, course type and sociodemographic factors on MRCS first attempt outcomes. The dataset had very little missing data enabling detailed and accurate analyses. We used candidate first attempt scores despite candidates being able to take multiple attempts at both parts of the MRCS, as first attempt on post-graduate examinations has been shown to be the best predictor of future performance (37) and this outcome has been used in previous studies looking at factors which predict performance in the MRCS.(14) Larger cohort sizes would enable a more detailed analysis of self-declared ethnicity data avoiding the binary categorisation required to ensure maximum statistical power in this study.(83) Courses change over time and as such results and attainment differences may also have changed throughout the study period: future studies may wish to use a time-series analysis to look at this.(78)

CONCLUSION

There are significant differences in MRCS performance between UK medical school course types and pedagogy. However, variation in MRCS pass rates between medical schools is largely due to the innate academic ability of individuals, rather than medical school factors. This study also highlights group level attainment differences that transcend training location and stage, warranting further investigation to ensure equity within medical training.

ABBREVIATIONS

FRCS: Fellowship of the Royal College of Surgeons Examinations

GEM: Graduate-Entry Medicine Course

GMC: General Medical Council

HESA: Higher Education Statistics Agency

MRCOG: Membership of the Royal College of Obstetricians and Gynaecologists

MRCP: Membership of the Royal College of Physicians

MRCPsych: Membership of the Royal College of Psychiatrists

MRCGP: Membership of the Royal College of General Practitioners

MRCS: Intercollegiate Membership of the Royal College of Surgeons Examinations

PBL: Problem Based Learning

SEM: Standard-Entry Medicine Course

UKMED: United Kingdom Medical Education Database

USMLE: United States Medical Licensing Examinations

ACKNOWLEDGEMENTS

The authors would like to acknowledge Iain Targett at the Royal College of Surgeons of England, for his help with data collection and Gregory Ayre from the Intercollegiate Committee for Basic Surgical Examinations for their support during this project. Our thanks to members of the UKMED Research Group who provided useful feedback on an earlier version of this manuscript, and whose comments were helpful in refining the paper. The authors would also like to acknowledge Daniel Smith for his help with the UKMED database. Data Source: UK Medical Education Database ("UKMED"). UKMEDP043 extract generated on 25/07/2018. We are grateful to UKMED for the use of these data. However, UKMED bears no responsibility for their analysis or interpretation the data includes information derived from that collected by the Higher Education Statistics Agency Limited ("HESA") and provided to the GMC ("HESA Data"). Source: HESA Student Records 2002/2003 to 2015/2016. Copyright Higher Education Statistics Agency Limited. The Higher Education Statistics Agency Limited makes no warranty as to the accuracy of the HESA Data, cannot accept responsibility for any inferences or conclusions derived by third parties from data or other Information supplied by it.

FUNDING

Royal College of Surgeons of England, Royal College of Surgeons of Edinburgh, Royal College of Surgeons of Ireland and Royal College of Physicians and Surgeons of Glasgow (grant number: not applicable).

COMPETING INTERESTS

No competing interests to declare.

ETHICS

No formal ethical approval was required for this study of existing UKMED data. UKMED has received ethics exemption for projects using exclusively UKMED data from Queen Marys University of London Ethics of Research Committee on behalf of all UK medical schools (https://www.ukmed.ac.uk/documents/UKMED_research_projects_ethics_exemption.pdf). The Intercollegiate Committee for Basic Surgical Examinations (ICBSE) and its Internal Quality Assurance Subcommittee, which monitors standards and quality, approved this study.

DATA AVAILABILITY

All data analysed in this study is stored in the UK Medical Education Database (https://www.ukmed.ac.uk).

AUTHOR CONTRIBUTIONS

RE wrote the first draft of the manuscript. RE performed statistical analyses with AL's supervision. All authors reviewed and edited the manuscript. JC led the study proposal for access to UKMED data. All authors approved final draft of the manuscript.

REFERENCES

1. Devine OP, Harborne AC, Horsfall HL, et al. The Analysis of Teaching of Medical Schools (AToMS) survey: an analysis of 47,258 timetabled teaching events in 25 UK medical schools relating to timing, duration, teaching formats, teaching content, and problem-based learning. *BMC Med* 2020 May 14;18(1):126.

2. Devine OP, Harborne AC, McManus IC. Assessment at UK medical schools varies substantially in volume, type and intensity and correlates with postgraduate attainment. *BMC Med Educ* 2015 Sep 11;15(1):146.

3. Taylor CA, Gurnell M, Melville CR, et al. Variation in passing standards for graduation-level knowledge items at UK medical schools. *Med Educ* 2017;51(6):612–20.

4. General Medical Council: Be prepared: are new doctors safe to practise? Manchester: General Medical Council. [Internet]. 2014. Available from: (Available at https://www.gmc-uk.org/Be_prepared___are_new_doctors_safe_to_practise_Oct_2014.pdf_58044232.pdf); 2014.)

5. Twigg V, Aldridge K, McNally S, et al. Does choice of medical school affect a student's likelihood of becoming a surgeon? *Bull R Coll Surg Engl* 2018 Mar 1;100(2):90–5.

6. Alberti H, Randles HL, Harding A, et al. Exposure of undergraduates to authentic GP teaching and subsequent entry to GP training: a quantitative study of UK medical schools. *Br J Gen Pract* 2017 Apr 1;67(657):e248–52.

7. Cleland JA, Johnston PW, Anthony M, et al. A survey of factors influencing career preference in new-entrant and exiting medical students from four UK medical schools. *BMC Med Educ* 2014 Jul 23;14(1):151.

8. Goldacre MJ, Turner G, Lambert TW. Variation by medical school in career choices of UK graduates of 1999 and 2000. *Med Educ* 2004;38(3):249–58.

9. Bowhay AR, Watmough SD. An evaluation of the performance in the UK Royal College of Anaesthetists primary examination by UK medical school and gender. *BMC Med Educ* 2009 Jun 29;9(1):38.

10. Rushd S, Landau AB, Khan JA, et al. An analysis of the performance of UK medical graduates in the MRCOG Part 1 and Part 2 written examinations. *Postgrad Med J* 2012 May 1;88(1039):249–54.

11. McManus IC, Harborne AC, Horsfall HL, et al. Exploring UK medical school differences: the MedDifs study of selection, teaching, student and F1 perceptions, postgraduate outcomes and fitness to practise. *BMC Med* 2020 May 14;18(1):136.

12. McManus IC, Wakeford R. PLAB and UK graduates' performance on MRCP(UK) and MRCGP examinations: data linkage study. *BMJ* 2014 Apr 17;348:g2621.

13. McManus I, Elder AT, de Champlain A, et al. Graduates of different UK medical schools show substantial differences in performance on MRCP(UK) Part 1, Part 2 and PACES examinations. *BMC Med* 2008 Feb 14;6(1):5.

14. Scrimgeour DSG, Cleland J, Lee AJ, et al. Prediction of success at UK Specialty Board Examinations using the mandatory postgraduate UK surgical examination. *BJS Open* 2019 Dec;3(6):865–71.

15. Scrimgeour D, Brennan P, Griffiths G, et al. Does the Intercollegiate Membership of the Royal College of Surgeons (MRCS) examination predict 'on-the-job' performance during UK higher specialty surgical training? *Ann R Coll Surg Engl* 2018 Nov;100(8):669–75.

16. Scrimgeour DSG, Cleland J, Lee AJ, et al. Impact of performance in a mandatory postgraduate surgical examination on selection into specialty training: Performance in a postgraduate surgical examination and selection into specialty training. *BJS Open* 2017 Oct;1(3):67–74.

17. Lee MJ, Drake TM, Malik TAM, et al. Has the Bachelor of Surgery Left Medical School?—A National Undergraduate Assessment. *J Surg Educ* 2016 Jul 1;73(4):655–9.

18. Cleland J, Johnston PW, French FH, et al. Associations between medical school and career preferences in Year 1 medical students in Scotland. *Med Educ* 2012 May;46(5):473–84.

19. Goldacre MJ, Laxton L, Harrison EM, et al. Early career choices and successful career progression in surgery in the UK: prospective cohort studies. *BMC Surg* 2010 Nov 2;10(1):32.

20. Twigg V, McNally S, Eardley I. What are the differences between medical schools that graduate more aspiring surgeons than others? *Bull R Coll Surg Engl* 2020 Feb;102(2):e009.

21. Adams T, Garden A. What influences medical school choice? *Med Teach* 2006 Feb;28(1):83–5.

22. Scanlan GM, Cleland J, Johnston P, et al. What factors are critical to attracting NHS foundation doctors into specialty or core training? A discrete choice experiment. *BMJ Open* 2018 Mar 1;8(3):e019911.

23. Kumwenda B, Cleland JA, Prescott GJ, et al. Relationship between sociodemographic factors and selection into UK postgraduate medical training programmes: a national cohort study. *BMJ Open* 2018 Jun;8(6):e021329.

24. Scanlan G, Johnston P, Walker K, et al. Today's doctors: What do men and women value in a training post? *Med Educ* 2020;54(5):408–18.

25. Cariaga-Lo LD, Richards BF, Hollingsworth MA, et al. Non-cognitive characteristics of medical students: entry to problem-based and lecture-based curricula. *Med Educ* 1996 May;30(3):179–86.

26. Holen A, Manandhar K, Pant DS, et al. Medical students' preferences for problem-based learning in relation to culture and personality: a multicultural study. *Int J Med Educ* 2015 Jul 19;6:84–92.

27. Bigsby E, McManus IC, Sedgwick P, et al. Which medical students enjoy problem-based learning? *Educ Med J* 2013 Mar 1 [cited 2020 Sep 10];5(1). Available from: http://www.eduimed.com/index.php/eimj/article/view/28

28. Carter YH, Peile E. Graduate entry medicine: high aspirations at birth. *Clin Med Lond Engl* 2007 Apr;7(2):143–7.

29. Broecke S. University rankings: do they matter in the UK? *Educ Econ* 2015 Mar 4;23(2):137–61.

30. McManus IC, Winder BC, Sproston KA, et al. Why do medical school applicants apply to particular schools? *Med Educ* 1993;27(2):116–23.

31. Brown C. A qualitative study of medical school choice in the UK. *Med Teach* 2007 Jan 1;29(1):27–32.

32. Woolf K, Cave J, Greenhalgh T, et al. Ethnic stereotypes and the underachievement of UK medical students from ethnic minorities: qualitative study. *BMJ* 2008 Aug 18;337:a1220

33. Richens D, Graham TR, James J, et al. Racial and Gender Influences on Pass Rates for the UK and Ireland Specialty Board Examinations. *J Surg Educ* 2016 Jan 1;73(1):143–50.

34. Puddey IB, Mercer A, Carr SE. Relative progress and academic performance of graduate vs undergraduate entrants to an Australian medical school. *BMC Med Educ* 2019 May 22;19(1):159.

35. Tiffin PA, Paton LW. Differential attainment in the MRCPsych according to ethnicity and place of qualification between 2013 and 2018: a UK cohort study. *Postgrad Med J* 2020 Sep 3;postgradmedj-2020-137913. doi:10.1136/postgradmedj-2020-137913

36. Dowell J, Cleland J, Fitzpatrick S, et al. The UK medical education database (UKMED) what is it? Why and how might you use it? *BMC Med Educ* 2018 Dec;18(1):6.

37. McManus I, Ludka K. Resitting a high-stakes postgraduate medical examination on multiple occasions: nonlinear multilevel modelling of performance in the MRCP(UK) examinations. *BMC Med* 2012 Jun 14;10(1):60.

38. Scrimgeour DSG, Cleland J, Lee AJ, et al. Prediction of success at UK Specialty Board Examinations using the mandatory postgraduate UK surgical examination. *BJS Open* 2019 Sep 30;3(6):865–71.

39. Medical Schools Council. Medicine Course Types [Internet]. 2018 [cited 2021 March 1]. Available from: https://www.medschools.ac.uk/studying-medicine/course-types

40. Kumwenda B, Cleland J, Greatrix R, et al. Are efforts to attract graduate applicants to UK medical schools effective in increasing the participation of under-represented socioeconomic groups? A national cohort study. *BMJ Open* 2018 14;8(2):e018946.

41. Medical School Ranking 2020, The Complete University Guide [Internet]. 2020. [cited 2021 March 1]. Available from: Accessed at https://www.thecompleteuniversityguide.co.uk/

42. Profile of the Russell Group of Universities [Internet]. Russell Group; 2016 [cited 2021 March 1]. Available from: https://russellgroup.ac.uk/policy/publications/profile-of-the-russell-group-of-universities/

43. Boliver V. Are there distinctive clusters of higher and lower status universities in the UK? *Oxf Rev Educ* 2015 Sep 3;41(5):608–27.

44. Coughlan S. Is the Russell Group really an 'oligarchy'? [Internet]. BBC News Education and Family.; 2014 [cited 2021 March 1]. Available from: https://www.bbc.co.uk/news/education-27399512

45. Fazackerley A. Should students be encouraged to set their sights on Russell Group universities? [Internet]. The Guardian; 2013 [cited 2021 March 1]. Available from: https://www.theguardian.com/education/2013/feb/18/russell-group-universities-students-ambitions

46. Lloyd-Jones, Margetson, Bligh. Problem-based learning: a coat of many colours. *Med Educ* 1998;32(5):492–4.

47. Maudsley G. Do we all mean the same thing by 'problem-based learning'? A review of the concepts and a formulation of the ground rules. *Acad Med J Assoc Am Med Coll* 1999 Feb;74(2):178–85.

48. British Medical Association. Course and teaching types at medical school. London, 2017. [cited 2021 March 1]; Available from:

https://www.bma.org.uk/advice/career/studying-medicine/becoming-a-doctor/course-types

49. Rounding and suppression to anonymise statistics | HESA [Internet]. [cited 2021 March 1]. Available from: https://www.hesa.ac.uk/about/regulation/data-protection/rounding-and-suppression-anonymise-statistics

50. McManus I, Woolf K, Dacre J, et al. The Academic Backbone: longitudinal continuities in educational achievement from secondary school and medical school to MRCP(UK) and the specialist register in UK medical students and doctors. *BMC Med* 2013 Dec;11(1):242.

51. Burk-Rafel J, Pulido RW, Elfanagely Y, et al. Institutional differences in USMLE Step 1 and 2 CK performance: Cross-sectional study of 89 US allopathic medical schools. *PLoS One* 2019 Nov 4;14(11):e0224675.

52. Ghaffari-Rafi A, Lee RE, Fang R, et al. Multivariable analysis of factors associated with USMLE scores across U.S. medical schools. *BMC Med Educ* 2019 May 20;19(1):154.

53. McManus I, Dewberry C, Nicholson S, et al. Construct-level predictive validity of educational attainment and intellectual aptitude tests in medical student selection: meta-regression of six UK longitudinal studies. *BMC Med* 2013 Nov 14;11(1):243.

54. Garrud P, McManus IC. Impact of accelerated, graduate-entry medicine courses: a comparison of profile, success, and specialty destination between graduate entrants to accelerated or standard medicine courses in UK. *BMC Med Educ* 2018 Nov 6;18(1):250.

55. McManus IC. A levels and intelligence as predictors of medical careers in UK doctors: 20 year prospective study. *BMJ* 2003 Jul 17;327(7407):139–42.

56. Ferguson E, James D, Madeley L. Factors associated with success in medical school: systematic review of the literature. *BMJ* 2002 Apr 20;324(7343):952–7.

57. Williams G, Lau A. Reform of undergraduate medical teaching in the United Kingdom: a triumph of evangelism over common sense. *BMJ* 2004 Jul 8;329(7457):92–4.

58. Garlick PB, Brown G. Widening participation in medicine. *BMJ* 2008 May 15;336(7653):1111–3.

59. Curtis S, Blundell C, Platz C, et al. Successfully widening access to medicine. Part 2: Curriculum design and student progression. *J R Soc Med* 2014 Oct;107(10):393–7.

60. Mahesan N, Crichton S, Sewell H, et al. The effect of an intercalated BSc on subsequent academic performance. *BMC Med Educ* 2011 Oct 3;11:76.

61. Curtis S, Smith D. A comparison of undergraduate outcomes for students from gateway courses and standard entry medicine courses. *BMC Med Educ* 2020 Jan 3;20(1):4.

62. Widening Participation it Matters! Our strategy and initial action plan [Internet]. Health Education England; 2014 [cited 2021 March 1]. Available from: https://www.hee.nhs.uk/sites/default/files/documents/Widening%20Participation%20it%20Matters_0.pdf

63. Specialty Recruitment Competition Ratios [Internet]. Health Education England; 2019 [cited 2021 March 1]. Available from: https://specialtytraining.hee.nhs.uk/

64. Puddey IB, Playford DE, Mercer A. Impact of medical student origins on the likelihood of ultimately practicing in areas of low vs high socio-economic status. *BMC Med Educ* 2017 Jan 5;17(1):1.

65. Dowell J, Norbury M, Steven K, et al. Widening access to medicine may improve general practitioner recruitment in deprived and rural communities: survey of GP origins and current place of work. *BMC Med Educ* 2015 Oct 1;15(1):165.

66. Manning G, Garrud P. Comparative attainment of 5-year undergraduate and 4-year graduate entry medical students moving into foundation training. *BMC Med Educ* 2009 Dec 22;9(1):76.

67. Reports on the progress of doctors in training split by postgraduate body. General Medical Council. [Internet]. [cited 2021 March 1]. Available from: https://www.gmc-uk.org/education/reports-and-reviews/progression-reports

68. Pyne Y, Ben-Shlomo Y. Older doctors and progression through specialty training in the UK: a cohort analysis of General Medical Council data. *BMJ Open* 2015 Feb 1;5(2):e005658.

69. Garrud P. Who applies and who gets admitted to UK graduate entry medicine? - an analysis of UK admission statistics. *BMC Med Educ* 2011 Sep 26;11(1):71.

70. Scrimgeour DSG, Cleland J, Lee AJ, et al. Which factors predict success in the mandatory UK postgraduate surgical exam: The Intercollegiate Membership of the Royal College of Surgeons (MRCS)? *Surg J R Coll Surg Edinb Irel* 2018 Aug;16(4):220–6.

71. Dewhurst NG, McManus C, Mollon J, et al. Performance in the MRCP(UK) Examination 2003–4: analysis of pass rates of UK graduates in relation to self-declared ethnicity and gender. *BMC Med* 2007 May 3;5:8.

72. Rubright JD, Jodoin M, Barone MA. Examining Demographics, Prior Academic Performance, and United States Medical Licensing Examination Scores. *Acad Med J Assoc Am Med Coll* 2019;94(3):364–70.

73. Cuddy MM, Swanson DB, Clauser BE. A multilevel analysis of examinee gender and USMLE step 1 performance. *Acad Med J Assoc Am Med Coll* 2008 Oct;83(10 Suppl):S58-62.

74. Woolf K, Potts HWW, McManus IC. Ethnicity and academic performance in UK trained doctors and medical students: systematic review and meta-analysis. *BMJ* 2011 Mar 8;342:d901

75. Wakeford R, Denney M, Ludka-Stempien K, et al. Cross-comparison of MRCGP & MRCP(UK) in a database linkage study of 2,284 candidates taking both examinations: assessment of validity and differential performance by ethnicity. *BMC Med Educ* 2015 Jan 16;15(1):1.

76. Hope D, Adamson K, McManus IC, et al. Using differential item functioning to evaluate potential bias in a high stakes postgraduate knowledge based assessment. *BMC Med Educ* 2018 Apr 3;18(1):64.

77. Patterson F, Knight A, Dowell J, et al. How effective are selection methods in medical education? A systematic review. *Med Educ* 2016 Jan;50(1):36–60.

78. Fielding S, Tiffin PA, Greatrix R, et al. Do changing medical admissions practices in the UK impact on who is admitted? An interrupted time series analysis. *BMJ Open* 2018 Oct 1;8(10):e023274.

79. Patterson F, Roberts C, Hanson MD, et al. 2018 Ottawa consensus statement: Selection and recruitment to the healthcare professions. *Med Teach* 2018 Nov;40(11):1091–101.

80. Ferguson E, James D, Yates J, et al. Predicting who applies to study medicine: implication for diversity in UK medical schools. *Med Teach* 2012;34(5):382–91.

81. Kumwenda B, Cleland JA, Walker K, et al. The relationship between school type and academic performance at medical school: a national, multi-cohort study. *BMJ Open* 2017 Aug 1;7(8):e016291.

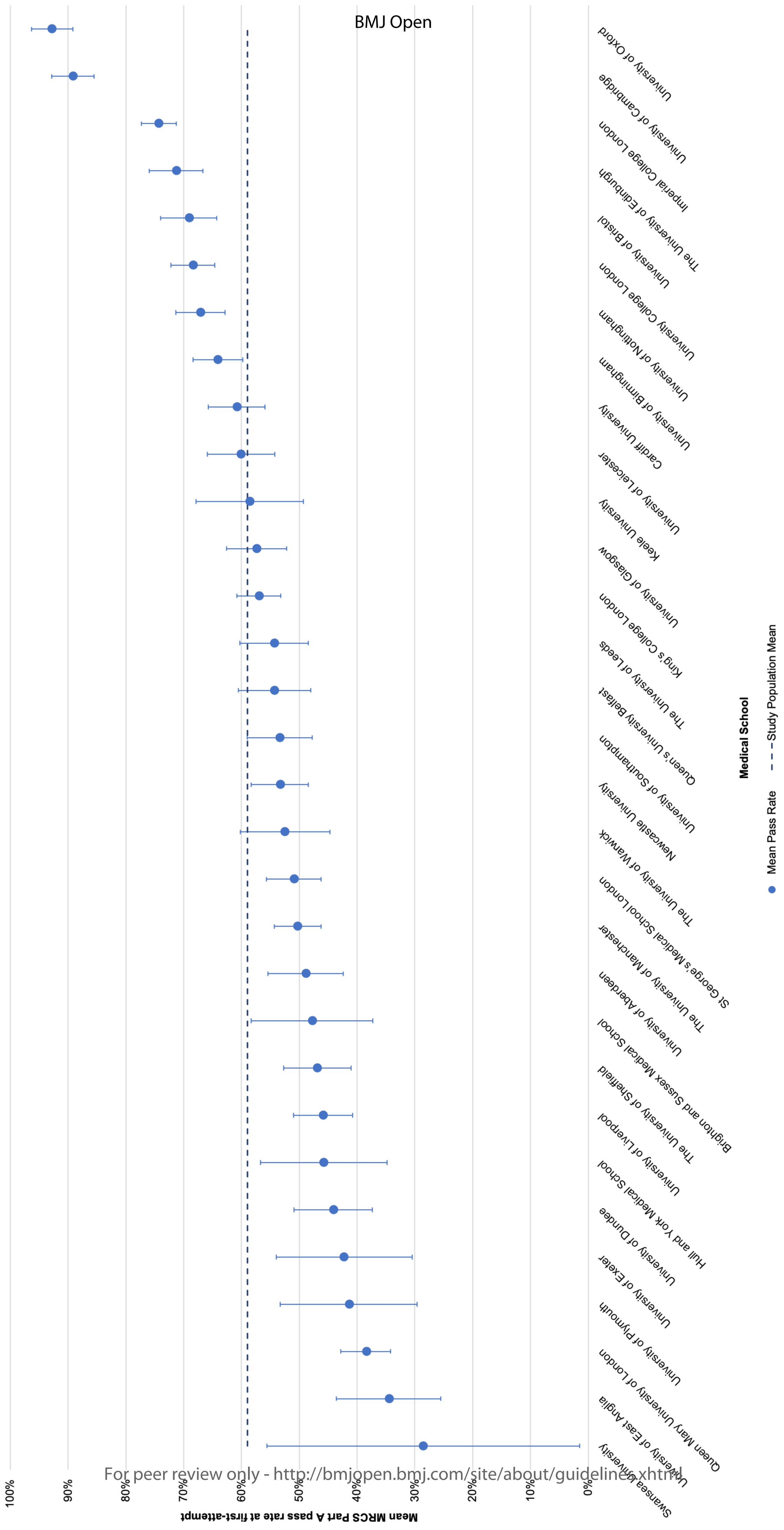
82. Berger AP, Giacalone JC, Barlow P, et al. Choosing surgery as a career: Early results of a longitudinal study of medical students. *Surgery* 2017 Jun 1;161(6):1683–9.

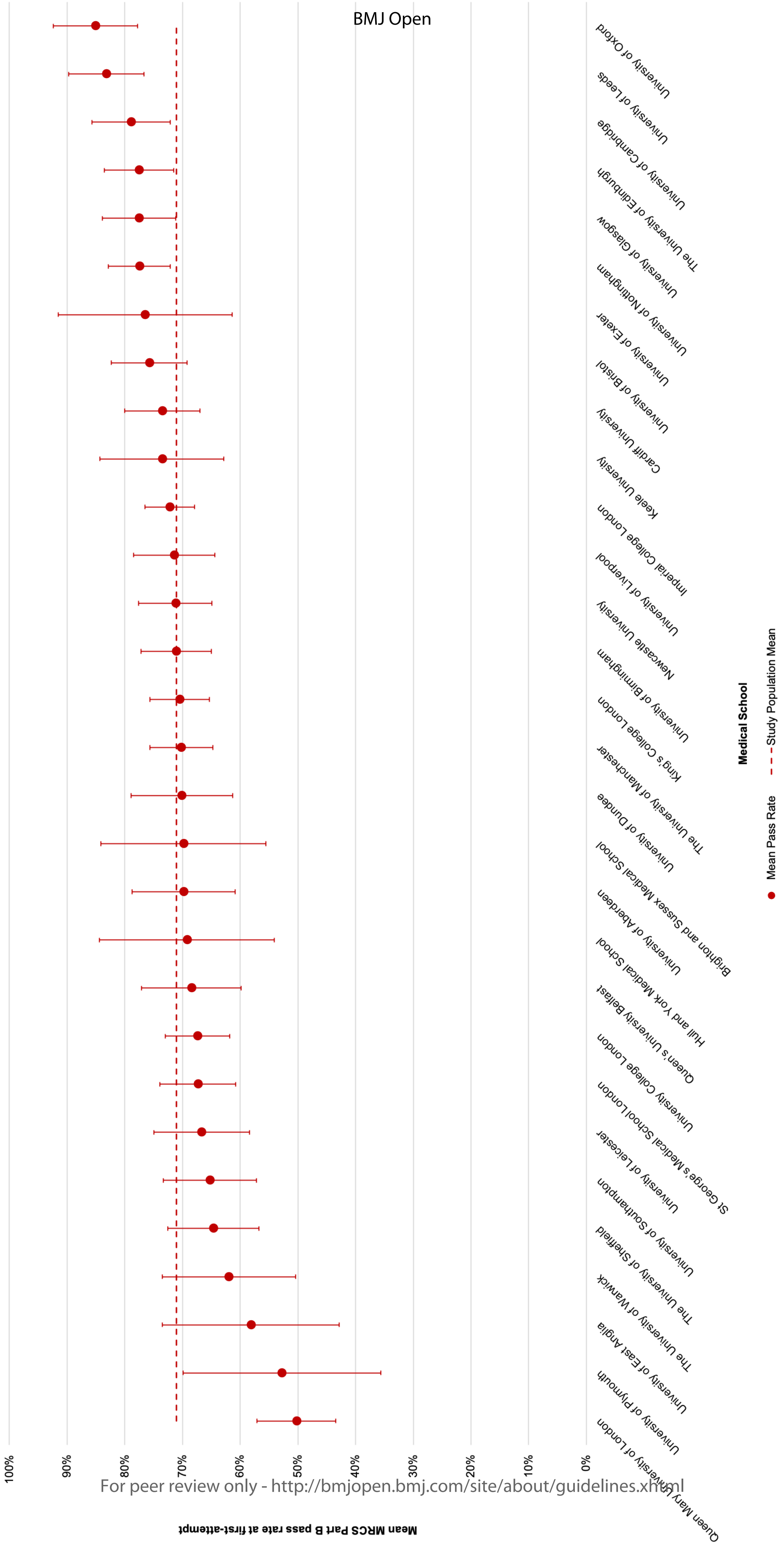
83. Ross PT, Hart-Johnson T, Santen SA, et al. Considerations for using race and ethnicity as quantitative variables in medical education research. *Perspect Med Educ* 2020 Oct;9(5):318–23.

Figure 1. MRCS Part A first attempt pass rates by Medical School with 95% Confidence Interval.

Figure 2. MRCS Part B first attempt pass rates by Medical School with 95% Confidence Interval. Swansea University Part B results excluded due to small cohort (n=2).

Appendix 1. MRCS first attempt pass rates by Medical School, ranked according to the Complete University Guide as of 2020 with corresponding university code. All values presented from Chi-squared analysis; Part A $X^2 = 626.05$ $P<0.001$ and Part B $X^2 = 104.47$ $P<0.001$. MRCS, Membership of the Royal College of Surgeons. C.I., Confidence Intervals to 95%.


Mean MRCS Part A pass rate at first-attempt
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Medical School
Mean Pass Rate
Study Population Mean
University of Oxford
University of Cambridge
Imperial College London
The University of Edinburgh
University of Bristol
University College London
University of Nottingham
University of Birmingham
Cardiff University
University of Leicester
Keele University
University of Glasgow
King's College London
The University of Leeds
Queen's University Belfast
University of Southampton
Newcastle University
The University of Warwick
St George's Medical School London
The University of Manchester
University of Aberdeen
Brighton and Sussex Medical School
The University of Sheffield
University of Liverpool
Hull and York Medical School
University of Dundee
University of Exeter
University of Plymouth
Queen Mary University of London
University of East Anglia
Swansea University


University of Oxford
University of Leeds
University of Cambridge
The University of Edinburgh
University of Glasgow
University of Nottingham
University of Exeter
University of Bristol
Cardiff University
Keele University
Imperial College London
University of Liverpool
Newcastle University
University of Birmingham
King's College London
The University of Manchester
University of Dundee
Brighton and Sussex Medical School
University of Aberdeen
Hull and York Medical School
Queen's University Belfast
University College London
St George's Medical School London
University of Leicester
University of Southampton
The University of Sheffield
The University of Warwick
University of East Anglia
University of Plymouth
Queen Mary University of London
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Mean MRCS Part B pass rate at first-attempt
Medical School
Mean Pass Rate
Study Population Mean

		Part A			Part B		
Rank	**Medical School**	**Total Number of Candidates (n=9730)**	**Pass rate (n=5740)**	**95% C.I.**	**Total Number of Candidates (n=4645)**	**Pass rate (n=3290)**	**95% C.I.**
1	The University of Oxford	210	92.8%	(89.2 – 96.3)	95	85.1%	(77.8 – 92.4)
2	The University of Cambridge	285	89.2%	(85.5 – 92.8)	140	78.9%	(72.1 – 85.7)
3	The University of Glasgow	350	57.4%	(52.2 – 62.6)	170	77.5%	(71.2 – 83.9)
4	The University of Swansea	15	28.6%	(1.5 – 55.6)	0	0%	-
5	The University of Edinburgh	365	71.3%	(66.7 – 76.0)	190	77.5%	(71.5 – 83.5)
6	The University of Dundee	215	44.1%	(37.4 – 50.9)	105	70.1%	(61.3 – 78.9)
7	Imperial College London	815	74.3%	(71.3 – 77.3)	415	72.2%	(67.9 – 76.5)
8	Queen Mary University of London	475	38.4%	(34.1 – 42.8)	210	50.2%	(43.4 – 57.1)
9	The University of Keele	110	58.6%	(49.3 – 67.9)	70	73.5%	(62.8 – 84.3)
10	The University of Exeter	70	42.3%	(30.5 – 54.0)	35	76.5%	(61.4 – 91.5)
11	The University of Aberdeen	230	48.9%	(42.4 – 55.4)	105	69.8%	(60.9 – 78.7)
12	The University of Bristol	355	69.1%	(64.3 – 74.0)	170	75.7%	(69.2 – 82.3)
13	University College London	575	68.4%	(64.6 – 72.2)	275	67.4%	(61.8 – 73.0)
14	University of Newcastle-upon-Tyne	390	53.3%	(48.4 – 58.3)	200	71.2%	(64.9 – 77.6)
15	Cardiff University	390	60.8%	(55.9 – 65.7)	180	73.5%	(67.0 – 80.0)
16	King's College London	665	57.0%	(53.2 – 60.8)	305	70.5%	(65.3 – 75.6)
17	The University of Sheffield	285	46.9%	(41.0 – 52.7)	145	64.6%	(56.7 – 72.5)
18	The University of Leeds	275	54.3%	(48.4 – 60.3)	130	83.2%	(76.7 – 89.7)
19	University of Plymouth	70	41.4%	(29.6 – 53.3)	35	52.8%	(35.6 – 69.9)
20	The University of East Anglia	110	34.5%	(25.5 – 43.6)	45	58.1%	(42.8 – 73.5)
21	Brighton and Sussex Medical School	90	47.8%	(37.3 – 58.3)	45	69.8%	(55.5 – 84.1)
22	The Queen's University of Belfast	245	54.3%	(48.0 – 60.5)	115	68.4%	(59.8 – 77.1)
23	University of Nottingham	465	67.1%	(62.8 – 71.4)	235	77.4%	(72.1 – 82.8)
24	The University of Manchester	580	50.3%	(46.2 – 54.3)	275	70.2%	(64.7 – 75.6)
25	Hull and York Medical School	85	45.8%	(34.8 – 56.7)	40	69.2%	(54.1 – 84.4)
26	The University of Birmingham	480	64.1%	(59.8 – 68.4)	220	71.1%	(65.0 – 77.2)
27	The University of Warwick	160	52.5%	(44.7 – 60.2)	70	62.0%	(50.4 – 73.5)
28	The University of Leicester	275	60.1%	(54.2 – 65.9)	130	66.7%	(58.4 – 74.9)
29	The University of Southampton	305	53.4%	(47.8 – 59.0)	140	65.2%	(57.2 – 73.3)
30	The University of Liverpool	365	45.9%	(40.8 – 51.0)	160	71.4%	(64.4 – 78.5)
31	St George's Medical School London	430	50.9%	(46.2 – 55.7)	200	67.3%	(60.8 – 73.9)

STROBE Statement—Checklist of items that should be included in reports of ***cohort studies***

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract (*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	1-4
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	5-6
Objectives	3	State specific objectives, including any prespecified hypotheses	5-6
Methods			
Study design	4	Present key elements of study design early in the paper	6-11
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6-11
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up (*b*) For matched studies, give matching criteria and number of exposed and unexposed	6-11
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6-11
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	6-11
Bias	9	Describe any efforts to address potential sources of bias	6-11
Study size	10	Explain how the study size was arrived at	6-11
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6-11
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding (*b*) Describe any methods used to examine subgroups and interactions (*c*) Explain how missing data were addressed (*d*) If applicable, explain how loss to follow-up was addressed (*e*) Describe any sensitivity analyses	6-11
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed (b) Give reasons for non-participation at each stage (c) Consider use of a flow diagram	11-20
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders (b) Indicate number of participants with missing data for each variable of interest (c) Summarise follow-up time (eg, average and total amount)	11-20
Outcome data	15*	Report numbers of outcome events or summary measures over time	11-20

Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included (*b*) Report category boundaries when continuous variables were categorized (*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	11-20
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	11-20
Discussion			
Key results	18	Summarise key results with reference to study objectives	21-25
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	21-25
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	21-25
Generalisability	21	Discuss the generalisability (external validity) of the study results	21-25
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	26

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at http://www.strobe-statement.org.

BMJ Open

Performance at Membership of the Royal College of Surgeons (MRCS) Examinations Varies According to UK Medical School and Course Type

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2021-054616.R1
Article Type:	Original research
Date Submitted by the Author:	17-Nov-2021
Complete List of Authors:	Ellis, Ricky; University of Aberdeen Institute of Applied Health Sciences; Nottingham University Hospitals NHS Trust, Urology Department Brennan, Peter ; Queen Alexandra Hospital, Department of Maxillo-Facial Surgery Scrimgeour, Duncan; Aberdeen Royal Infirmary, Department of Colorectal Surgery; University of Aberdeen Institute of Applied Health Sciences Lee, Amanda; University of Aberdeen Institute of Applied Health Sciences, Medical Statistics Team Cleland, Jennifer; Lee Kong Chian School of Medicine, Medical Education Research and Scholarship Unit (MERSU)
Primary Subject Heading:	Medical education and training
Secondary Subject Heading:	Medical education and training, Surgery
Keywords:	MEDICAL EDUCATION & TRAINING, SURGERY, Adult surgery < SURGERY

SCHOLARONE™ Manuscripts

I, the Submitting Author has the right to grant and does grant on behalf of all authors of the Work (as defined in the below author licence), an exclusive licence and/or a non-exclusive licence for contributions from authors who are: i) UK Crown employees; ii) where BMJ has agreed a CC-BY licence shall apply, and/or iii) in accordance with the terms applicable for US Federal Government officers or employees acting as part of their official duties; on a worldwide, perpetual, irrevocable, royalty-free basis to BMJ Publishing Group Ltd ("BMJ") its licensees and where the relevant Journal is co-owned by BMJ to the co-owners of the Journal, to publish the Work in this journal and any other BMJ products and to exploit all rights, as set out in our licence.

The Submitting Author accepts and understands that any supply made under these terms is made by BMJ to the Submitting Author unless you are acting as an employee on behalf of your employer or a postgraduate student of an affiliated institution which is paying any applicable article publishing charge ("APC") for Open Access articles. Where the Submitting Author wishes to make the Work available on an Open Access basis (and intends to pay the relevant APC), the terms of reuse of such Open Access shall be governed by a Creative Commons licence – details of these licences and which Creative Commons licence will apply to this Work are set out in our licence referred to above.

Other than as permitted in any relevant BMJ Author's Self Archiving Policies, I confirm this Work has not been accepted for publication elsewhere, is not being considered for publication elsewhere and does not duplicate material already published. I confirm all authors consent to publication of this Work and authorise the granting of this licence.

Performance at Membership of the Royal College of Surgeons (MRCS) Examinations Varies According to UK Medical School and Course Type

Authors

R Ellis[1,2], PA Brennan[3], DSG Scrimgeour[4], AJ Lee[5], J Cleland[6]

[1]Institute of Applied Health Sciences, University of Aberdeen, and [2]Urology Department, Nottingham University Hospitals NHS Trust, Nottingham and [3]Department of Maxillo-Facial Surgery, Queen Alexandra Hospital, Portsmouth. and [4]Department of Colorectal Surgery, Aberdeen Royal Infirmary, Aberdeen and [5]Medical Statistics Team, Institute of Applied Health Sciences, University of Aberdeen, and [6]Lee Kong Chian School of Medicine, Nanyang Technological University, Singapore.

Correspondence to:

Mr Ricky Ellis

Urology Specialist Registrar and Intercollegiate Research Fellow.

Institute of Applied Health Sciences, University of Aberdeen, Aberdeen, AB25 2ZD.

Rickyellis@nhs.net

@RickJEllis1 07886102573

Co-author details

Professor Peter A Brennan, PhD

Professor of Surgery, Consultant Maxillo-Facial Surgeon and Research Lead for the Intercollegiate Committee for Basic Surgical Examinations

Department of Maxillo-Facial Surgery, Queen Alexandra Hospital, Portsmouth, PO6 3LY, United Kingdom.

Peter.brennan@porthosp.nhs.uk

@BrennanSurgeon

Mr Duncan SG Scrimgeour, PhD

Colorectal Specialist Registrar and Past Intercollegiate Research Fellow

Department of Colorectal Surgery, Aberdeen Royal Infirmary, Aberdeen, AB25 2ZN, United Kingdom.

duncan.scrimgeour@nhs.scot

@dsgscrimgeour

Professor Amanda J Lee, PhD

Chair in Medical Statistics and Director of the Institute of Applied Health Sciences

University of Aberdeen, AB25 2ZD, United Kingdom.

a.j.lee@abdn.ac.uk

Professor Jennifer Cleland, PhD

Professor of Medical Education Research and Vice-Dean of Education

Medical Education Research and Scholarship Unit, Lee Kong Chian School of Medicine, Nanyang Technological University, Singapore.

jennifer.cleland@ntu.edu.sg

Key words:

MRCS, Post-graduate examinations, Medical Education and Training, Pedagogy

Word Count: 5,288

ABSTRACT

Objectives: The knowledge, skills and behaviours required of new UK medical graduates are the same but how these are achieved differs given medical schools vary in their mission, curricula and pedagogy. Medical school differences seem to influence performance on postgraduate assessments. To date, the relationship between medical schools, course types, and performance at the Membership of the Royal College of Surgeons examination (MRCS) has not been investigated. Understanding this relationship is vital to achieving alignment across undergraduate and postgraduate training, learning and assessment values.

Design and Participants: A retrospective longitudinal cohort study of UK medical graduates who attempted MRCS Part A (n=9730) and MRCS Part B (n=4645) between 2007-2017, utilising individual-level linked sociodemographic and prior academic attainment data from the UK Medical Education Database.

Methods: We studied MRCS performance across all UK medical schools and examined relationships between potential predictors and MRCS performance using chi-squared analysis. Multivariate logistic regression models identified independent predictors of MRCS success at first attempt.

Results: MRCS pass rates differed significantly between individual medical schools (P<0.001) but not after adjusting for prior A-Level performance. Candidates from courses other than those described as problem-based learning (PBL) were 53% more likely to pass MRCS Part A (Odds ratio (OR) 1.53 [95% Confidence Interval 1.25-1.87] and 54% more likely to pass Part B (OR 1.54 [1.05-2.25]) at first attempt after adjusting for prior academic performance. Attending a Standard-Entry 5-year medicine programme, having no prior degree and attending a Russell Group university were independent predictors of MRCS success in regression models (P<0.05).

Conclusions: There are significant differences in MRCS performance between medical schools. However, this variation is largely due to individual factors such as academic ability,

rather than medical school factors. This study also highlights group level attainment differences that warrant further investigation to ensure equity within medical training.

Keywords

Medical Education and Training, Surgery, Adult Surgery

Strengths and Limitations of this study

- This is the first study to explore differences in MRCS performance between medical school course types, pedagogy and indicators of institutional esteem.
- It is a large-scale longitudinal cohort study utilising the UK Medical Education Database.
- The outcome measure of pass/fail at the MRCS examination may hide institutional differences in performance at the question level.
- A-Levels were used as a marker of prior academic attainment in this study. This does not represent the full range of school leaving examinations used across the UK.
- A larger sample would enable a more granular look at group-level differential attainment.

BACKGROUND

Medical schools vary significantly in their teaching methodology, curriculum, course structure, assessment methods and standards (1–4). In the United Kingdom (UK), the General Medical Council (GMC) acknowledged that these differences between medical schools exist and that it is “inevitable” that this variation can influence a graduate’s “interests, abilities and career progression” but that it is not a “cause for concern” (5), presumably because all new medical graduates must meet the same GMC standards. This view can be debated given that medical school seems to influence career progression, direction and success. For example, the number of graduates choosing each speciality differs significantly across medical schools (6–8). There is significant variation in preparedness for practice, progression through Annual Reviews of Competency Progression (ARCP) in UK training programmes and fitness to practice sanctions according to the medical school of primary qualification (5,9). There are also significant differences in the performance of graduates from different medical schools on high-stakes postgraduate examinations such as the FRCA (10) MRCOG (11), MRCPCH (12), MRCGP (13,14) and MRCP (14–16) (see abbreviations list). This variation in performance is far from unique to the UK, with significant differences in performance according to medical school also found in postgraduate assessments in other countries such as the United States (US) (17,18). However, to our knowledge, no studies have yet demonstrated whether success at postgraduate surgical examinations differs according to medical school, course type or medical school indicators of esteem (e.g., institutional ranking) in the UK.

Understanding the relationship between medical school, course type and pedagogy with markers of postgraduate success is vital for the optimisation of undergraduate teaching by enabling the alignment of undergraduate and postgraduate curricula and assessment values. This alignment ensures best educational practices and the optimisation of training to produce safe and prepared doctors.

The Membership of the Royal College of Surgeons examination (MRCS) is a high-stakes postgraduate examination, highly valued in the UK as a gatekeeper to the surgical profession (19). Success at MRCS is associated with success in surgical training, national selection for higher specialty training and first attempt success in the Fellowship of the Royal College of Surgeons examinations (FRCS) and can therefore be used as an indicative marker of future outcomes in a surgical career (20–22). Success in this examination can be used by medical schools in the alignment of training and assessment values, and students who wish to pursue surgery as a specialty may want to know which medical school will “best” prepare them for a surgical career (23).

In this study, we aimed to evaluate whether medical school of primary qualification or medical course type influence MRCS success. We aimed to establish this by the comparison of first attempt pass rates for MRCS across all UK medical schools and understanding the likelihood of passing MRCS based on university, course type and course pedagogy. Additionally, we aimed to investigate whether indicators of esteem such as Russell Group membership and institutional national ranking predict MRCS success.

Moreover, in order to understand the true impact of medical school differences on MRCS performance we adjusted analyses for prior academic attainment and sociodemographic factors that are known to predict MRCS success (24,25). Previous studies have found that after adjusting for these demographic factors (gender, maturity and ethnicity), variation in early surgical training experiences in the UK (Foundation and Core Surgical Training) has little impact on MRCS success (26,27). Prior academic attainment is known to be the strongest predictor of later success in medical education (20,28,29), and at MRCS (24,25,30). Given that some universities are more competitive at entry than others (30,31), it is likely that some medical schools recruit the highest performing candidates. As such, both factors are, adjusted for in our analyses.

METHODS

This was a longitudinal retrospective cohort study. Individual-level linked data was obtained from the UK Medical Education Database (UKMED) (32) and the four Royal Colleges of Surgeons of the UK and Ireland (Edinburgh, Glasgow, England and Ireland). The UKMED database contains background sociodemographic details and assessment results from school to postgraduate examinations and career progression data from combined sources linked at an individual level for all UK medical students and doctors in training (32). This novel database enables powerful multicentre longitudinal cohort studies by including large study populations with minimal missing data. Anonymised data were extracted from UKMED for all UK medical graduates who had attempted either the Part A or the Part B MRCS examination between 2007-2017.

The following data were extracted: Place of primary medical qualification, course pedagogy and type, MRCS Part A and B first attempt result, gender, self-declared ethnicity and graduation status at the time of entry to medical school. Gender, ethnicity and graduate status were extracted as these are known predictors of MRCS success (24,25). Candidate first attempt results were used as they have been shown to be the best predictor of future performance in postgraduate examinations (24,33). These variables are described in more detail below.

Except for place of primary qualification, all variables were dichotomized. Part A and B MRCS performance was categorized as "pass" or "fail" at first attempt. Graduation status was defined as "no" if candidates had not obtained a degree prior to entering medicine and "yes" if they entered as a graduate. Self-declared ethnicity was coded as "white" or "non-white" as per similar studies to enable powered analysis of smaller cohorts, rather than this being an ethical or social decision (20,21,34). Course pedagogy was classified as "Problem Based Learning" (PBL) or "Not Problem Based Learning" (nPBL). Course type was classified as “Graduate-Entry” (GEM: four-year accelerated Graduate-Entry medicine programmes) or “Undergraduate” which was later further classified into “Standard-Entry” program (SEM) or “Medicine with a Gateway Year” (five years plus one preparatory year). Note that foundation year students were combined with gateway students for this last category, as both approaches have the aim of widening access to medicine; that is, providing alternative ways into medicine for those who do not meet the academic criteria for SEM courses because of socio-economic or personal disadvantage (35).

Finally, there are a significant number of graduates who choose to do a SEM programme (36), so candidates who undertook SEM courses were further defined as “Graduate on Entry” or “Not Graduate on Entry”.

Medical Schools

At the time of this study, there were 35 medical schools in the United Kingdom recognised by the GMC, including a combined University of London awarding body. Most are undergraduate courses, offering a five-year programme, plus 16 accelerated graduate entry programmes. Eleven medical schools offer gateway/foundation courses. The study-specific dataset included values for 31 medical schools: newer medical schools (e.g., Lancaster, Anglia Ruskin and The University of Buckingham) were not represented in the dataset as very few if any of their graduates had attempted MRCS within the study period. Several GEM courses included in the analysis have since ceased to exist (such as Leicester and Bristol), additionally, new GEM and Gateway courses were not included if graduates of these courses had not attempted the MRCS within the study period.

Within the UK, a number of universities combine to create linked medical schools such as Leicester-Warwick Medical School (a combination of the Universities of Leicester and Warwick) and Peninsula Medical School (a combination of Plymouth and Exeter Universities). Many later cease their partnership, creating two independent medical schools. To represent this in the data analysis candidates who studied at either Leicester-Warwick or

Peninsula Medical Schools were categorized according to the university from which they graduated (i.e., Leicester, Warwick, Plymouth or Exeter). Graduates of Hull-York Medical School and Brighton and Sussex Medical School remain under the combined title as they were still combined institutions at the time of data analysis. Within the study period certain medical schools were also linked (e.g., Keele students were awarded degrees by the University of Manchester until 2012). To acknowledge this, students were categorised by the place of graduation for their primary medical qualification, including London graduates.

Indicators of esteem: Rankings

In this study, universities were ordered according to their ranking by 'The Complete University Guide' as of August 2020. 'The Complete University Guide' is the most well recognised independent university ranking system in the UK and uses the following data annually to create an overall score (100 points being the most a university can be awarded): entry standards, student satisfaction, research quality and intensity, graduate prospects, student to staff ratio, spending, honours and degree completion. More information on how the ranking system is calculated is available on the complete university guide website (31). This ranking system provides a quantitative comparator between universities for this study and its use does not suggest that its value is greater than that of any other ranking systems that exist which are calculated using similar data. Note that Lancaster University (ranked 16th) was excluded having only opened in 2006 and having insufficient outcome data. St Andrews Medical School (ranked 25th) was also excluded as it offers only pre-clinical education: those who commenced their studies at St Andrews were therefore categorised by their place of graduation (e.g. Manchester University, The University of Dundee, etc.). The ranking table was adjusted accordingly, to create an ordinal variable.

Indicators of esteem: Russell Group

Russell Group Institutions are a collection of self-selected research-driven universities that have developed a reputation of excellence (37). Most older medical schools are associated with the Russell Group. Whether these universities are truly the elite institutions within the UK is a highly debated topic (38–40) but they do graduate the majority (80%) of the UK medical students.

Pedagogy

Despite well-established definitions of what comprises problem-based learning (PBL) it can be challenging to identify which medical schools run PBL courses (41,42). We have aligned our definition with that of the British Medical Association (BMA) as well as that used in recent studies to ensure consistency within the literature, enabling comparisons to be drawn between the results of these studies (1,15,43). PBL schools are: Liverpool, Manchester, Glasgow, Queen Mary, Cardiff, Plymouth, Exeter, Sheffield, Keele, Hull-York and East Anglia.

Markers of prior academic attainment

Individual-level linked performance data was extracted for A-Levels as a marker of prior academic attainment. A-Levels are taken as school exit examinations in the majority of schools in England and in some schools elsewhere in the United Kingdom. A-Level results are routinely used as a medical school selection metric (30). Total A-Level scores used in data analyses are the sum of all A-Level scores achieved i.e. A=10 (being the highest score achievable for each A-Level), B=8, C=6, D=4, E=2, U=0 (being the lowest score for each A-Level). A small minority of candidates in the dataset (n=30) undertook A-Levels after A* grades were implemented in 2010. These were subsequently excluded for cohort homogeneity.

MRCS examination background

The examination comprises two parts; Part A, the written component made up of two multiple-choice questionnaire tests and Part B, a clinical examination that includes 17 Objective Structured Clinical Examination stations (44). Taken during Foundation and Core

Surgical Training, both MRCS Part A and Part B must now be passed to enable the progression of trainees into higher surgical specialty (residency) training (45).

Statistical analysis

All analyses were conducted using SPSS® v22.0 (IBM, Armonk, New York, USA). Chi-squared tests were used to assess the relationship between two categorical factors such as medical school and first attempt MRCS pass/fail outcomes.

All counts have been rounded to the nearest 5 for illustration according to Higher Education Statistics Agency (HESA) data standards (46). Regression models were used to calculate the odd's ratios (OR) and 95% confidence interval (CI) for passing MRCS Parts A and B at first attempt according to place of primary medical qualification. The University of Keele was declared the reference category for construction of the logistic regression model for MRCS Part A, as the pass rate at this university (58.6%) most closely resembled the pass rate of the entire cohort of Part A candidates from all universities. The University of Birmingham was declared the reference category for Part B in the logistic regression model, as the pass rate at this university (71.1%) most closely resembled the pass rate of the entire cohort of Part B candidates from all universities.

Potential independent predictors of first attempt success at Part A and B MRCS were identified using multivariate logistic regression models. Regression models were constructed using backward stepwise regression with and without adjustment for prior academic attainment (A-level performance) for direct comparison (47). Any variable (sociodemographic factor, course type, teaching methodology or marker of institutional esteem) with an association with the outcome at a conservative P<0.10 on univariate analysis (shown in Tables 2 and 4) was entered into the logistic regression model. All potential predictors with P>0.05 in the full model were subsequently removed until only statistically significant predictors remained in the final model. Potential interactions between the remaining significant predictors were also examined.

Data management

The highest standards of security, governance and confidentiality were ensured when storing handling and analysing data. See later for details of ethics approval.

Patient and public involvement

No patients or members of the public were involved in this study.

RESULTS

Medical School Differences

Between 2007 to 2017 a total of 9,730 UK medical graduates from 31 medical schools attempted the MRCS Part A, with 59% (standard deviation (SD) 49) passing on the first attempt. A total of 4,645 candidates attempted MRCS Part B and 71% (SD 45) passed at their first attempt. Of all Part A exam candidates 64% were male, 59% were white and 86% had no degree-level qualification prior to studying medicine. Similar demographics were seen in Part B applicants with 65% male candidates, 61% white candidates and 86% of candidates having no prior degree. Chi-squared analysis revealed a significant difference in MRCS pass rates between medical schools for Part A (P<0.001) and Part B (P<0.001). Figure 1 shows MRCS Part A first attempt pass rates by medical school and Figure 2 shows MRCS Part B first attempt pass rates by medical school. Raw data is presented in Appendix 1).

Figure 1 and Figure 2 about here

Medical School ranking and position of esteem

Odds ratios for passing MRCS Part A and B at the first attempt for each medical school can be found in Table 1. Oxford and Cambridge University graduates (ranked 1st and 2nd respectively) performed significantly better in MRCS Part A than the mean with resulting odds ratio of 9.11 (95% CI 4.77 to 17.39) and 5.82 (3.42 to 9.90) respectively. After adjusting for prior academic attainment, Oxford University graduates were still found to be more than three times more likely to pass MRCS Part A at first attempt (OR 3.18 (95% CI 1.15 to 8.81)) and Cambridge graduates were more than twice as likely to pass (OR 2.64 (95% CI 1.03 to 6.78)). After adjusting for prior academic attainment, no medical schools were found to be statistically significant predictors of MRCS Part B first-attempt success and there was no statistically significant difference in MRCS performance between most medical schools.

Table 1. Odds ratio for pass at first attempt at Part A and Part B MRCS across all UK medical schools ranked according to the Complete University Guide as of 2019-2020. C.I., Confidence Interval. Statistically significant odds ratios are shown in bold.

		Part A			Part B		
Rank	**Medical School**	**MRCS Candidates (n=9730)**	**Unadjusted Odds Ratio (95% C.I.)**	**Odds Ratio Adjusted for prior academic attainment (95% C.I.)**	**MRCS Candidates (n=4645)**	**Unadjusted Odds Ratio (95% C.I.)**	**Odds Ratio Adjusted for prior academic attainment (95% C.I.)**
1	University of Oxford	210	**9.11 (4.77 – 17.39)**	**3.18 (1.15-8.81)**	94	**2.32 (1.23 – 4.40)**	4.43 (0.51-38.58)
2	University of Cambridge	285	**5.82 (3.42 – 9.90)**	**2.64 (1.03-6.78)**	142	1.52 (0.92 – 2.50)	3.92 (0.77-19.82)
3	University of Glasgow	350	0.96 (0.62 – 1.47)	0.51 (0.18-1.39)	169	1.40 (0.88 – 2.23)	1.11 (0.20-6.09)
4	Swansea University	15	**0.28 (0.08 – 0.96)**	**0.90 (0.83-0.97)**	0	- -	- -
5	The University of Edinburgh	365	**1.76 (1.13 – 2.74)**	2.01 (0.81-5.00)	190	1.40 (0.89 – 2.19)	0.56 (0.19-1.62)
6	University of Dundee	215	**0.56 (0.35 – 0.89)**	0.73 (0.26-2.05)	105	0.95 (0.57 – 1.58)	0.42 (0.14-1.32)
7	Imperial College London	815	**2.05 (1.36 – 3.08)**	1.26 (0.58-2.75)	415	1.06 (0.73 – 1.52)	1.22 (0.47-3.20)
8	Queen Mary University of London	475	**0.44 (0.29 – 0.67)**	0.45 (0.19-1.04)	210	**0.41 (0.28 – 0.61)**	0.38 (0.14-1.01)
9	Keele University	110	- -	- -	70	1.13 (0.61 – 2.09)	0.61 (0.17-2.17)
10	University of Exeter	70	**0.52 (0.28 – 0.95)**	0.38 (0.13-1.07)	35	1.32 (0.57 – 3.08)	2.24 (0.25-20.12)
11	University of Aberdeen	230	0.68 (0.43 – 1.07)	0.39 (0.12-1.29)	105	0.94 (0.57 – 1.56)	0.28 (0.04-2.23)
12	University of Bristol	355	**1.58 (1.02 – 2.46)**	0.66 (0.28-1.52)	170	1.27 (0.80 – 2.01)	0.83 (0.24-2.86)
13	University College London	575	**1.53 (1.02 – 2.33)**	1.25 (0.55-2.82)	275	0.84 (0.57 – 1.24)	1.11 (0.37-3.31)
14	Newcastle University	390	0.81 (0.53 – 1.24)	0.59 (0.26-1.32)	200	1.01 (0.66 – 1.54)	1.44 (0.50-4.17)
15	Cardiff University	390	1.10 (0.72 – 1.69)	0.79 (0.35-1.78)	180	1.13 (0.72 – 1.75)	1.34 (0.44-4.14)
16	King's College London	665	0.94 (0.62 – 1.41)	0.63 (0.29-1.38)	305	0.97 (0.66 – 1.42)	1.31 (0.45-3.84)
17	The University of Sheffield	285	**0.62 (0.40 – 0.97)**	0.82 (0.34-2.00)	145	0.74 (0.47 – 1.16)	0.43 (0.15-1.30)
18	University of Leeds	275	0.84 (0.54 – 1.32)	0.67 (0.28-1.64)	130	**2.01 (1.17 – 3.47)**	2.63 (0.51-13.58)
19	University of Plymouth	70	**0.50 (0.27 – 0.92)**	0.63 (0.23-1.70)	35	**0.45 (0.22 – 0.93)**	0.39 (0.10-1.50)
20	University of East Anglia	110	**0.37 (0.22 – 0.64)**	0.44 (0.17-1.14)	45	0.57 (0.29 – 1.11)	1.54 (0.27-8.73)
21	Brighton and Sussex Medical School	90	0.65 (0.37 – 1.13)	1.10 (0.35-3.44)	45	0.94 (0.46 – 1.92)	0.35 (0.08-1.57)
22	Queen's University Belfast	245	0.84 (0.53 – 1.32)	0.49 (0.21-1.15)	115	0.88 (0.54 – 1.44)	0.80 (0.25-2.56)
23	University of Nottingham	465	1.44 (0.94 – 2.21)	0.92 (0.41-2.07)	235	1.40 (0.91 – 2.13)	2.03 (0.63-6.54)
24	The University of Manchester	580	0.72 (0.47 – 1.08)	0.58 (0.26-1.28)	275	0.96 (0.65 – 1.41)	0.78 (0.29-2.09)
25	Hull York Medical School	85	0.60 (0.34 – 1.06)	0.79 (0.25-2.50)	40	0.92 (0.44 – 1.92)	1.30 (0.11-16.01)
26	University of Birmingham	480	1.26 (0.83 – 1.93)	1.08 (0.48-2.41)	220	- -	- -
27	University of Warwick	160	0.78 (0.48 – 1.27)	2.08 (0.16-27.09)	70	0.66 (0.38 – 1.16)	0.80 (0.69-1.02)
28	University of Leicester	275	1.07 (0.68 – 1.67)	0.80 (0.33-1.94)	130	0.81 (0.51 – 1.30)	0.54 (0.17-1.72)
29	University of Southampton	310	0.81 (0.52 – 1.26)	0.63 (0.27-1.45)	140	0.76 (0.48 – 1.20)	0.56 (0.19-1.61)
30	University of Liverpool	365	**0.60 (0.39 – 0.92)**	0.66 (0.30-1.47)	160	1.02 (0.65 – 1.59)	1.01 (0.35-2.88)
31	St George's University of London	430	0.73 (0.48 – 1.12)	0.73 (0.32-1.62)	200	0.84 (0.55 – 1.27)	0.46 (0.18-1.13)

There was a significant difference in MRCS Part A pass rates between candidates from Russell Group Universities (60.7% (4970/8185)) and Non-Russell Group Universities (49.9% (770/1540)) *P*<0.001 (Table 2). Similarly, a significant difference was seen in Part B of the examination with a pass rate of 71.4% (2790/3910) for Russell Group Universities and 67.5% (495/735) for Non-Russell Group Universities *P*=0.038.

Table 2. MRCS first attempt pass rates by course type and prior degree status.

Predictor	Part A (n= 9730)	Part B (n = 4645)
Russell Group		
Yes	60.7% (4970/8185)	71.4% (2790/3910)
No	49.9% (770/1540)	67.5% (495/735)
Missing	n=0	n=0
p-value	< 0.001	0.038
Course		
Undergraduate	59.3% (5305/8950)	71.0% (3050/4300)
Graduate-Entry	54.6% (405/745)	69.3% (230/335)
Missing	n=35	n=10
p-value	0.012	0.533
Undergraduate Course Classification		
Standard-Entry Medicine	60.0% (5255/8755)	71.1% (3010/4230)
Medicine with Gateway Year	28.1% (55/190)	60.9% (40/70)
Missing	n=0	n=0
p-value	< 0.001	0.081
Prior Degree Status on Undergraduate Courses		
Not Graduate on entry	60.2% (4945/8220)	71.5% (2830/3960)
Graduate on entry	49.5% (360/730)	65.0% (220/335)
Missing	n=0	n=0
p-value	< 0.001	0.015
Graduate Student Outcomes		
Graduate on Standard-Entry Course	49.5% (360/730)	65.0% (220/335)
Graduate on Graduate-Entry Course	54.6% (405/745)	69.3% (230/335)
Missing	n=0	n=0
p-value	0.054	0.251

Teaching Methodology		
Not Problem Based Learning	63.1% (4560/7225)	72.2% (2505/3465)
Problem Based Learning	47.0% (1175/2500)	66.6% (785/1180)
Missing	n=0	n=0
p-value	< 0.001	< 0.001

Note. All p-values presented are from chi-squared analysis. MRCS, Membership of the Royal College of Surgeons.

Course Type

Univariate analysis of pass rates by course type is displayed in Table 2. The majority of all MRCS Part A candidates had studied a Standard-Entry Medicine (SEM) course (8950/9730): only 745 candidates had graduated from a Graduate-Entry Medicine (GEM) course. There was a significant difference between Part A pass rates of SEM (59.3%) and GEM graduates (54.6%) *P*=0.012. Of the 335 graduates who attempted Part B, 69.3% passed first time, and there was no statistically significant difference in MRCS Part B pass rates between SEM and GEM candidates (*P*=0.533).

A small proportion of the trainees attempting MRCS Part A who had studied a SEM course (n=8950) entered medicine as graduates (n=730). There was a significant difference in MRCS Part A success between those entering without a prior degree 60.2% (4945/8220) and graduates 49.5% (360/730) from SEM courses, *P*<0.001. Similar results were found for MRCS Part B (71.5% (2830/3960) versus 65% (220/335) respectively *P*<0.001).

Table 2 shows that of all candidates who attended a SEM, 190 entered their course via a 'Gateway year'. A statistically significant difference was seen in MRCS Part A pass rates between students who undertook a Gateway year (28.1%) and those who entered directly into a Standard-entry course (60.0%) *P*<0.001. There was a difference in MRCS Part B pass rates between Gateway students (60.9% (40/70)) and direct-entry students (71.1% (3010/4230)) but this was not statistically significant (*P*=0.081).

Of all graduates from SEM courses, 49.5% passed Part A first time compared to 54.6% of graduates from GEM courses (*P*=0.054). Similarly, 65% of SEM graduates passed Part B first time compared to 69.3% of GEM graduates (*P*=0.251).

Course pedagogy

A significant difference was observed in MRCS Part A first attempt pass rates between candidates who studied on a course described as PBL and those who studied at medical schools with other core pedagogies (47.0% (1175/2505) versus 63.1% (4560/7225) *P*<0.001 (Table 2)). A similar difference was observed in Part B of the MRCS (PBL: 66.6% (785/1180) and non-PBL: 72.2% (2505/3465) *P*<0.001).

A comparison of MRCS pass rates between GEM courses can also be found in Table 3. There was a significant difference in pass rates between GEM schools for MRCS Part A (*P*=0.028) but not for MRCS Part B (*P*=0.072). Drilling down further highlights that the aggregate data disguise variation. For example, graduates of the King's College London GEM programme performed above average (e.g., 76.7% Part A and 81.0% Part B pass rates; Table 3) but the MRCS performance of candidates from their undergraduate programme was lower than average (57% Part A and 70.5% Part B, Figure 1).

Table 3. MRCS first attempt pass rates by Graduate-Entry Medicine course.

	Part A			Part B		
Medical School	**Total Number of Candidates (n=745)**	**Pass rate (n=405)**	**95% C.I.**	**Total Number of Candidates (n=335)**	**Pass rate (n=230)**	**95% C.I.**
The University of Oxford	5	100.0%	(100.0 – 100.0)	5	100.0%	(100.0 – 100.0)
The University of Cambridge	25	80.0%	(63.1 – 96.9)	10	40.0%	(0.31 – 76.9)

The University of Swansea	15	28.6%	(1.5 – 55.6)	0	-	-
Imperial College London	25	51.9%	(31.7 – 72.0)	10	60.0%	(23.1 – 96.9)
Queen Mary University of London	75	51.3%	(39.8 – 62.8)	35	58.8%	(41.4 – 76.3)
The University of Bristol	25	60.9%	(39.3 – 82.4)	10	72.7%	(41.3 – 100.0)
University of Newcastle-upon-Tyne	35	63.6%	(46.3 – 81.0)	20	85.7%	(69.4 – 100.0)
Cardiff University	50	51.0%	(36.8 – 65.2)	20	84.2%	(66.2 – 100.0)
King's College London	30	76.7%	(60.6 – 92.7)	20	81.0%	(62.6 – 99.3)
University of Nottingham	95	56.3%	(46.1 – 66.4)	45	59.6%	(45.0 – 74.1)
The University of Birmingham	30	50.0%	(31.0 – 69.0)	15	88.2%	(71.2 – 100.0)
The University of Warwick	160	52.5%	(44.7 – 60.2)	70	62.0%	(50.4 – 73.5)
The University of Leicester	40	47.6%	(31.9 – 63.4)	15	78.6%	(54.0 – 100.0)
The University of Southampton	25	52.0%	(31.0 – 73.0)	10	77.8%	(43.9 – 100.0)
The University of Liverpool	20	45.0%	(21.1 – 68.9)	15	84.6%	(61.9 – 100.0)
St George's Medical School London	85	50.0%	(39.2 – 60.8)	35	66.7%	(49.7 – 83.6)

Note: All values presented from Chi-squared analysis; Part A 27.12 P=0.028 and Part B 23.59 P=0.72. MRCS, Membership of the Royal College of Surgeons. C.I., Confidence Intervals to 95%.

Sociodemographic Factors

Pass rates for MRCS Parts A and B by graduate on entry to medicine status, gender and ethnicity are shown in Table 4. Non-graduates, males and individuals of white ethnicity had significantly higher pass rates for MRCS Parts A and B compared to their graduate, female and non-white ethnicity counterparts.

Table 4. MRCS first attempt pass rates by gender, ethnicity and graduation status for UK medical graduates.

Predictor	Part A (n= 9730)	Part B (n = 4645)
Graduate on entry to medicine		
No	60.2% (4945/8220)	71.5% (2830/3960)
Yes	52.4% (790/1510)	66.8% (455/685)
Missing	n=0	n=0
p-value	< 0.001	0.014
Gender		
Male	62.5% (3865/6185)	72.1% (2185/3030)
Female	52.8% (1870/3545)	68.3% (1100/1615)
Missing	n=0	n=0
p-value	< 0.001	0.007
Ethnicity		
White	63.7% (3580/5615)	76.6% (2130/2780)
Non-white	52.3% (2055/3930)	62.5% (1120/1790)
Missing	n=180	n=75
p-value	< 0.001	< 0.001

Note. All p-values presented are from chi-squared analysis. MRCS, Membership of the Royal College of Surgeons.

Multivariate analysis

The multivariate logistic regression models showing independent predictors of success at MRCS Part A and MRCS Part B can be found in Table 5. After adjusting for prior academic attainment, white candidates, males and those who studied medicine without a prior degree-level qualification were all significantly more likely to pass MRCS Part A at the first attempt (*P*<0.05). After adjusting for prior attainment, white ethnicity remains a statistically significant predictor of Part B success (*P*<0.05), although gender and graduate status were not independent predictors of Part B success.

Candidates who attended a non-PBL medical school were found to be 53% (OR 1.53 (95% CI 1.25 to 1.87)) more likely to pass Part A and 54% (OR 1.54 (95% CI 1.05 to 2.25)) more likely to pass Part B at the first attempt after adjusting for prior academic performance, compared to those who attended a PBL school. Candidates attending a SEM course were nearly four times more likely to pass Part A at first attempt (OR 3.72 (95% CI 2.69 to 5.15)) and 67% more likely to pass Part B (OR 1.67 (95% CI 1.02 to 2.76)) when compared to those entering SEM via a Gateway Year. After adjusting for prior attainment, SEM candidates were more than twice as likely to pass Part A (OR 2.34 (95% CI 1.21 to 4.52)) but attending an SEM course was not found to be a statistically significant predictor of Part B success.

Candidates who attended a Russell Group university were 79% more likely to pass Part A (OR 1.79 (95% CI 1.56 to 2.05)) and 24% more likely to pass Part B (OR 1.24 (95% CI 1.03 to 1.49)). However, after adjusting for prior academic attainment, attending a Russell Group university was found to predict success at MRCS Part B (OR 1.81 (95% CI 1.17 to 2.80)) but not Part A.

Table 5. Predictors of pass at first attempt at MRCS Part A (n=5735) and Part B (n=3285) for UK medical graduates. Odds ratios (95% Confidence Interval) given prior to and after adjustment for prior academic attainment.

	Part A		Part B	
Predictor	**Unadjusted OR (95% CI)**	**Adjusted OR (95% CI)**	**Unadjusted OR (95% CI)**	**Adjusted OR (95% CI)**
Graduate on entry into medicine Non-Graduates vs. Graduates	1.40 (1.19-1.64)	2.86 (1.00-8.16)	1.66 (1.24-2.24)	2.08 (0.74-5.88)
Gender Males vs. Females	1.66 (1.48-1.88)	1.62 (1.34-1.95)	1.25 (1.09-1.44)	1.23 (0.86-1.77)
Ethnicity White vs. Non-White	1.65 (1.46-1.87)	1.40 (1.17-1.68)	2.06 (1.80-2.36)	2.07 (1.46-2.93)
Russell Group Russel Group vs. Non-Russell Group	1.79 (1.56-2.05)	1.14 (0.88-1.48)	1.24 (1.03-1.49)	1.81 (1.17-2.80)
Undergraduate Course Type Standard-Entry vs. Gateway Year	3.72 (2.69-5.15)	2.34 (1.21-4.52)	1.67 (1.02-2.76)	2.53 (0.89-7.17)
Teaching Methodology Not PBL vs. PBL	1.99 (1.74-2.27)	1.53 (1.25-1.87)	1.49 (1.27-1.75)	1.54 (1.05-2.25)

MRCS, Membership of the Royal College of Surgeons; CI, Confidence Interval. OR, Odds Ratio. *P*=0.034 for interaction between Ethnicity and Gender, *P*=0.001 for Ethnicity and Teaching Methodology, *P*=0.001 for PBL and Russell group classification in unadjusted Part A regression model and *P*=0.031 for Graduate status and Russell group classification in adjusted Part A model. **P*=0.022 for interaction between Graduate Status and Teaching Methodology in unadjusted Part B regression model.

DISCUSSION

This study, the first to examine the variation in pass rates for the MRCS examination across UK medical schools, identified significant differences in pass rates for both MRCS Part A and Part B across schools, course type and pedagogy.

Our most important finding is the lack of statistically significant difference in MRCS success between medical schools after adjusting for A-levels as a measure of prior academic attainment. This indicates that prior attainment is a significant contributory factor to postgraduate performance between different schools. In other words, differences in postgraduate exam performance are more closely related to individual factors than medical school differences. This reflects patterns seen in other medical assessments (11,14,17,20,21,28,48–51).

Institutional esteem is a known pull factor for medical school applicants (52–54). We found that even after adjusting for prior academic attainment and, by extension, the selection of the highest achieving applicants (see later), both Oxford and Cambridge universities performed significantly better than other academic institutions. These results suggest that the training and education offered by these schools does add value to the likelihood of their student's later success, over and above the individual's academic ability.

However, with the exceptions of Oxford and Cambridge, we found little association between MRCS pass rates and medical school rankings. This is perhaps unsurprising given that rankings are based on amalgamated scores (31), several of which are not relevant to vocational medical degrees with their high retention and employability rates. Additionally, earlier studies indicated that staff to student ratio and student feedback, two seemingly relevant measures used in university rankings, seem to have no effect on performance in medical graduates (15,16). In contrast, Russell Group (research-intensive/focused universities) medical graduates were far more likely to pass MRCS at the first attempt. The relationship between research intensity/focus and MRCS outcomes is unclear. However, it may be that higher entry requirements for Russell Group universities (55,56) play a role given the strong message from our findings and those of the wider literature that prior academic performance is the strongest predictor of future success (14,17,20,21,25,28–30,48–51). Indeed, we would suggest that educational institutions that are self-selecting as an elite group have a self-interest in selecting the very best applicants who will continue to perform at a high level after graduating in order to perpetuate their status as the leading schools.

As per McManus et al.'s MedDifs paper (2020) (15), we found that pedagogic differences (PBL versus non-PBL) are related to variation in outcome measures on postgraduate examinations. Graduates from PBL courses perform less well on MRCS A and B. Other literature hints at possible reasons for this. PBL graduates have strengths compared to those from non-PBL courses in some areas (57,58), but PBL graduates have reported less surgical teaching than is offered at other medical schools (15) and differences in time dedicated to undergraduate surgical training in UK medical schools has been found to correlate with preparedness for clinical practice in surgery (23). PBL courses have also been criticised for neglecting basic science content (59,60), and this may be a contributing factor in the performance of PBL students at Part A of the MRCS, given that paper 1 (of 2) is dedicated to applied basic sciences.

Gateway courses provide a pathway to medicine for students from more diverse sociodemographic and academic backgrounds (61,62). Students from Gateway courses perform less well on assessments during medical school (61,63), at Foundation Programme Selection (64) and, as found in this study. the MRCS. However, there are two points to note. Whilst increasing the diversity of the medical workforce is high on the workforce planning agenda (65), the actual number of Gateway programme graduates in our analysis was very small (n=190). This suggests that surgery is not a common career pathway for these students. Why this is the case is unknown but it may be related to myriad factors including high competition for surgical training posts (66), a lack of perceived “fit” with surgery, few visible role models from similar backgrounds in senior surgical roles, and/or a greater preference to choose a medical career which enables them to give back to under-served communities (67,68). Future research is required to examine this further.

Despite the performance of those who entered medical school as graduates being comparable to those who entered as undergraduates throughout medical school (69,70) and on graduation (63), there remains a significant attainment difference between these groups on postgraduate specialty examinations (20,71,72). Our analysis suggests that this is not due to course type (GEM or SEM). Further work is required to ascertain whether graduates are disadvantaged in postgraduate training due to other factors, such as increased commitments on their time (e.g. family, dependants and financial obligations) (72) or whether this is a reflection of lower prior academic achievement (56,73).

Implications for research, policy and practice

Much literature indicates that medical school influences the progression, direction and performance of their graduates (5–7,9–13,15,16,74). However, it is reassuring to find that the majority of this variation in performance between schools on the MRCS at least can be accounted for by individual factors, namely prior academic attainment. There were, however, clear differences in performance by course pedagogy and markers of institutional esteem which can be used by medical schools to optimise the alignment between undergraduate and postgraduate teaching, learning and assessment values in surgery, and by individuals when considering where to apply to study medicine.

These findings are relevant to medical school selection. In the UK, the first and major hurdle to entry into medicine is achieving high grades on school exit examinations (such as A-

Levels). This is usually coupled with an aptitude test and, if an applicant reaches the required standard on these measures, an interview to assess non-cognitive (personal) qualities (75). There has been much debate in the selection literature as to the weight which should be placed on each of these selection components (76). Our data suggest that if a medical school wants to graduate doctors who are good at passing postgraduate exams, then prior academic attainment should be heavily weighted at the point of selection.

However, if the mission of medical schools is to graduate doctors who will, for example, meet social accountability mandates, then more holistic selection criteria are required (77). Moreover, there are other factors potentially influencing postgraduate success which we could not take into account: group factors (e.g., factors related to the demographics of the student group) (78); individual career preferences (16) and prior schooling (79); mentorship and research opportunities (80) and a student's overall experience of a specialty (74). We are unlikely to ever characterise all variables that contribute to postgraduate examination success, but this study goes some way to identifying key patterns.

In addition to variation in MRCS pass rates, there is also significant variation in the number of graduates from each medical school entering careers in surgery (6,52). Students who wish to pursue surgery as a specialty may want to know which medical school will "best" prepare them for a surgical career (23). Many students enter medicine with clear views as to which specialty they wish to pursue (52,81,82). Perceptions of how well an individual will be placed for a surgical career on graduation may be one factor that is taken into account at the time of application to medical school (83). However, it will not be the only factor. Studies indicate that numerous factors are "traded-off" when considering training location and these trade-offs differ for different groups (e.g., on the basis of gender, or socio-economic background) (84,85). Similarly, applicants may consider factors such as pedagogic approach (e.g., problem-based learning [PBL] versus, for example, or a lecture-based course) (86–88); course length if a graduate (graduates have the choice between a traditional five-year programme or an accelerated GEM course (89)); and/or the reputation and national ranking of a medical school when considering where to apply (52–54,90). In short, choosing which medical school to attend is a major decision and factors other than career preference may be important in this process.

Differential attainment

Group differences in performance by gender, maturity and ethnicity reflect those seen in previous studies (20,24). These attainment differences have also been identified in other high-stakes medical examinations, including FRCS, MRCP, MRCGP, MRCPsych and the USMLE (20,34,48,91–93). Research that aims to investigate this differential attainment at MRCS is currently ongoing. Bias and discrimination at the question level must be ruled out using techniques such as differential item functioning analysis (94), as should the possibility of examiner bias (95,96). The wider literature also suggests the need to examine systemic inequities in the workplace learning environment (97).

Strengths and Limitations

To our knowledge, this large cohort study is the first to assess the relationship between MRCS success and medical school choice, type and ranking after adjusting for measures of prior academic attainment. The UKMED dataset enabled a large-scale, multi-cohort analysis of medical school differences on MRCS first attempt outcomes. The dataset had very little missing data enabling detailed and accurate analyses, demonstrating the utility of national medical education databases. We used candidate first attempt scores despite candidates being able to take multiple attempts at both parts of the MRCS, as first attempt performance in postgraduate examinations has been shown to be the best predictor of future performance (33) and this outcome has been used in previous studies looking at factors which predict performance in the MRCS (20,24). The outcome measure of pass/fail was used as in previous studies since this is what is meaningful to those sitting MRCS

(24,25,98). Data were not available for individual MRCS questions and stations potentially hiding institutional differences in performance.

A-Levels were used as a marker of prior academic attainment in this study. This does not represent the full range of school leaving examinations used by all UK schools (others include Irish and Scottish Highers and the International Baccalaureate). However, A-Levels have been used previously as markers of prior academic attainment in seminal medical education papers and we have no reason to believe that other school leaving examinations would show different results (28,29). The strengths and limitations of using markers of prior academic attainment such as A-Levels in high achieving cohorts such as doctors are discussed in these papers and in our previous work (30).

Despite a long study period and a large study population; stratification of the analysis by medical school results in smaller cohort numbers (and therefore reduced statistical power) for comparison. Smaller cohort numbers and lower numbers of actual observations in some sub-analyses may result in overfitting, affecting the predictive ability of regression models. Larger cohort sizes would have enabled a more detailed analysis of group differences such as self-declared ethnicity data, avoiding the need for the binary categorisation used here which ensured maximum statistical power (97,99).

Analysis that includes multiple sociodemographic and course factors inevitably includes a degree of multicollinearity, although every effort was made to minimise this. Interaction terms were explored and statistically significant interactions are listed in the footnote for Table 5. These highlight differences in cohort sociodemographics between each teaching methodology and course type. Further exploration of these differences may be of interest to those in charge of selection and recruitment for medical school. Courses change over time and as such results and attainment differences may also have changed throughout the study period: future studies may wish to use a time-series analysis to look at this (76).

CONCLUSION

There are significant differences in MRCS performance between UK medical school course types and pedagogy. However, variation in MRCS pass rates between medical schools is largely due to individual factors, such as the academic ability of individuals, rather than medical school factors. This data has implications for those in charge of selection policy and curricula delivery. This study also highlights group level attainment differences that transcend training location and stage, warranting further investigation to ensure equity within medical training.

ABBREVIATIONS

ARCP: Annual Review of Competency Progression

FRCS: Fellowship of the Royal College of Surgeons Examinations

GEM: Graduate-Entry Medicine Course

GMC: General Medical Council

HESA: Higher Education Statistics Agency

MRCOG: Membership of the Royal College of Obstetricians and GynaecologistsMRCP:

Membership of the Royal College of Physician

MRCPCH: Membership of the Royal College of Paediatrics and Child Health

MRCPsych: Membership of the Royal College of Psychiatrists

MRCGP: Membership of the Royal College of General Practitioners

MRCS: Intercollegiate Membership of the Royal College of Surgeons Examinations

PBL: Problem Based Learning

SEM: Standard-Entry Medicine Course

UKMED: United Kingdom Medical Education Database

USMLE: United States Medical Licensing Examinations

ACKNOWLEDGEMENTS

The authors would like to acknowledge Iain Targett at the Royal College of Surgeons of England, for his help with data collection and John Hines and Gregory Ayre from the Intercollegiate Committee for Basic Surgical Examinations for their support during this project. Our thanks to members of the UKMED Research Group who provided useful feedback on an earlier version of this manuscript, and whose comments helped refine the paper. The authors would also like to acknowledge Daniel Smith for his help with the UKMED database. Data Source: UK Medical Education Database ("UKMED"). UKMEDP043 extract generated on 25/07/2018. We are grateful to UKMED for the use of these data. However, UKMED bears no responsibility for their analysis or interpretation the data includes information derived from that collected by the Higher Education Statistics Agency Limited ("HESA") and provided to the GMC ("HESA Data"). Source: HESA Student Records 2002/2003 to 2015/2016. Copyright Higher Education Statistics Agency Limited. The Higher Education Statistics Agency Limited makes no warranty as to the accuracy of the HESA Data, cannot accept responsibility for any inferences or conclusions derived by third parties from data or other Information supplied by it.

FUNDING

Royal College of Surgeons of England.

Royal College of Surgeons of Edinburgh.

Royal College of Surgeons of Ireland.

Royal College of Physicians and Surgeons of Glasgow.

COMPETING INTERESTS

None to declare.

ETHICAL APPROVAL

No formal ethical approval was required for this study of existing UKMED data. UKMED has received ethics exemption for projects using exclusively UKMED data from Queen Marys University of London Ethics of Research Committee on behalf of all UK medical schools (https://www.ukmed.ac.uk/documents/UKMED_research_projects_ethics_exemption.pdf). The Intercollegiate Committee for Basic Surgical Examinations (ICBSE) and its Internal Quality Assurance Subcommittee, which monitors MRCS standards, research and quality, approved this study.

AVAILABILITY OF DATA AND MATERIALS

The dataset used in this study was acquired from the UK Medical Education Database and is held in Safe Haven. Data access requests must be made to UKMED. Full information for applications can be found at https://www.ukmed.ac.uk.

AUTHOR CONTRIBUTIONS

RE wrote the first draft of the manuscript. RE performed statistical analyses with AJL's supervision. RE, PAB, DSGS, AJL and JC all reviewed and edited the manuscript. JC led the study proposal for access to UKMED data. All authors approved the final draft of the manuscript.

REFERENCES

1. Devine OP, Harborne AC, Horsfall HL, et al. The Analysis of Teaching of Medical Schools (AToMS) survey: an analysis of 47,258 timetabled teaching events in 25 UK medical schools relating to timing, duration, teaching formats, teaching content, and problem-based learning. *BMC Med* 2020 May 14;18(1):126.

2. Devine OP, Harborne AC, McManus IC. Assessment at UK medical schools varies substantially in volume, type and intensity and correlates with postgraduate attainment. *BMC Med Educ* 2015 Sep 11;15(1):146.

3. Taylor CA, Gurnell M, Melville CR, et al. Variation in passing standards for graduation-level knowledge items at UK medical schools. *Med Educ* 2017;51(6):612–20.

4. McCrorie P, Boursicot KAM. Variations in medical school graduating examinations in the United Kingdom: are clinical competence standards comparable? Med Teach. 2009 Mar;31(3):223–9.

5. General Medical Council: Be prepared: are new doctors safe to practise? Manchester: General Medical Council. [Internet]. 2014. Available from: (Available at https://www.gmc-uk.org/Be_prepared___are_new_doctors_safe_to_practise_Oct_2014.pdf_58044232.pdf); 2014.)

6. Twigg V, Aldridge K, McNally S, et al. Does choice of medical school affect a student's likelihood of becoming a surgeon? Bull R Coll Surg Engl. 2018 Mar 1;100(2):90–5.

7. Alberti H, Randles HL, Harding A, et al. Exposure of undergraduates to authentic GP teaching and subsequent entry to GP training: a quantitative study of UK medical schools. Br J Gen Pract. 2017 Apr 1;67(657):e248–52.

8. Cleland JA, Johnston PW, Anthony M, et al. A survey of factors influencing career preference in new-entrant and exiting medical students from four UK medical schools. BMC Med Educ. 2014 Jul 23;14(1):151.

9. Goldacre MJ, Taylor K, Lambert TW. Views of junior doctors about whether their medical school prepared them well for work: questionnaire surveys. BMC Med Educ. 2010 Dec;10(1):78.

10. Bowhay AR, Watmough SD. An evaluation of the performance in the UK Royal College of Anaesthetists primary examination by UK medical school and gender. BMC Med Educ. 2009 Jun 29;9(1):38.

11. Rushd S, Landau AB, Khan JA, et al. An analysis of the performance of UK medical graduates in the MRCOG Part 1 and Part 2 written examinations. Postgrad Med J. 2012 May 1;88(1039):249–54.

12. Menzies L, Minson S, Brightwell A, et al. An evaluation of demographic factors affecting performance in a paediatric membership multiple-choice examination. Postgrad Med J. 2015 Feb;91(1072):72–6.

13. Wakeford R, Foulkes J, McManus C, et al. MRCGP pass rate by medical school and region of postgraduate training. Royal College of General Practitioners. BMJ. 1993 Aug 28;307(6903):542–3.

14. McManus IC, Wakeford R. PLAB and UK graduates' performance on MRCP(UK) and MRCGP examinations: data linkage study. BMJ. 2014 Apr 17;348:g2621.

15. McManus IC, Harborne AC, Horsfall HL, et al. Exploring UK medical school differences: the MedDifs study of selection, teaching, student and F1 perceptions, postgraduate outcomes and fitness to practise. BMC Med. 2020 May 14;18(1):136.

16. McManus I, Elder AT, de Champlain A, et al. Graduates of different UK medical schools show substantial differences in performance on MRCP(UK) Part 1, Part 2 and PACES examinations. BMC Med. 2008 Feb 14;6(1):5.

17. Hecker K, Violato C. How Much Do Differences in Medical Schools Influence Student Performance? A Longitudinal Study Employing Hierarchical Linear Modeling. Teach Learn Med. 2008 Apr 10;20(2):104–13.

18. Burk-Rafel J, Pulido RW, Elfanagely Y, et al. Institutional differences in USMLE Step 1 and 2 CK performance: Cross-sectional study of 89 US allopathic medical schools. PLOS ONE. 2019 Nov 4;14(11):e0224675.

19. Ellis R, Cleland J, Scrimgeour D, et al. Does the MRCS exam fulfil its purpose in surgical professions? Bull R Coll Surg Engl. 2021 Oct 1;103(7):344–50.

20. Scrimgeour DSG, Cleland J, Lee AJ, et al. Prediction of success at UK Specialty Board Examinations using the mandatory postgraduate UK surgical examination. BJS Open. 2019 Dec;3(6):865–71.

21. Scrimgeour D, Brennan P, Griffiths G, et al. Does the Intercollegiate Membership of the Royal College of Surgeons (MRCS) examination predict 'on-the-job' performance during UK higher specialty surgical training? Ann R Coll Surg Engl. 2018 Nov;100(8):669–75.

22. Scrimgeour DSG, Cleland J, Lee AJ, et al. Impact of performance in a mandatory postgraduate surgical examination on selection into specialty training: Performance in a postgraduate surgical examination and selection into specialty training. BJS Open. 2017 Oct;1(3):67–74.

23. Lee MJ, Drake TM, Malik TAM, et al. Has the Bachelor of Surgery Left Medical School? A National Undergraduate Assessment. J Surg Educ. 2016 Jul 1;73(4):655–9.

24. Scrimgeour DSG, Cleland J, Lee AJ, et al. Which factors predict success in the mandatory UK postgraduate surgical exam: The Intercollegiate Membership of the Royal College of Surgeons (MRCS)? Surg J R Coll Surg Edinb Irel. 2018 Aug;16(4):220–6.

25. Ellis R, Scrimgeour DSG, Brennan PA, et al. Does performance at medical school predict success at the Intercollegiate Membership of the Royal College of Surgeons (MRCS) examination? A retrospective cohort study. BMJ Open. 2021 Aug;11(8):e046615.

26. Ellis R, Brennan P, Scrimgeour D, et al. A cross-sectional study examining associations between foundation school and MRCS performance. Bull R Coll Surg Engl. 2021 Nov 1;103(8):398–402.

27. Ellis R, Cleland J, Lee AJ, et al. A cross-sectional study examining MRCS performance by core surgical training location. Med Teach. 2021 Nov 2;1–6.

28. McManus I, Woolf K, Dacre J, et al. The Academic Backbone: longitudinal continuities in educational achievement from secondary school and medical school to MRCP(UK) and the specialist register in UK medical students and doctors. BMC Med. 2013 Dec;11(1):242.

29. Ferguson E, James D, Madeley L. Factors associated with success in medical school: systematic review of the literature. BMJ. 2002 Apr 20;324(7343):952–7.

30. Ellis R, Brennan P, Scrimgeour DS, et al. Performance at medical school selection correlates with success in Part A of the intercollegiate Membership of the Royal College of Surgeons (MRCS) examination. Postgrad Med J. 2021 Mar 10;postgradmedj-2021-139748.

31. Medical School Ranking 2020, The Complete University Guide [Internet]. 2020. [cited 2021 November 11] Available from: Accessed at https://www.thecompleteuniversityguide.co.uk/

32. Dowell J, Cleland J, Fitzpatrick S, et al. The UK medical education database (UKMED) what is it? Why and how might you use it? BMC Med Educ. 2018 Dec;18(1):6.

33. McManus I, Ludka K. Resitting a high-stakes postgraduate medical examination on multiple occasions: nonlinear multilevel modelling of performance in the MRCP(UK) examinations. BMC Med. 2012 Jun 14;10(1):60.

34. Woolf K, Potts H W W, McManus I C. Ethnicity and academic performance in UK trained doctors and medical students: systematic review and meta-analysis BMJ 2011; 342 :d901.

35. Medical Schools Council. Medicine Course Types [Internet]. 2018 [2021 November 11]. Available from: https://www.medschools.ac.uk/studying-medicine/course-types

36. Kumwenda B, Cleland J, Greatrix R, et al. Are efforts to attract graduate applicants to UK medical schools effective in increasing the participation of under-represented socioeconomic groups? A national cohort study. BMJ Open. 2018 14;8(2):e018946.

37. Profile of the Russell Group of Universities [Internet]. Russell Group; 2016 [cited 2021 November 11]. Available from: https://russellgroup.ac.uk/policy/publications/profile-of-the-russell-group-of-universities/

38. Boliver V. Are there distinctive clusters of higher and lower status universities in the UK? Oxf Rev Educ. 2015 Sep 3;41(5):608–27.

39. Coughlan S. Is the Russell Group really an 'oligarchy'? [Internet]. BBC News Education and Family.; 2014 [cited 2021 November 11]. Available from: https://www.bbc.co.uk/news/education-27399512

40. Fazackerley A. Should students be encouraged to set their sights on Russell Group universities? [Internet]. The Guardian; 2013 [cited 2021 November 11]. Available from: https://www.theguardian.com/education/2013/feb/18/russell-group-universities-students-ambitions

41. Lloyd-Jones, Margetson, Bligh. Problem-based learning: a coat of many colours. Med Educ. 1998;32(5):492–4.

42. Maudsley G. Do we all mean the same thing by 'problem-based learning'? A review of the concepts and a formulation of the ground rules. Acad Med J Assoc Am Med Coll. 1999 Feb;74(2):178–85.

43. British Medical Association. Course and teaching types at medical school. London, 2017. [cited 2021 November 11]; Available from: https://www.bma.org.uk/advice/career/studying-medicine/becoming-a-doctor/course-types

44. Guide to the intercollegiate MRCS examination [Internet]. Intercollegiate Committee for Basic Surgical Examinations; 2013 [cited 2021 November 11]. Available from: https://www.intercollegiatemrcsexams.org.uk/mrcs/candidate-guidance/

45. Surgical selection in the UK. [Internet]. Joint Committee on Surgical Training; [cited 2021 November 11]. Available from: https://www.jcst.org/introduction-to-training/selection-and-recruitment/

46. Rounding and suppression to anonymise statistics | HESA [Internet]. [cited 2021 November 11]. Available from: https://www.hesa.ac.uk/about/regulation/data-protection/rounding-and-suppression-anonymise-statistics

47. Harrell FE. Regression Modeling Strategies: With Applications to Linear Models, Logistic Regression, and Survival Analysis. 2nd edition. New York: Springer; 2006. 600 p.

48. Rubright JD, Jodoin M, Barone MA. Examining Demographics, Prior Academic Performance, and United States Medical Licensing Examination Scores. Acad Med J Assoc Am Med Coll. 2019;94(3):364–70.

49. Sutton E, Richardson JD, Ziegler C, et al. Is USMLE Step 1 score a valid predictor of success in surgical residency? Am J Surg. 2014 Dec;208(6):1029–34; discussion 1034.

50. Swanson DB, Sawhill A, Holtzman KZ, et al. Relationship between performance on part I of the American Board of Orthopaedic Surgery Certifying Examination and Scores on USMLE Steps 1 and 2. Acad Med J Assoc Am Med Coll. 2009 Oct;84(10 Suppl):S21-24.

51. Ghaffari-Rafi A, Lee RE, Fang R, et al. Multivariable analysis of factors associated with USMLE scores across U.S. medical schools. BMC Med Educ. 2019 May 20;19(1):154.

52. Twigg V, McNally S, Eardley I. What are the differences between medical schools that graduate more aspiring surgeons than others? Bull R Coll Surg Engl. 2020 Feb;102(2):e009.

53. McManus IC, Winder BC, Sproston KA, et al. Why do medical school applicants apply to particular schools? Med Educ. 1993;27(2):116–23.

54. Brown C. A qualitative study of medical school choice in the UK. Med Teach. 2007 Jan 1;29(1):27–32.

55. McManus I, Dewberry C, Nicholson S, et al. Construct-level predictive validity of educational attainment and intellectual aptitude tests in medical student selection: meta-regression of six UK longitudinal studies. BMC Med. 2013 Nov 14;11(1):243.

56. Garrud P, McManus IC. Impact of accelerated, graduate-entry medicine courses: a comparison of profile, success, and specialty destination between graduate entrants to accelerated or standard medicine courses in UK. BMC Med Educ. 2018 Nov 6;18(1):250.

57. Jones A, McArdle PJ, O'Neill PA. Perceptions of how well graduates are prepared for the role of pre-registration house officer: a comparison of outcomes from a traditional and an integrated PBL curriculum. Med Educ. 2002;36(1):16–25.

58. Miles S, Kellett J, Leinster SJ. Medical graduates' preparedness to practice: a comparison of undergraduate medical school training. BMC Med Educ. 2017 Dec;17(1):33.

59. Williams G, Lau A. Reform of undergraduate medical teaching in the United Kingdom: a triumph of evangelism over common sense. BMJ. 2004 Jul 8;329(7457):92–4.

60. Albanese MA, Mitchell S. Problem-based learning: a review of literature on its outcomes and implementation issues. Acad Med J Assoc Am Med Coll. 1993 Jan;68(1):52–81.

61. Garlick PB, Brown G. Widening participation in medicine. BMJ. 2008 May 15;336(7653):1111–3.

62. Curtis S, Blundell C, Platz C, et al. Successfully widening access to medicine. Part 2: Curriculum design and student progression. J R Soc Med. 2014 Oct;107(10):393–7.

63. Mahesan N, Crichton S, Sewell H, et al. The effect of an intercalated BSc on subsequent academic performance. BMC Med Educ. 2011 Oct 3;11:76.

64. Curtis S, Smith D. A comparison of undergraduate outcomes for students from gateway courses and standard entry medicine courses. BMC Med Educ. 2020 Jan 3;20(1):4.

65. Widening Participation it Matters! Our strategy and initial action plan [Internet]. Health Education England; 2014 [cited 2021 November 11]. Available from: https://www.hee.nhs.uk/sites/default/files/documents/Widening%20Participation%20it%20Matters_0.pdf

66. Specialty Recruitment Competition Ratios [Internet]. Health Education England; 2020 [cited 2021 November 11]. Available from: https://specialtytraining.hee.nhs.uk/Competition-Ratios

67. Puddey IB, Playford DE, Mercer A. Impact of medical student origins on the likelihood of ultimately practicing in areas of low vs high socio-economic status. BMC Med Educ. 2017 Jan 5;17(1):1.

68. Dowell J, Norbury M, Steven K, et al. Widening access to medicine may improve general practitioner recruitment in deprived and rural communities: survey of GP origins and current place of work. BMC Med Educ. 2015 Oct 1;15(1):165.

69. Puddey IB, Mercer A, Carr SE. Relative progress and academic performance of graduate vs undergraduate entrants to an Australian medical school. BMC Med Educ. 2019 May 22;19(1):159.

70. Manning G, Garrud P. Comparative attainment of 5-year undergraduate and 4-year graduate entry medical students moving into foundation training. BMC Med Educ. 2009 Dec 22;9(1):76.

71. Reports on the progress of doctors in training split by postgraduate body. General Medical Council. [Internet]. [cited 2021 November 11]. Available from: https://www.gmc-uk.org/education/reports-and-reviews/progression-reports

72. Pyne Y, Ben-Shlomo Y. Older doctors and progression through specialty training in the UK: a cohort analysis of General Medical Council data. BMJ Open. 2015 Feb 1;5(2):e005658.

73. Garrud P. Who applies and who gets admitted to UK graduate entry medicine? - an analysis of UK admission statistics. BMC Med Educ. 2011 Sep 26;11(1):71.

74. Goldacre MJ, Turner G, Lambert TW. Variation by medical school in career choices of UK graduates of 1999 and 2000. Med Educ. 2004;38(3):249–58.

75. Patterson F, Knight A, Dowell J, et al. How effective are selection methods in medical education? A systematic review. Med Educ. 2016 Jan;50(1):36–60.

76. Fielding S, Tiffin PA, Greatrix R, et al. Do changing medical admissions practices in the UK impact on who is admitted? An interrupted time series analysis. BMJ Open. 2018 Oct 1;8(10):e023274.

77. Patterson F, Roberts C, Hanson MD, et al. 2018 Ottawa consensus statement: Selection and recruitment to the healthcare professions. Med Teach. 2018 Nov;40(11):1091–101.

78. Ferguson E, James D, Yates J, et al. Predicting who applies to study medicine: implication for diversity in UK medical schools. Med Teach. 2012;34(5):382–91.

79. Kumwenda B, Cleland JA, Walker K, et al. The relationship between school type and academic performance at medical school: a national, multi-cohort study. BMJ Open. 2017 Aug 1;7(8):e016291.

80. Berger AP, Giacalone JC, Barlow P, et al. Choosing surgery as a career: Early results of a longitudinal study of medical students. Surgery. 2017 Jun 1;161(6):1683–9.

81. Cleland J, Johnston PW, French FH, et al. Associations between medical school and career preferences in Year 1 medical students in Scotland. Med Educ. 2012 May;46(5):473–84.

82. Goldacre MJ, Laxton L, Harrison EM, et al. Early career choices and successful career progression in surgery in the UK: prospective cohort studies. BMC Surg. 2010 Nov 2;10(1):32.

83. Adams T, Garden A. What influences medical school choice? Med Teach. 2006 Feb;28(1):83–5.

84. Kumwenda B, Cleland JA, Prescott GJ, et al. Relationship between sociodemographic factors and selection into UK postgraduate medical training programmes: a national cohort study. BMJ Open. 2018 Jun;8(6):e021329.

85. Scanlan GM, Cleland J, Johnston P, et al. What factors are critical to attracting NHS foundation doctors into specialty or core training? A discrete choice experiment. BMJ Open. 2018 Mar 1;8(3):e019911.

86. Cariaga-Lo LD, Richards BF, Hollingsworth MA, et al. Non-cognitive characteristics of medical students: entry to problem-based and lecture-based curricula. Med Educ. 1996 May;30(3):179–86.

87. Holen A, Manandhar K, Pant DS, et al. Medical students' preferences for problem-based learning in relation to culture and personality: a multicultural study. Int J Med Educ. 2015 Jul 19;6:84–92.

88. Bigsby E, McManus IC, Sedgwick P, et al. Which medical students enjoy problem-based learning? Educ Med J. 2013 Mar;5(1):e72-e76

89. Carter YH, Peile E. Graduate entry medicine: high aspirations at birth. Clin Med Lond Engl. 2007 Apr;7(2):143–7.

90. Broecke S. University rankings: do they matter in the UK? Educ Econ. 2015 Mar 4;23(2):137–61.

91. Tiffin PA, Paton LW. Differential attainment in the MRCPsych according to ethnicity and place of qualification between 2013 and 2018: a UK cohort study. Postgrad Med J. 2020 Sep 3;postgradmedj-2020-137913.

92. Dewhurst NG, McManus C, Mollon J, et al. Performance in the MRCP(UK) Examination 2003–4: analysis of pass rates of UK graduates in relation to self-declared ethnicity and gender. BMC Med. 2007 May 3;5:8.

93. Wakeford R, Denney M, Ludka-Stempien K, et al. Cross-comparison of MRCGP & MRCP(UK) in a database linkage study of 2,284 candidates taking both examinations: assessment of validity and differential performance by ethnicity. BMC Med Educ. 2015 Jan 16;15(1):1.

94. Hope D, Adamson K, McManus IC, et al. Using differential item functioning to evaluate potential bias in a high stakes postgraduate knowledge based assessment. BMC Med Educ. 2018 Apr 3;18(1):64.

95. McManus IC, Elder AT, Dacre J. Investigating possible ethnicity and sex bias in clinical examiners: an analysis of data from the MRCP(UK) PACES and nPACES examinations. BMC Med Educ. 2013 Dec;13(1):103.

96. Yeates P, Woolf K, Benbow E, et al. A randomised trial of the influence of racial stereotype bias on examiners' scores, feedback and recollections in undergraduate clinical exams. BMC Med. 2017 Dec;15(1):179.

97. Fyfe M, Horsburgh J, Blitz J, et al. Dos, Don'ts, Don't Knows: Redressing differential attainment related to race/ethnicity in medical schools. Perspect Med Educ. 2021 Oct;In Press.

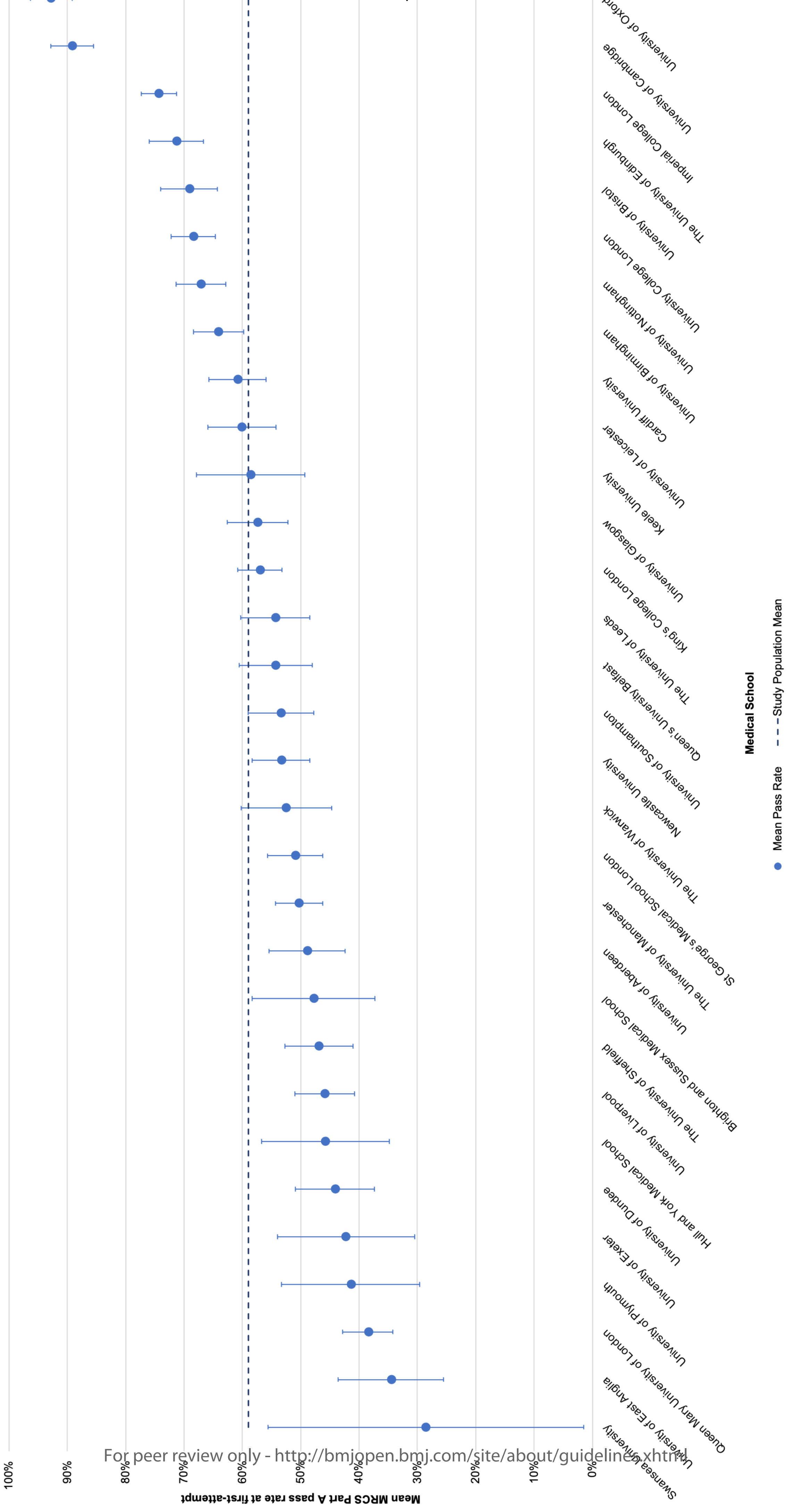
98. Ellis R, Cleland J, Scrimgeour D, et al. The impact of disability on performance in a high-stakes postgraduate surgical examination: a retrospective cohort study. J R Soc Med. 2021 Jul 16;01410768211032573.

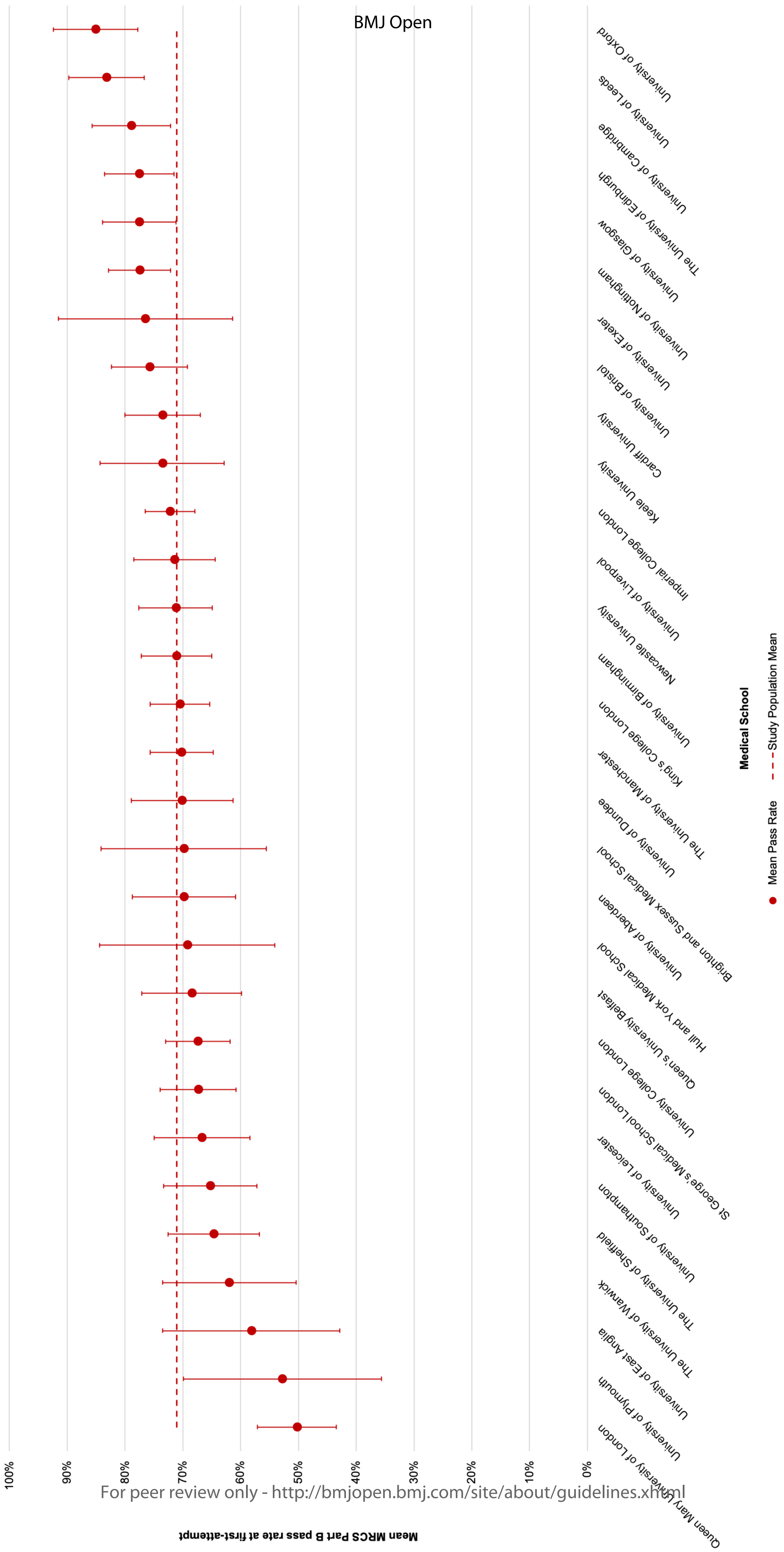
99. Ross PT, Hart-Johnson T, Santen SA, et al. Considerations for using race and ethnicity as quantitative variables in medical education research. Perspect Med Educ. 2020 Oct;9(5):318–23.

Figure 1. MRCS Part A first attempt pass rates by Medical School with 95% Confidence Interval.

Figure 2. MRCS Part B first attempt pass rates by Medical School with 95% Confidence Interval. Swansea University Part B results excluded due to small cohort (n=2).

Appendix 1. MRCS first attempt pass rates by Medical School, ranked according to the Complete University Guide as of 2020 with corresponding university code. All values presented from Chi-squared analysis; Part A X^2 = 626.05 *P*<0.001 and Part B X^2 =104.47 *P*<0.001. MRCS, Membership of the Royal College of Surgeons. C.I., Confidence Intervals to 95%.


University of Oxford
University of Cambridge
Imperial College London
The University of Edinburgh
University of Bristol
University College London
University of Nottingham
University of Birmingham
Cardiff University
University of Leicester
Keele University
University of Glasgow
King's College London
The University of Leeds
Queen's University Belfast
University of Southampton
Newcastle University
The University of Warwick
St George's Medical School London
The University of Manchester
University of Aberdeen
Brighton and Sussex Medical School
The University of Sheffield
University of Liverpool
Hull and York Medical School
University of Dundee
University of Exeter
University of Plymouth
Queen Mary University of London
University of East Anglia
Swansea University
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Mean MRCS Part A pass rate at first-attempt
Medical School
Mean Pass Rate
Study Population Mean


University of Oxford
University of Leeds
University of Cambridge
The University of Edinburgh
University of Glasgow
University of Nottingham
University of Exeter
University of Bristol
Cardiff University
Keele University
Imperial College London
University of Liverpool
Newcastle University
University of Birmingham
King's College London
The University of Manchester
University of Dundee
Brighton and Sussex Medical School
University of Aberdeen
Hull and York Medical School
Queen's University Belfast
University College London
St George's Medical School London
University of Leicester
University of Southampton
The University of Sheffield
The University of Warwick
University of East Anglia
University of Plymouth
Queen Mary University of London
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Mean MRCS Part B pass rate at first-attempt
Medical School
Mean Pass Rate
Study Population Mean

		Part A			Part B		
Rank	Medical School	Total Number of Candidates (n=9730)	Pass rate (n=5740)	95% C.I.	Total Number of Candidates (n=4645)	Pass rate (n=3290)	95% C.I.
1	The University of Oxford	210	92.8%	(89.2 – 96.3)	95	85.1%	(77.8 – 92.4)
2	The University of Cambridge	285	89.2%	(85.5 – 92.8)	140	78.9%	(72.1 – 85.7)
3	The University of Glasgow	350	57.4%	(52.2 – 62.6)	170	77.5%	(71.2 – 83.9)
4	The University of Swansea	15	28.6%	(1.5 – 55.6)	0	0%	-
5	The University of Edinburgh	365	71.3%	(66.7 – 76.0)	190	77.5%	(71.5 – 83.5)
6	The University of Dundee	215	44.1%	(37.4 – 50.9)	105	70.1%	(61.3 – 78.9)
7	Imperial College London	815	74.3%	(71.3 – 77.3)	415	72.2%	(67.9 – 76.5)
8	Queen Mary University of London	475	38.4%	(34.1 – 42.8)	210	50.2%	(43.4 – 57.1)
9	The University of Keele	110	58.6%	(49.3 – 67.9)	70	73.5%	(62.8 – 84.3)
10	The University of Exeter	70	42.3%	(30.5 – 54.0)	35	76.5%	(61.4 – 91.5)
11	The University of Aberdeen	230	48.9%	(42.4 – 55.4)	105	69.8%	(60.9 – 78.7)
12	The University of Bristol	355	69.1%	(64.3 – 74.0)	170	75.7%	(69.2 – 82.3)
13	University College London	575	68.4%	(64.6 – 72.2)	275	67.4%	(61.8 – 73.0)
14	University of Newcastle-upon-Tyne	390	53.3%	(48.4 – 58.3)	200	71.2%	(64.9 – 77.6)
15	Cardiff University	390	60.8%	(55.9 – 65.7)	180	73.5%	(67.0 – 80.0)
16	King's College London	665	57.0%	(53.2 – 60.8)	305	70.5%	(65.3 – 75.6)
17	The University of Sheffield	285	46.9%	(41.0 – 52.7)	145	64.6%	(56.7 – 72.5)
18	The University of Leeds	275	54.3%	(48.4 – 60.3)	130	83.2%	(76.7 – 89.7)
19	University of Plymouth	70	41.4%	(29.6 – 53.3)	35	52.8%	(35.6 – 69.9)
20	The University of East Anglia	110	34.5%	(25.5 – 43.6)	45	58.1%	(42.8 – 73.5)
21	Brighton and Sussex Medical School	90	47.8%	(37.3 – 58.3)	45	69.8%	(55.5 – 84.1)
22	The Queen's University of Belfast	245	54.3%	(48.0 – 60.5)	115	68.4%	(59.8 – 77.1)
23	University of Nottingham	465	67.1%	(62.8 – 71.4)	235	77.4%	(72.1 – 82.8)
24	The University of Manchester	580	50.3%	(46.2 – 54.3)	275	70.2%	(64.7 – 75.6)
25	Hull and York Medical School	85	45.8%	(34.8 – 56.7)	40	69.2%	(54.1 – 84.4)
26	The University of Birmingham	480	64.1%	(59.8 – 68.4)	220	71.1%	(65.0 – 77.2)
27	The University of Warwick	160	52.5%	(44.7 – 60.2)	70	62.0%	(50.4 – 73.5)
28	The University of Leicester	275	60.1%	(54.2 – 65.9)	130	66.7%	(58.4 – 74.9)
29	The University of Southampton	305	53.4%	(47.8 – 59.0)	140	65.2%	(57.2 – 73.3)
30	The University of Liverpool	365	45.9%	(40.8 – 51.0)	160	71.4%	(64.4 – 78.5)
31	St George's Medical School London	430	50.9%	(46.2 – 55.7)	200	67.3%	(60.8 – 73.9)

STROBE Statement—Checklist of items that should be included in reports of ***cohort studies***

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract (*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	1-4
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	5-6
Objectives	3	State specific objectives, including any prespecified hypotheses	5-6
Methods			
Study design	4	Present key elements of study design early in the paper	6-11
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6-11
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up (*b*) For matched studies, give matching criteria and number of exposed and unexposed	6-11
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6-11
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	6-11
Bias	9	Describe any efforts to address potential sources of bias	6-11
Study size	10	Explain how the study size was arrived at	6-11
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6-11
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding (*b*) Describe any methods used to examine subgroups and interactions (*c*) Explain how missing data were addressed (*d*) If applicable, explain how loss to follow-up was addressed (*e*) Describe any sensitivity analyses	6-11
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed (b) Give reasons for non-participation at each stage (c) Consider use of a flow diagram	11-20
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders (b) Indicate number of participants with missing data for each variable of interest (c) Summarise follow-up time (eg, average and total amount)	11-20
Outcome data	15*	Report numbers of outcome events or summary measures over time	11-20

Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included (*b*) Report category boundaries when continuous variables were categorized (*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	11-20
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	11-20
Discussion			
Key results	18	Summarise key results with reference to study objectives	21-25
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	21-25
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	21-25
Generalisability	21	Discuss the generalisability (external validity) of the study results	21-25
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	26

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at http://www.strobe-statement.org.

BMJ Open

Does Performance at the Intercollegiate Membership of the Royal Colleges of Surgeons (MRCS) Examination Vary According to UK Medical School and Course Type? A retrospective cohort study

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2021-054616.R2
Article Type:	Original research
Date Submitted by the Author:	01-Dec-2021
Complete List of Authors:	Ellis, Ricky; University of Aberdeen Institute of Applied Health Sciences; Nottingham University Hospitals NHS Trust, Urology Department Brennan, Peter ; Queen Alexandra Hospital, Department of Maxillo-Facial Surgery Scrimgeour, Duncan; Aberdeen Royal Infirmary, Department of Colorectal Surgery; University of Aberdeen Institute of Applied Health Sciences Lee, Amanda; University of Aberdeen Institute of Applied Health Sciences, Medical Statistics Team Cleland, Jennifer; Lee Kong Chian School of Medicine, Medical Education Research and Scholarship Unit (MERSU)
Primary Subject Heading:	Medical education and training
Secondary Subject Heading:	Medical education and training, Surgery
Keywords:	MEDICAL EDUCATION & TRAINING, SURGERY, Adult surgery < SURGERY

SCHOLARONE™
Manuscripts

I, the Submitting Author has the right to grant and does grant on behalf of all authors of the Work (as defined in the below author licence), an exclusive licence and/or a non-exclusive licence for contributions from authors who are: i) UK Crown employees; ii) where BMJ has agreed a CC-BY licence shall apply, and/or iii) in accordance with the terms applicable for US Federal Government officers or employees acting as part of their official duties; on a worldwide, perpetual, irrevocable, royalty-free basis to BMJ Publishing Group Ltd ("BMJ") its licensees and where the relevant Journal is co-owned by BMJ to the co-owners of the Journal, to publish the Work in this journal and any other BMJ products and to exploit all rights, as set out in our licence.

The Submitting Author accepts and understands that any supply made under these terms is made by BMJ to the Submitting Author unless you are acting as an employee on behalf of your employer or a postgraduate student of an affiliated institution which is paying any applicable article publishing charge ("APC") for Open Access articles. Where the Submitting Author wishes to make the Work available on an Open Access basis (and intends to pay the relevant APC), the terms of reuse of such Open Access shall be governed by a Creative Commons licence – details of these licences and which Creative Commons licence will apply to this Work are set out in our licence referred to above.

Other than as permitted in any relevant BMJ Author's Self Archiving Policies, I confirm this Work has not been accepted for publication elsewhere, is not being considered for publication elsewhere and does not duplicate material already published. I confirm all authors consent to publication of this Work and authorise the granting of this licence.

Does Performance at the Intercollegiate Membership of the Royal Colleges of Surgeons (MRCS) Examination Vary According to UK Medical School and Course Type? A retrospective cohort study

Authors

R Ellis[1,2], PA Brennan[3], DSG Scrimgeour[4,] AJ Lee[5], J Cleland[6]

[1]Institute of Applied Health Sciences, University of Aberdeen, and [2]Urology Department, Nottingham University Hospitals NHS Trust, Nottingham and [3]Department of Maxillo-Facial Surgery, Queen Alexandra Hospital, Portsmouth. and [4]Department of Colorectal Surgery, Aberdeen Royal Infirmary, Aberdeen and [5]Medical Statistics Team, Institute of Applied Health Sciences, University of Aberdeen, and [6]Lee Kong Chian School of Medicine, Nanyang Technological University, Singapore.

Correspondence to:

Mr Ricky Ellis

Urology Specialist Registrar and Intercollegiate Research Fellow.

Institute of Applied Health Sciences, University of Aberdeen, Aberdeen, AB25 2ZD.

Rickyellis@nhs.net

@RickJEllis1

Co-author details

Professor Peter A Brennan, PhD

Professor of Surgery, Consultant Maxillo-Facial Surgeon and Research Lead for the Intercollegiate Committee for Basic Surgical Examinations

Department of Maxillo-Facial Surgery, Queen Alexandra Hospital, Portsmouth, PO6 3LY, United Kingdom.

Peter.brennan@porthosp.nhs.uk

@BrennanSurgeon

Mr Duncan SG Scrimgeour, PhD

Colorectal Specialist Registrar and Past Intercollegiate Research Fellow

Department of Colorectal Surgery, Aberdeen Royal Infirmary, Aberdeen, AB25 2ZN, United Kingdom.

duncan.scrimgeour@nhs.scot

@dsgscrimgeour

Professor Amanda J Lee, PhD

Chair in Medical Statistics and Director of the Institute of Applied Health Sciences

University of Aberdeen, AB25 2ZD, United Kingdom.

a.j.lee@abdn.ac.uk

Professor Jennifer Cleland, PhD

Professor of Medical Education Research and Vice-Dean of Education

Medical Education Research and Scholarship Unit, Lee Kong Chian School of Medicine, Nanyang Technological University, Singapore.

jennifer.cleland@ntu.edu.sg

Key words:

MRCS, Post-graduate examinations, Medical Education and Training, Pedagogy

Word Count: 5,528

ABSTRACT

Objectives: The knowledge, skills and behaviours required of new UK medical graduates are the same but how these are achieved differs given medical schools vary in their mission, curricula and pedagogy. Medical school differences seem to influence performance on postgraduate assessments. To date, the relationship between medical schools, course types, and performance at the Membership of the Royal Colleges of Surgeons examination (MRCS) has not been investigated. Understanding this relationship is vital to achieving alignment across undergraduate and postgraduate training, learning and assessment values.

Design and Participants: A retrospective longitudinal cohort study of UK medical graduates who attempted MRCS Part A (n=9730) and MRCS Part B (n=4645) between 2007-2017, utilising individual-level linked sociodemographic and prior academic attainment data from the UK Medical Education Database.

Methods: We studied MRCS performance across all UK medical schools and examined relationships between potential predictors and MRCS performance using chi-squared analysis. Multivariate logistic regression models identified independent predictors of MRCS success at first attempt.

Results: MRCS pass rates differed significantly between individual medical schools (P<0.001) but not after adjusting for prior A-Level performance. Candidates from courses other than those described as problem-based learning (PBL) were 53% more likely to pass MRCS Part A (Odds ratio (OR) 1.53 [95% Confidence Interval 1.25-1.87] and 54% more likely to pass Part B (OR 1.54 [1.05-2.25]) at first attempt after adjusting for prior academic performance. Attending a Standard-Entry 5-year medicine programme, having no prior degree and attending a Russell Group university were independent predictors of MRCS success in regression models (P<0.05).

Conclusions: There are significant differences in MRCS performance between medical schools. However, this variation is largely due to individual factors such as academic ability, rather than medical school factors. This study also highlights group level attainment differences that warrant further investigation to ensure equity within medical training.

Keywords

Medical Education and Training, Surgery, Adult Surgery

Strengths and Limitations of this study

- This is the first study to explore differences in MRCS performance between medical school course types, pedagogy and indicators of institutional esteem.
- It is a large-scale longitudinal cohort study utilising the UK Medical Education Database.
- The outcome measure of pass/fail at the MRCS examination may hide institutional differences in performance at the question level.
- A-Levels were used as a marker of prior academic attainment in this study, which does not represent the full range of school-leaving examinations used across the UK.
- A larger sample would enable a more granular look at group-level differential attainment.

BACKGROUND

Medical schools vary significantly in their teaching methodology, curriculum, course structure, assessment methods and standards (1–4). In the United Kingdom (UK), the General Medical Council (GMC) acknowledged that these differences between medical schools exist and that it is “inevitable” that this variation can influence a graduate’s “interests, abilities and career progression” but that it is not a “cause for concern” (5), presumably because all new medical graduates must meet the same GMC standards. This view can be debated given that medical school seems to influence career progression, direction and success. For example, the number of graduates choosing each speciality differs significantly across medical schools (6–8). There is significant variation in preparedness for practice, progression through Annual Reviews of Competency Progression (ARCP) in UK training programmes and fitness to practice sanctions according to the medical school of primary qualification (5,9). There are also significant differences in the performance of graduates from different medical schools on high-stakes postgraduate examinations such as the FRCA (10) MRCOG (11), MRCPCH (12), MRCGP (13,14) and MRCP (14–16) (see abbreviations list). This variation in performance is far from unique to the UK, with significant differences in performance according to medical school also found in postgraduate assessments in other countries such as the United States (US) (17,18). However, to our knowledge, no studies have yet demonstrated whether success at postgraduate surgical examinations differs according to medical school, course type or medical school indicators of esteem (e.g., institutional ranking) in the UK.

Understanding the relationship between medical school, course type and pedagogy with markers of postgraduate success is vital for the optimisation of undergraduate teaching by enabling the alignment of undergraduate and postgraduate curricula and assessment values. This alignment ensures best educational practices and the optimisation of training to produce safe and prepared doctors.

The Intercollegiate Membership of the Royal Colleges of Surgeons examination (MRCS) is a high-stakes postgraduate examination, highly valued in the UK as a gatekeeper to the surgical profession (19). Success at MRCS is associated with success in surgical training, national selection for higher specialty training and first attempt success in the Fellowship of the Royal College of Surgeons examinations (FRCS) and can therefore be used as an indicative marker of future outcomes in a surgical career (20–22). Success in this examination can be used by medical schools in the alignment of training and assessment values, and students who wish to pursue surgery as a specialty may want to know which medical school will "best" prepare them for a surgical career (23).

In this study, we aimed to evaluate whether medical school of primary qualification or medical course type influence MRCS success. We aimed to establish this by the comparison of first attempt pass rates for MRCS across all UK medical schools and understanding the likelihood of passing MRCS based on university, course type and course pedagogy. Additionally, we aimed to investigate whether indicators of esteem such as Russell Group membership and institutional national ranking predict MRCS success.

Moreover, in order to understand the true impact of medical school differences on MRCS performance we adjusted analyses for prior academic attainment and sociodemographic factors that are known to predict MRCS success (24,25). Previous studies have found that after adjusting for these demographic factors (gender, maturity and ethnicity), variation in early surgical training experiences in the UK (Foundation and Core Surgical Training) has little impact on MRCS success (26,27). Prior academic attainment is known to be the strongest predictor of later success in medical education (20,28,29), and at MRCS (24,25,30). Given that some universities are more competitive at entry than others (30,31), it is likely that some medical schools recruit the highest performing candidates. As such, both factors are, adjusted for in our analyses.

METHODS

This was a longitudinal retrospective cohort study. Individual-level linked data was obtained from the UK Medical Education Database (UKMED) (32) and the four Royal Colleges of Surgeons of the UK and Ireland (Edinburgh, Glasgow, England and Ireland). The UKMED database contains background sociodemographic details and assessment results from school to postgraduate examinations and career progression data from combined sources linked at an individual level for all UK medical students and doctors in training (32). This novel database enables powerful multicentre longitudinal cohort studies by including large study populations with minimal missing data. Anonymised data were extracted from UKMED for all UK medical graduates who had attempted either the Part A or the Part B MRCS examination between 2007-2017.

The following data were extracted: Place of primary medical qualification, course pedagogy and type, MRCS Part A and B first attempt result, gender, self-declared ethnicity and graduation status at the time of entry to medical school. Gender, ethnicity and graduate status were extracted as these are known predictors of MRCS success (24,25). Candidate first attempt results were used as they have been shown to be the best predictor of future performance in postgraduate examinations (24,33). These variables are described in more detail below.

Except for place of primary qualification, all variables were dichotomized. Part A and B MRCS performance was categorized as “pass” or “fail” at first attempt. Graduation status was defined as “no” if candidates had not obtained a degree prior to entering medicine and “yes” if they entered as a graduate. Self-declared ethnicity was coded as “white” or “non-white” as per similar studies to enable powered analysis of smaller cohorts, rather than this being an ethical or social decision (20,21,34). Course pedagogy was classified as “Problem Based Learning” (PBL) or “Not Problem Based Learning” (nPBL). Course type was classified as “Graduate-Entry” (GEM: four-year accelerated Graduate-Entry medicine programmes) or “Undergraduate” which was later further classified into “Standard-Entry” program (SEM) or “Medicine with a Gateway Year” (five years plus one preparatory year). Note that foundation year students were combined with gateway students for this last category, as both approaches have the aim of widening access to medicine; that is, providing alternative ways into medicine for those who do not meet the academic criteria for SEM courses because of socio-economic or personal disadvantage (35).

Finally, there are a significant number of graduates who choose to do a SEM programme (36), so candidates who undertook SEM courses were further defined as “Graduate on Entry” or “Not Graduate on Entry”.

Medical Schools

At the time of this study, there were 35 medical schools in the United Kingdom recognised by the GMC, including a combined University of London awarding body. Most are undergraduate courses, offering a five-year programme, plus 16 accelerated graduate entry programmes. Eleven medical schools offer gateway/foundation courses. The study-specific dataset included values for 31 medical schools: newer medical schools (e.g., Lancaster, Anglia Ruskin and The University of Buckingham) were not represented in the dataset as very few if any of their graduates had attempted MRCS within the study period. Several GEM courses included in the analysis have since ceased to exist (such as Leicester and Bristol), additionally, new GEM and Gateway courses were not included if graduates of these courses had not attempted the MRCS within the study period.

Within the UK, a number of universities combine to create linked medical schools such as Leicester-Warwick Medical School (a combination of the Universities of Leicester and Warwick) and Peninsula Medical School (a combination of Plymouth and Exeter Universities). Many later cease their partnership, creating two independent medical schools. To represent this in the data analysis candidates who studied at either Leicester-Warwick or

Peninsula Medical Schools were categorized according to the university from which they graduated (i.e., Leicester, Warwick, Plymouth or Exeter). Graduates of Hull-York Medical School and Brighton and Sussex Medical School remain under the combined title as they were still combined institutions at the time of data analysis. Within the study period certain medical schools were also linked (e.g., Keele students were awarded degrees by the University of Manchester until 2012). To acknowledge this, students were categorised by the place of graduation for their primary medical qualification, including London graduates.

Indicators of esteem: Rankings

In this study, universities were ordered according to their ranking by 'The Complete University Guide' as of August 2020. 'The Complete University Guide' is the most well recognised independent university ranking system in the UK and uses the following data annually to create an overall score (100 points being the most a university can be awarded): entry standards, student satisfaction, research quality and intensity, graduate prospects, student to staff ratio, spending, honours and degree completion. More information on how the ranking system is calculated is available on the complete university guide website (31). This ranking system provides a quantitative comparator between universities for this study and its use does not suggest that its value is greater than that of any other ranking systems that exist which are calculated using similar data. Note that Lancaster University (ranked 16th) was excluded having only opened in 2006 and having insufficient outcome data. St Andrews Medical School (ranked 25th) was also excluded as it offers only pre-clinical education: those who commenced their studies at St Andrews were therefore categorised by their place of graduation (e.g. Manchester University, The University of Dundee, etc.). The ranking table was adjusted accordingly, to create an ordinal variable.

Indicators of esteem: Russell Group

Russell Group Institutions are a collection of self-selected research-driven universities that have developed a reputation of excellence (37). Most older medical schools are associated with the Russell Group. Whether these universities are truly the elite institutions within the UK is a highly debated topic (38–40) but they do graduate the majority (80%) of the UK medical students.

Pedagogy

Despite well-established definitions of what comprises problem-based learning (PBL) it can be challenging to identify which medical schools run PBL courses (41,42). We have aligned our definition with that of the British Medical Association (BMA) as well as that used in recent studies to ensure consistency within the literature, enabling comparisons to be drawn between the results of these studies (1,15,43). PBL schools are: Liverpool, Manchester, Glasgow, Queen Mary, Cardiff, Plymouth, Exeter, Sheffield, Keele, Hull-York and East Anglia.

Markers of prior academic attainment

Individual-level linked performance data was extracted for A-Levels as a marker of prior academic attainment. A-Levels are taken as school exit examinations in the majority of schools in England and in some schools elsewhere in the United Kingdom. A-Level results are routinely used as a medical school selection metric (30). Total A-Level scores used in data analyses are the sum of all A-Level scores achieved i.e. A=10 (being the highest score achievable for each A-Level), B=8, C=6, D=4, E=2, U=0 (being the lowest score for each A-Level). A small minority of candidates in the dataset (n=30) undertook A-Levels after A* grades were implemented in 2010. These were subsequently excluded for cohort homogeneity.

MRCS examination background

The examination comprises two parts; Part A, the written component made up of two multiple-choice questionnaire tests and Part B, a clinical examination that includes 17 Objective Structured Clinical Examination stations (44). Taken during Foundation and Core

Surgical Training, both MRCS Part A and Part B must now be passed to enable the progression of trainees into higher surgical specialty (residency) training (45).

Statistical analysis

All analyses were conducted using SPSS® v22.0 (IBM, Armonk, New York, USA). Chi-squared tests were used to assess the relationship between two categorical factors such as medical school and first attempt MRCS pass/fail outcomes.

All counts have been rounded to the nearest 5 for illustration according to Higher Education Statistics Agency (HESA) data standards (46). Regression models were used to calculate the odd's ratios (OR) and 95% confidence interval (CI) for passing MRCS Parts A and B at first attempt according to place of primary medical qualification. The University of Keele was declared the reference category for construction of the logistic regression model for MRCS Part A, as the pass rate at this university (58.6%) most closely resembled the pass rate of the entire cohort of Part A candidates from all universities. The University of Birmingham was declared the reference category for Part B in the logistic regression model, as the pass rate at this university (71.1%) most closely resembled the pass rate of the entire cohort of Part B candidates from all universities.

Potential independent predictors of first attempt success at Part A and B MRCS were identified using multivariate logistic regression models. Regression models were constructed using backward stepwise regression with and without adjustment for prior academic attainment (A-level performance) for direct comparison (47). Any variable (sociodemographic factor, course type, teaching methodology or marker of institutional esteem) with an association with the outcome at a conservative $P<0.10$ on univariate analysis was entered into the logistic regression model. All potential predictors with $P>0.05$ in the full model were subsequently removed until only statistically significant predictors remained in the final model. Potential interactions between the remaining significant predictors were also examined.

Data management

The highest standards of security, governance and confidentiality were ensured when storing handling and analysing data. See later for details of ethics approval.

Patient and public involvement

No patients or members of the public were involved in this study.

RESULTS

Medical School Differences

Between 2007 to 2017 a total of 9,730 UK medical graduates from 31 medical schools attempted the MRCS Part A, with 59% (standard deviation (SD) 49) passing on the first attempt. A total of 4,645 candidates attempted MRCS Part B and 71% (SD 45) passed at their first attempt. Of all Part A exam candidates 64% were male, 59% were white and 86% had no degree-level qualification prior to studying medicine. Similar demographics were seen in Part B applicants with 65% male candidates, 61% white candidates and 86% of candidates having no prior degree. Chi-squared analysis revealed a significant difference in MRCS pass rates between medical schools for Part A (P<0.001) and Part B (P<0.001). Figure 1 shows MRCS Part A first attempt pass rates by medical school and Figure 2 shows MRCS Part B first attempt pass rates by medical school. Raw data is presented in Appendix 1).

Figure 1 and Figure 2 about here

Medical School ranking and position of esteem

Odds ratios for passing MRCS Part A and B at the first attempt for each medical school can be found in Table 1. Oxford and Cambridge University graduates (ranked 1st and 2nd respectively) performed significantly better in MRCS Part A than the mean with resulting odds ratio of 9.11 (95% CI 4.77 to 17.39) and 5.82 (3.42 to 9.90) respectively. After adjusting for prior academic attainment, Oxford University graduates were still found to be more than three times more likely to pass MRCS Part A at first attempt (OR 3.18 (95% CI 1.15 to 8.81)) and Cambridge graduates were more than twice as likely to pass (OR 2.64 (95% CI 1.03 to 6.78)). After adjusting for prior academic attainment, no medical schools were found to be statistically significant predictors of MRCS Part B first-attempt success and there was no statistically significant difference in MRCS performance between most medical schools.

Table 1. Odds ratio for pass at first attempt at Part A and Part B MRCS across all UK medical schools ranked according to the Complete University Guide as of 2019-2020. C.I., Confidence Interval. Statistically significant odds ratios are shown in bold.

		Part A			**Part B**		
Rank	**Medical School**	**MRCS Candidates (n=9730)**	**Unadjusted Odds Ratio (95% C.I.)**	**Odds Ratio Adjusted for prior academic attainment (95% C.I.)**	**MRCS Candidates (n=4645)**	**Unadjusted Odds Ratio (95% C.I.)**	**Odds Ratio Adjusted for prior academic attainment (95% C.I.)**
1	University of Oxford	210	**9.11 (4.77 – 17.39)**	**3.18 (1.15-8.81)**	94	**2.32 (1.23 – 4.40)**	4.43 (0.51-38.58)
2	University of Cambridge	285	**5.82 (3.42 – 9.90)**	**2.64 (1.03-6.78)**	142	1.52 (0.92 – 2.50)	3.92 (0.77-19.82)
3	University of Glasgow	350	0.96 (0.62 – 1.47)	0.51 (0.18-1.39)	169	1.40 (0.88 – 2.23)	1.11 (0.20-6.09)
4	Swansea University	15	**0.28 (0.08 – 0.96)**	**0.90 (0.83-0.97)**	0	- -	- -
5	The University of Edinburgh	365	**1.76 (1.13 – 2.74)**	2.01 (0.81-5.00)	190	1.40 (0.89 – 2.19)	0.56 (0.19-1.62)
6	University of Dundee	215	**0.56 (0.35 – 0.89)**	0.73 (0.26-2.05)	105	0.95 (0.57 – 1.58)	0.42 (0.14-1.32)
7	Imperial College London	815	**2.05 (1.36 – 3.08)**	1.26 (0.58-2.75)	415	1.06 (0.73 – 1.52)	1.22 (0.47-3.20)
8	Queen Mary University of London	475	**0.44 (0.29 – 0.67)**	0.45 (0.19-1.04)	210	**0.41 (0.28 – 0.61)**	0.38 (0.14-1.01)
9	Keele University	110	- -	- -	70	1.13 (0.61 – 2.09)	0.61 (0.17-2.17)
10	University of Exeter	70	**0.52 (0.28 – 0.95)**	0.38 (0.13-1.07)	35	1.32 (0.57 – 3.08)	2.24 (0.25-20.12)
11	University of Aberdeen	230	0.68 (0.43 – 1.07)	0.39 (0.12-1.29)	105	0.94 (0.57 – 1.56)	0.28 (0.04-2.23)
12	University of Bristol	355	**1.58 (1.02 – 2.46)**	0.66 (0.28-1.52)	170	1.27 (0.80 – 2.01)	0.83 (0.24-2.86)
13	University College London	575	**1.53 (1.02 – 2.33)**	1.25 (0.55-2.82)	275	0.84 (0.57 – 1.24)	1.11 (0.37-3.31)
14	Newcastle University	390	0.81 (0.53 – 1.24)	0.59 (0.26-1.32)	200	1.01 (0.66 – 1.54)	1.44 (0.50-4.17)
15	Cardiff University	390	1.10 (0.72 – 1.69)	0.79 (0.35-1.78)	180	1.13 (0.72 – 1.75)	1.34 (0.44-4.14)
16	King's College London	665	0.94 (0.62 – 1.41)	0.63 (0.29-1.38)	305	0.97 (0.66 – 1.42)	1.31 (0.45-3.84)
17	The University of Sheffield	285	**0.62 (0.40 – 0.97)**	0.82 (0.34-2.00)	145	0.74 (0.47 – 1.16)	0.43 (0.15-1.30)
18	University of Leeds	275	0.84 (0.54 – 1.32)	0.67 (0.28-1.64)	130	**2.01 (1.17 – 3.47)**	2.63 (0.51-13.58)
19	University of Plymouth	70	**0.50 (0.27 – 0.92)**	0.63 (0.23-1.70)	35	**0.45 (0.22 – 0.93)**	0.39 (0.10-1.50)
20	University of East Anglia	110	**0.37 (0.22 – 0.64)**	0.44 (0.17-1.14)	45	0.57 (0.29 – 1.11)	1.54 (0.27-8.73)
21	Brighton and Sussex Medical School	90	0.65 (0.37 – 1.13)	1.10 (0.35-3.44)	45	0.94 (0.46 – 1.92)	0.35 (0.08-1.57)
22	Queen's University Belfast	245	0.84 (0.53 – 1.32)	0.49 (0.21-1.15)	115	0.88 (0.54 – 1.44)	0.80 (0.25-2.56)
23	University of Nottingham	465	1.44 (0.94 – 2.21)	0.92 (0.41-2.07)	235	1.40 (0.91 – 2.13)	2.03 (0.63-6.54)
24	The University of Manchester	580	0.72 (0.47 – 1.08)	0.58 (0.26-1.28)	275	0.96 (0.65 – 1.41)	0.78 (0.29-2.09)
25	Hull York Medical School	85	0.60 (0.34 – 1.06)	0.79 (0.25-2.50)	40	0.92 (0.44 – 1.92)	1.30 (0.11-16.01)
26	University of Birmingham	480	1.26 (0.83 – 1.93)	1.08 (0.48-2.41)	220	- -	- -
27	University of Warwick	160	0.78 (0.48 – 1.27)	2.08 (0.16-27.09)	70	0.66 (0.38 – 1.16)	0.80 (0.69-1.02)
28	University of Leicester	275	1.07 (0.68 – 1.67)	0.80 (0.33-1.94)	130	0.81 (0.51 – 1.30)	0.54 (0.17-1.72)
29	University of Southampton	310	0.81 (0.52 – 1.26)	0.63 (0.27-1.45)	140	0.76 (0.48 – 1.20)	0.56 (0.19-1.61)
30	University of Liverpool	365	**0.60 (0.39 – 0.92)**	0.66 (0.30-1.47)	160	1.02 (0.65 – 1.59)	1.01 (0.35-2.88)
31	St George's University of London	430	0.73 (0.48 – 1.12)	0.73 (0.32-1.62)	200	0.84 (0.55 – 1.27)	0.46 (0.18-1.13)

There was a significant difference in MRCS Part A pass rates between candidates from Russell Group Universities (60.7% (4970/8185)) and Non-Russell Group Universities (49.9% (770/1540)) *P*<0.001 (Table 2). Similarly, a significant difference was seen in Part B of the examination with a pass rate of 71.4% (2790/3910) for Russell Group Universities and 67.5% (495/735) for Non-Russell Group Universities *P*=0.038.

Table 2. MRCS first attempt pass rates by course type and prior degree status.

Predictor	Part A (n= 9730)	Part B (n = 4645)
Russell Group		
Yes	60.7% (4970/8185)	71.4% (2790/3910)
No	49.9% (770/1540)	67.5% (495/735)
Missing	n=0	n=0
p-value	< 0.001	0.038
Course		
Undergraduate	59.3% (5305/8950)	71.0% (3050/4300)
Graduate-Entry	54.6% (405/745)	69.3% (230/335)
Missing	n=35	n=10
p-value	0.012	0.533
Undergraduate Course Classification		
Standard-Entry Medicine	60.0% (5255/8755)	71.1% (3010/4230)
Medicine with Gateway Year	28.1% (55/190)	60.9% (40/70)
Missing	n=0	n=0
p-value	< 0.001	0.081
Prior Degree Status on Undergraduate Courses		
Not Graduate on entry	60.2% (4945/8220)	71.5% (2830/3960)
Graduate on entry	49.5% (360/730)	65.0% (220/335)
Missing	n=0	n=0
p-value	< 0.001	0.015
Graduate Student Outcomes		
Graduate on Standard-Entry Course	49.5% (360/730)	65.0% (220/335)
Graduate on Graduate-Entry Course	54.6% (405/745)	69.3% (230/335)
Missing	n=0	n=0
p-value	0.054	0.251

Teaching Methodology		
Not Problem Based Learning	63.1% (4560/7225)	72.2% (2505/3465)
Problem Based Learning	47.0% (1175/2500)	66.6% (785/1180)
Missing	n=0	n=0
p-value	< 0.001	< 0.001

Note. All p-values presented are from chi-squared analysis. MRCS, Membership of the Royal College of Surgeons.

Course Type

Univariate analysis of pass rates by course type is displayed in Table 2. The majority of all MRCS Part A candidates had studied a Standard-Entry Medicine (SEM) course (8950/9730): only 745 candidates had graduated from a Graduate-Entry Medicine (GEM) course. There was a significant difference between Part A pass rates of SEM (59.3%) and GEM graduates (54.6%) *P*=0.012. Of the 335 graduates who attempted Part B, 69.3% passed first time, and there was no statistically significant difference in MRCS Part B pass rates between SEM and GEM candidates (*P*=0.533).

A small proportion of the trainees attempting MRCS Part A who had studied a SEM course (n=8950) entered medicine as graduates (n=730). There was a significant difference in MRCS Part A success between those entering without a prior degree 60.2% (4945/8220) and graduates 49.5% (360/730) from SEM courses, *P*<0.001. Similar results were found for MRCS Part B (71.5% (2830/3960) versus 65% (220/335) respectively *P*<0.001).

Table 2 shows that of all candidates who attended a SEM, 190 entered their course via a ‘Gateway year’. A statistically significant difference was seen in MRCS Part A pass rates between students who undertook a Gateway year (28.1%) and those who entered directly into a Standard-entry course (60.0%) *P*<0.001. There was a difference in MRCS Part B pass rates between Gateway students (60.9% (40/70)) and direct-entry students (71.1% (3010/4230)) but this was not statistically significant (*P*=0.081).

Of all graduates from SEM courses, 49.5% passed Part A first time compared to 54.6% of graduates from GEM courses (*P*=0.054). Similarly, 65% of SEM graduates passed Part B first time compared to 69.3% of GEM graduates (*P*=0.251).

Course pedagogy

A significant difference was observed in MRCS Part A first attempt pass rates between candidates who studied on a course described as PBL and those who studied at medical schools with other core pedagogies (47.0% (1175/2505) versus 63.1% (4560/7225) *P*<0.001 (Table 2)). A similar difference was observed in Part B of the MRCS (PBL: 66.6% (785/1180) and non-PBL: 72.2% (2505/3465) *P*<0.001).

A comparison of MRCS pass rates between GEM courses can also be found in Table 3. There was a significant difference in pass rates between GEM schools for MRCS Part A (*P*=0.028) but not for MRCS Part B (*P*=0.072). Drilling down further highlights that the aggregate data disguise variation. For example, graduates of the King's College London GEM programme performed above average (e.g., 76.7% Part A and 81.0% Part B pass rates; Table 3) but the MRCS performance of candidates from their undergraduate programme was lower than average (57% Part A and 70.5% Part B, Figure 1).

Table 3. MRCS first attempt pass rates by Graduate-Entry Medicine course.

	Part A			Part B		
Medical School	**Total Number of Candidates (n=745)**	**Pass rate (n=405)**	**95% C.I.**	**Total Number of Candidates (n=335)**	**Pass rate (n=230)**	**95% C.I.**
The University of Oxford	5	100.0%	(100.0 – 100.0)	5	100.0%	(100.0 – 100.0)
The University of Cambridge	25	80.0%	(63.1 – 96.9)	10	40.0%	(0.31 – 76.9)

The University of Swansea	15	28.6%	(1.5 – 55.6)	0	-	-
Imperial College London	25	51.9%	(31.7 – 72.0)	10	60.0%	(23.1 – 96.9)
Queen Mary University of London	75	51.3%	(39.8 – 62.8)	35	58.8%	(41.4 – 76.3)
The University of Bristol	25	60.9%	(39.3 – 82.4)	10	72.7%	(41.3 – 100.0)
University of Newcastle-upon-Tyne	35	63.6%	(46.3 – 81.0)	20	85.7%	(69.4 – 100.0)
Cardiff University	50	51.0%	(36.8 – 65.2)	20	84.2%	(66.2 – 100.0)
King's College London	30	76.7%	(60.6 – 92.7)	20	81.0%	(62.6 – 99.3)
University of Nottingham	95	56.3%	(46.1 – 66.4)	45	59.6%	(45.0 – 74.1)
The University of Birmingham	30	50.0%	(31.0 – 69.0)	15	88.2%	(71.2 – 100.0)
The University of Warwick	160	52.5%	(44.7 – 60.2)	70	62.0%	(50.4 – 73.5)
The University of Leicester	40	47.6%	(31.9 – 63.4)	15	78.6%	(54.0 – 100.0)
The University of Southampton	25	52.0%	(31.0 – 73.0)	10	77.8%	(43.9 – 100.0)
The University of Liverpool	20	45.0%	(21.1 – 68.9)	15	84.6%	(61.9 – 100.0)
St George's Medical School London	85	50.0%	(39.2 – 60.8)	35	66.7%	(49.7 – 83.6)

Note: All values presented from Chi-squared analysis; Part A 27.12 *P*=0.028 and Part B 23.59 *P*=0.72. MRCS, Membership of the Royal College of Surgeons. C.I., Confidence Intervals to 95%.

Sociodemographic Factors

Pass rates for MRCS Parts A and B by graduate on entry to medicine status, gender and ethnicity are shown in Table 4. Non-graduates, males and individuals of white ethnicity had significantly higher pass rates for MRCS Parts A and B compared to their graduate, female and non-white ethnicity counterparts.

Table 4. MRCS first attempt pass rates by gender, ethnicity and graduation status for UK medical graduates.

Predictor	Part A (n= 9730)	Part B (n = 4645)
Graduate on entry to medicine		
No	60.2% (4945/8220)	71.5% (2830/3960)
Yes	52.4% (790/1510)	66.8% (455/685)
Missing	n=0	n=0
p-value	< 0.001	0.014
Gender		
Male	62.5% (3865/6185)	72.1% (2185/3030)
Female	52.8% (1870/3545)	68.3% (1100/1615)
Missing	n=0	n=0
p-value	< 0.001	0.007
Ethnicity		
White	63.7% (3580/5615)	76.6% (2130/2780)
Non-white	52.3% (2055/3930)	62.5% (1120/1790)
Missing	n=180	n=75
p-value	< 0.001	< 0.001

Note. All p-values presented are from chi-squared analysis. MRCS, Membership of the Royal College of Surgeons.

Multivariate analysis

The multivariate logistic regression models showing independent predictors of success at MRCS Part A and MRCS Part B can be found in Table 5. After adjusting for prior academic attainment, white candidates, males and those who studied medicine without a prior degree-level qualification were all significantly more likely to pass MRCS Part A at the first attempt (P<0.05). After adjusting for prior attainment, white ethnicity remains a statistically significant predictor of Part B success (P<0.05), although gender and graduate status were not independent predictors of Part B success.

Candidates who attended a non-PBL medical school were found to be 53% (OR 1.53 (95% CI 1.25 to 1.87)) more likely to pass Part A and 54% (OR 1.54 (95% CI 1.05 to 2.25)) more likely to pass Part B at the first attempt after adjusting for prior academic performance, compared to those who attended a PBL school. Candidates attending a SEM course were nearly four times more likely to pass Part A at first attempt (OR 3.72 (95% CI 2.69 to 5.15)) and 67% more likely to pass Part B (OR 1.67 (95% CI 1.02 to 2.76)) when compared to those entering SEM via a Gateway Year. After adjusting for prior attainment, SEM candidates were more than twice as likely to pass Part A (OR 2.34 (95% CI 1.21 to 4.52)) but attending an SEM course was not found to be a statistically significant predictor of Part B success.

Candidates who attended a Russell Group university were 79% more likely to pass Part A (OR 1.79 (95% CI 1.56 to 2.05)) and 24% more likely to pass Part B (OR 1.24 (95% CI 1.03 to 1.49)). However, after adjusting for prior academic attainment, attending a Russell Group university was found to predict success at MRCS Part B (OR 1.81 (95% CI 1.17 to 2.80)) but not Part A.

Table 5. Predictors of pass at first attempt at MRCS Part A (n=5735) and Part B (n=3285) for UK medical graduates. Odds ratios (95% Confidence Interval) given prior to and after adjustment for prior academic attainment.

	Part A		Part B	
Predictor	**Unadjusted OR (95% CI)**	**Adjusted OR (95% CI)**	**Unadjusted OR (95% CI)**	**Adjusted OR (95% CI)**
Graduate on entry into medicine Non-Graduates vs. Graduates	1.40 (1.19-1.64)	2.86 (1.00-8.16)	1.66 (1.24-2.24)	2.08 (0.74-5.88)
Gender Males vs. Females	1.66 (1.48-1.88)	1.62 (1.34-1.95)	1.25 (1.09-1.44)	1.23 (0.86-1.77)
Ethnicity White vs. Non-White	1.65 (1.46-1.87)	1.40 (1.17-1.68)	2.06 (1.80-2.36)	2.07 (1.46-2.93)
Russell Group Russel Group vs. Non-Russell Group	1.79 (1.56-2.05)	1.14 (0.88-1.48)	1.24 (1.03-1.49)	1.81 (1.17-2.80)
Undergraduate Course Type Standard-Entry vs. Gateway Year	3.72 (2.69-5.15)	2.34 (1.21-4.52)	1.67 (1.02-2.76)	2.53 (0.89-7.17)
Teaching Methodology Not PBL vs. PBL	1.99 (1.74-2.27)	1.53 (1.25-1.87)	1.49 (1.27-1.75)	1.54 (1.05-2.25)

MRCS, Membership of the Royal College of Surgeons; CI, Confidence Interval. OR, Odds Ratio. *P*=0.034 for interaction between Ethnicity and Gender, *P*=0.001 for Ethnicity and Teaching Methodology, *P*=0.001 for PBL and Russell group classification in unadjusted Part A regression model and *P*=0.031 for Graduate status and Russell group classification in adjusted Part A model. **P*=0.022 for interaction between Graduate Status and Teaching Methodology in unadjusted Part B regression model.

DISCUSSION

This study, the first to examine the variation in pass rates for the MRCS examination across UK medical schools, identified significant differences in pass rates for both MRCS Part A and Part B across schools, course type and pedagogy.

Our most important finding is the lack of statistically significant difference in MRCS success between medical schools after adjusting for A-levels as a measure of prior academic attainment. This indicates that prior attainment is a significant contributory factor to postgraduate performance between different schools. In other words, differences in postgraduate exam performance are more closely related to individual factors than medical school differences. This reflects patterns seen in other medical assessments (11,14,17,20,21,28,48–51).

Institutional esteem is a known pull factor for medical school applicants (52–54). We found that even after adjusting for prior academic attainment and, by extension, the selection of the highest achieving applicants (see later), both Oxford and Cambridge universities performed significantly better than other academic institutions. These results suggest that the training and education offered by these schools does add value to the likelihood of their student's later success, over and above the individual's academic ability.

However, with the exceptions of Oxford and Cambridge, we found little association between MRCS pass rates and medical school rankings. This is perhaps unsurprising given that rankings are based on amalgamated scores (31), several of which are not relevant to vocational medical degrees with their high retention and employability rates. Additionally, earlier studies indicated that staff to student ratio and student feedback, two seemingly relevant measures used in university rankings, seem to have no effect on performance in medical graduates (15,16). In contrast, Russell Group (research-intensive/focused universities) medical graduates were far more likely to pass MRCS at the first attempt. The relationship between research intensity/focus and MRCS outcomes is unclear. However, it may be that higher entry requirements for Russell Group universities (55,56) play a role given the strong message from our findings and those of the wider literature that prior academic performance is the strongest predictor of future success (14,17,20,21,25,28–30,48–51). Indeed, we would suggest that educational institutions that are self-selecting as an elite group have a self-interest in selecting the very best applicants who will continue to perform at a high level after graduating in order to perpetuate their status as the leading schools.

As per McManus et al.'s MedDifs paper (2020) (15), we found that pedagogic differences (PBL versus non-PBL) are related to variation in outcome measures on postgraduate examinations. Graduates from PBL courses perform less well on MRCS A and B. Other literature hints at possible reasons for this. PBL graduates have strengths compared to those from non-PBL courses in some areas (57,58), but PBL graduates have reported less surgical teaching than is offered at other medical schools (15) and differences in time dedicated to undergraduate surgical training in UK medical schools has been found to correlate with preparedness for clinical practice in surgery (23). PBL courses have also been criticised for neglecting basic science content (59,60), and this may be a contributing factor in the performance of PBL students at Part A of the MRCS, given that paper 1 (of 2) is dedicated to applied basic sciences.

Gateway courses provide a pathway to medicine for students from more diverse sociodemographic and academic backgrounds (61,62). Students from Gateway courses perform less well on assessments during medical school (61,63), at Foundation Programme Selection (64) and, as found in this study. the MRCS. However, there are two points to note. Whilst increasing the diversity of the medical workforce is high on the workforce planning agenda (65), the actual number of Gateway programme graduates in our analysis was very small (n=190). This suggests that surgery is not a common career pathway for these students. Why this is the case is unknown but it may be related to myriad factors including high competition for surgical training posts (66), a lack of perceived "fit" with surgery, few visible role models from similar backgrounds in senior surgical roles, and/or a greater preference to choose a medical career which enables them to give back to under-served communities (67,68). Future research is required to examine this further.

Despite the performance of those who entered medical school as graduates being comparable to those who entered as undergraduates throughout medical school (69,70) and on graduation (63), there remains a significant attainment difference between these groups on postgraduate specialty examinations (20,71,72). Our analysis suggests that this is not due to course type (GEM or SEM). Further work is required to ascertain whether graduates are disadvantaged in postgraduate training due to other factors, such as increased commitments on their time (e.g. family, dependants and financial obligations) (72) or whether this is a reflection of lower prior academic achievement (56,73).

Implications for research, policy and practice

Much literature indicates that medical school influences the progression, direction and performance of their graduates (5–7,9–13,15,16,74). However, it is reassuring to find that the majority of this variation in performance between schools on the MRCS at least can be accounted for by individual factors, namely prior academic attainment. There were, however, clear differences in performance by course pedagogy and markers of institutional esteem which can be used by medical schools to optimise the alignment between undergraduate and postgraduate teaching, learning and assessment values in surgery, and by individuals when considering where to apply to study medicine.

These findings are relevant to medical school selection. In the UK, the first and major hurdle to entry into medicine is achieving high grades on school exit examinations (such as A-

Levels). This is usually coupled with an aptitude test and, if an applicant reaches the required standard on these measures, an interview to assess non-cognitive (personal) qualities (75). There has been much debate in the selection literature as to the weight which should be placed on each of these selection components (76). Our data suggest that if a medical school wants to graduate doctors who are good at passing postgraduate exams, then prior academic attainment should be heavily weighted at the point of selection.

However, if the mission of medical schools is to graduate doctors who will, for example, meet social accountability mandates, then more holistic selection criteria are required (77). Moreover, there are other factors potentially influencing postgraduate success which we could not take into account: group factors (e.g., factors related to the demographics of the student group) (78); individual career preferences (16) and prior schooling (79); mentorship and research opportunities (80) and a student's overall experience of a specialty (74). We are unlikely to ever characterise all variables that contribute to postgraduate examination success, but this study goes some way to identifying key patterns.

In addition to variation in MRCS pass rates, there is also significant variation in the number of graduates from each medical school entering careers in surgery (6,52). Students who wish to pursue surgery as a specialty may want to know which medical school will "best" prepare them for a surgical career (23). Many students enter medicine with clear views as to which specialty they wish to pursue (52,81,82). Perceptions of how well an individual will be placed for a surgical career on graduation may be one factor that is taken into account at the time of application to medical school (83). However, it will not be the only factor. Studies indicate that numerous factors are "traded-off" when considering training location and these trade-offs differ for different groups (e.g., on the basis of gender, or socio-economic background) (84,85). Similarly, applicants may consider factors such as pedagogic approach (e.g., problem-based learning [PBL] versus, for example, or a lecture-based course) (86–88); course length if a graduate (graduates have the choice between a traditional five-year programme or an accelerated GEM course (89)); and/or the reputation and national ranking of a medical school when considering where to apply (52–54,90). In short, choosing which medical school to attend is a major decision and factors other than career preference may be important in this process.

Differential attainment

Group differences in performance by gender, maturity and ethnicity reflect those seen in previous studies (20,24). These attainment differences have also been identified in other high-stakes medical examinations, including FRCS, MRCP, MRCGP, MRCPsych and the USMLE (20,34,48,91–93). Research that aims to investigate this differential attainment at MRCS is currently ongoing. Bias and discrimination at the question level must be ruled out using techniques such as differential item functioning analysis (94), as should the possibility of examiner bias (95,96). The wider literature also suggests the need to examine systemic inequities in the workplace learning environment (97).

Strengths and Limitations

To our knowledge, this large cohort study is the first to assess the relationship between MRCS success and medical school choice, type and ranking after adjusting for measures of prior academic attainment. The UKMED dataset enabled a large-scale, multi-cohort analysis of medical school differences on MRCS first attempt outcomes. The dataset had very little missing data enabling detailed and accurate analyses, demonstrating the utility of national medical education databases. We used candidate first attempt scores despite candidates being able to take multiple attempts at both parts of the MRCS, as first attempt performance in postgraduate examinations has been shown to be the best predictor of future performance (33) and this outcome has been used in previous studies looking at factors which predict performance in the MRCS (20,24). The outcome measure of pass/fail was used as in previous studies since this is what is meaningful to those sitting MRCS (24,25,98). Data were not available for individual MRCS questions and stations potentially hiding institutional differences in performance.

A-Levels were used as a marker of prior academic attainment in this study. This does not represent the full range of school-leaving examinations used by all UK schools (others include Irish and Scottish Highers and the International Baccalaureate). However, A-Levels have been used previously as markers of prior academic attainment in seminal medical education papers and we have no reason to believe that other school-leaving examinations would show different results (28,29). The strengths and limitations of using markers of prior academic attainment such as A-Levels in high achieving cohorts such as doctors are discussed in these papers and in our previous work (30).

Despite a long study period and a large study population; stratification of the analysis by medical school results in smaller cohort numbers (and therefore reduced statistical power) for comparison. Smaller cohort numbers and lower numbers of actual observations in some sub-analyses may result in overfitting, affecting the predictive ability of regression models. Larger cohort sizes would have enabled a more detailed analysis of group differences such as self-declared ethnicity data, avoiding the need for the binary categorisation used here which ensured maximum statistical power (97,99).

Stage of training is known to have an impact on MRCS performance, with those who attempt the examination earlier in their training generally performing better than their peers (24). Without access to stage of training data for the first attempt at MRCS, we were unable to adjust for this variable in the analyses. Stage of training could be extrapolated using the date of graduation, however, given that over half of UK doctors take at least one year out of training after the Foundation programme, this would introduce a significant degree of inaccuracy to the analyses. Similarly, we were unable to adjust for degree intercalation. Those who undertake an intercalated degree are known to perform better in later medical school examinations, which is to be expected, given that entry to intercalation programmes is competitive (100). It is therefore likely that this group will continue to be top performers in postgraduate assessments, given prior academic attainment is the best predictor of later success (28). Additionally, very few intercalating students will be graduates on entry to medicine and are therefore unlikely to experience the same burden of time, financial and caring commitments as graduates. The impact of intercalating on markers of postgraduate performance across all specialties would be best assessed in a separate study. This would be particularly relevant given the recent removal of points scored for undergraduate degrees in UK Foundation Programme selection measures, which has started a debate regarding the future merit of intercalating.

Analysis that includes multiple sociodemographic and course factors inevitably includes a degree of multicollinearity, although every effort was made to minimise this. Interaction terms were explored and statistically significant interactions are listed in the footnote for Table 5. These highlight differences in cohort sociodemographics between each teaching methodology and course type. Further exploration of these differences may be of interest to those in charge of selection and recruitment for medical school. Courses change over time and as such results and attainment differences may also have changed throughout the study period: future studies may wish to use a time-series analysis to look at this (76).

CONCLUSION

There are significant differences in MRCS performance between UK medical school course types and pedagogy. However, variation in MRCS pass rates between medical schools is largely due to individual factors, such as the academic ability of individuals, rather than medical school factors. This data has implications for those in charge of selection policy and curricula delivery. This study also highlights group level attainment differences that transcend training location and stage, warranting further investigation to ensure equity within medical training.

ABBREVIATIONS

ARCP: Annual Review of Competency Progression

FRCS: Fellowship of the Royal College of Surgeons Examinations

GEM: Graduate-Entry Medicine Course

GMC: General Medical Council

HESA: Higher Education Statistics Agency

MRCOG: Membership of the Royal College of Obstetricians and Gynaecologists

MRCP: Membership of the Royal College of Physician

MRCPCH: Membership of the Royal College of Paediatrics and Child Health

MRCPsych: Membership of the Royal College of Psychiatrists

MRCGP: Membership of the Royal College of General Practitioners

MRCS: Intercollegiate Membership of the Royal Colleges of Surgeons Examinations

PBL: Problem Based Learning

SEM: Standard-Entry Medicine Course

UKMED: United Kingdom Medical Education Database

USMLE: United States Medical Licensing Examinations

ACKNOWLEDGMENTS

The authors would like to acknowledge Iain Targett at the Royal College of Surgeons of England, for his help with data collection and John Hines and Gregory Ayre from the Intercollegiate Committee for Basic Surgical Examinations for their support during this project. Our thanks to members of the UKMED Research Group who provided useful feedback on an earlier version of this manuscript, and whose comments helped refine the paper. The authors would also like to acknowledge Daniel Smith for his help with the UKMED database. Data Source: UK Medical Education Database ("UKMED"). UKMEDP043 extract generated on 25/07/2018. We are grateful to UKMED for the use of these data. However, UKMED bears no responsibility for their analysis or interpretation the data includes information derived from that collected by the Higher Education Statistics Agency

Limited ("HESA") and provided to the GMC ("HESA Data"). Source: HESA Student Records 2002/2003 to 2015/2016. Copyright Higher Education Statistics Agency Limited. The Higher Education Statistics Agency Limited makes no warranty as to the accuracy of the HESA Data, cannot accept responsibility for any inferences or conclusions derived by third parties from data or other Information supplied by it.

FUNDING

Royal College of Surgeons of England.

Royal College of Surgeons of Edinburgh.

Royal College of Surgeons of Ireland.

Royal College of Physicians and Surgeons of Glasgow.

COMPETING INTERESTS

None to declare.

ETHICAL APPROVAL

No formal ethical approval was required for this study of existing UKMED data. UKMED has received ethics exemption for projects using exclusively UKMED data from Queen Marys University of London Ethics of Research Committee on behalf of all UK medical schools (https://www.ukmed.ac.uk/documents/UKMED_research_projects_ethics_exemption.pdf). The Intercollegiate Committee for Basic Surgical Examinations (ICBSE) and its Internal Quality Assurance Subcommittee, which monitors MRCS standards, research and quality, approved this study.

DATA AVAILABILITY STATEMENT

The dataset used in this study was acquired from the UK Medical Education Database and is held in Safe Haven. Data access requests must be made to UKMED. Full information for applications can be found at https://www.ukmed.ac.uk.

AUTHOR CONTRIBUTIONS

RE wrote the first draft of the manuscript. RE performed statistical analyses with AJL's supervision. RE, PAB, DSGS, AJL and JC all reviewed and edited the manuscript. JC led the study proposal for access to UKMED data. All authors approved the final draft of the manuscript.

REFERENCES

1. Devine OP, Harborne AC, Horsfall HL, et al. The Analysis of Teaching of Medical Schools (AToMS) survey: an analysis of 47,258 timetabled teaching events in 25 UK medical schools relating to timing, duration, teaching formats, teaching content, and problem-based learning. *BMC Med* 2020 May 14;18(1):126.

2. Devine OP, Harborne AC, McManus IC. Assessment at UK medical schools varies substantially in volume, type and intensity and correlates with postgraduate attainment. *BMC Med Educ* 2015 Sep 11;15(1):146.

3. Taylor CA, Gurnell M, Melville CR, et al. Variation in passing standards for graduation-level knowledge items at UK medical schools. *Med Educ* 2017;51(6):612–20.

4. McCrorie P, Boursicot KAM. Variations in medical school graduating examinations in the United Kingdom: are clinical competence standards comparable? Med Teach. 2009 Mar;31(3):223–9.

5. General Medical Council: Be prepared: are new doctors safe to practise? Manchester: General Medical Council. [Internet]. 2014. Available from: (Available at https://www.gmc-uk.org/Be_prepared___are_new_doctors_safe_to_practise_Oct_2014.pdf_58044232.pdf); 2014.)

6. Twigg V, Aldridge K, McNally S, et al. Does choice of medical school affect a student's likelihood of becoming a surgeon? Bull R Coll Surg Engl. 2018 Mar 1;100(2):90–5.

7. Alberti H, Randles HL, Harding A, et al. Exposure of undergraduates to authentic GP teaching and subsequent entry to GP training: a quantitative study of UK medical schools. Br J Gen Pract. 2017 Apr 1;67(657):e248–52.

8. Cleland JA, Johnston PW, Anthony M, et al. A survey of factors influencing career preference in new-entrant and exiting medical students from four UK medical schools. BMC Med Educ. 2014 Jul 23;14(1):151.

9. Goldacre MJ, Taylor K, Lambert TW. Views of junior doctors about whether their medical school prepared them well for work: questionnaire surveys. BMC Med Educ. 2010 Dec;10(1):78.

10. Bowhay AR, Watmough SD. An evaluation of the performance in the UK Royal College of Anaesthetists primary examination by UK medical school and gender. BMC Med Educ. 2009 Jun 29;9(1):38.

11. Rushd S, Landau AB, Khan JA, et al. An analysis of the performance of UK medical graduates in the MRCOG Part 1 and Part 2 written examinations. Postgrad Med J. 2012 May 1;88(1039):249–54.

12. Menzies L, Minson S, Brightwell A, et al. An evaluation of demographic factors affecting performance in a paediatric membership multiple-choice examination. Postgrad Med J. 2015 Feb;91(1072):72–6.

13. Wakeford R, Foulkes J, McManus C, et al. MRCGP pass rate by medical school and region of postgraduate training. Royal College of General Practitioners. BMJ. 1993 Aug 28;307(6903):542–3.

14. McManus IC, Wakeford R. PLAB and UK graduates' performance on MRCP(UK) and MRCGP examinations: data linkage study. BMJ. 2014 Apr 17;348:g2621.

15. McManus IC, Harborne AC, Horsfall HL, et al. Exploring UK medical school differences: the MedDifs study of selection, teaching, student and F1 perceptions, postgraduate outcomes and fitness to practise. BMC Med. 2020 May 14;18(1):136.

16. McManus I, Elder AT, de Champlain A, et al. Graduates of different UK medical schools show substantial differences in performance on MRCP(UK) Part 1, Part 2 and PACES examinations. BMC Med. 2008 Feb 14;6(1):5.

17. Hecker K, Violato C. How Much Do Differences in Medical Schools Influence Student Performance? A Longitudinal Study Employing Hierarchical Linear Modeling. Teach Learn Med. 2008 Apr 10;20(2):104–13.

18. Burk-Rafel J, Pulido RW, Elfanagely Y, et al. Institutional differences in USMLE Step 1 and 2 CK performance: Cross-sectional study of 89 US allopathic medical schools. PLOS ONE. 2019 Nov 4;14(11):e0224675.

19. Ellis R, Cleland J, Scrimgeour D, et al. Does the MRCS exam fulfil its purpose in surgical professions? Bull R Coll Surg Engl. 2021 Oct 1;103(7):344–50.

20. Scrimgeour DSG, Cleland J, Lee AJ, et al. Prediction of success at UK Specialty Board Examinations using the mandatory postgraduate UK surgical examination. BJS Open. 2019 Dec;3(6):865–71.

21. Scrimgeour D, Brennan P, Griffiths G, et al. Does the Intercollegiate Membership of the Royal College of Surgeons (MRCS) examination predict 'on-the-job' performance during UK higher specialty surgical training? Ann R Coll Surg Engl. 2018 Nov;100(8):669–75.

22. Scrimgeour DSG, Cleland J, Lee AJ, et al. Impact of performance in a mandatory postgraduate surgical examination on selection into specialty training: Performance in a postgraduate surgical examination and selection into specialty training. BJS Open. 2017 Oct;1(3):67–74.

23. Lee MJ, Drake TM, Malik TAM, et al. Has the Bachelor of Surgery Left Medical School? A National Undergraduate Assessment. J Surg Educ. 2016 Jul 1;73(4):655–9.

24. Scrimgeour DSG, Cleland J, Lee AJ, et al. Which factors predict success in the mandatory UK postgraduate surgical exam: The Intercollegiate Membership of the Royal College of Surgeons (MRCS)? Surg J R Coll Surg Edinb Irel. 2018 Aug;16(4):220–6.

25. Ellis R, Scrimgeour DSG, Brennan PA, et al. Does performance at medical school predict success at the Intercollegiate Membership of the Royal College of Surgeons (MRCS) examination? A retrospective cohort study. BMJ Open. 2021 Aug;11(8):e046615.

26. Ellis R, Brennan P, Scrimgeour D, et al. A cross-sectional study examining associations between foundation school and MRCS performance. Bull R Coll Surg Engl. 2021 Nov 1;103(8):398–402.

27. Ellis R, Cleland J, Lee AJ, et al. A cross-sectional study examining MRCS performance by core surgical training location. Med Teach. 2021 Nov 2;1–6.

28. McManus I, Woolf K, Dacre J, et al. The Academic Backbone: longitudinal continuities in educational achievement from secondary school and medical school to MRCP(UK) and the specialist register in UK medical students and doctors. BMC Med. 2013 Dec;11(1):242.

29. Ferguson E, James D, Madeley L. Factors associated with success in medical school: systematic review of the literature. BMJ. 2002 Apr 20;324(7343):952–7.

30. Ellis R, Brennan P, Scrimgeour DS, et al. Performance at medical school selection correlates with success in Part A of the intercollegiate Membership of the Royal College of Surgeons (MRCS) examination. Postgrad Med J. 2021 Mar 10;postgradmedj-2021-139748.

31. Medical School Ranking 2020, The Complete University Guide [Internet]. 2020. [cited 2021 November 11] Available from: Accessed at https://www.thecompleteuniversityguide.co.uk/

32. Dowell J, Cleland J, Fitzpatrick S, et al. The UK medical education database (UKMED) what is it? Why and how might you use it? BMC Med Educ. 2018 Dec;18(1):6.

33. McManus I, Ludka K. Resitting a high-stakes postgraduate medical examination on multiple occasions: nonlinear multilevel modelling of performance in the MRCP(UK) examinations. BMC Med. 2012 Jun 14;10(1):60.

34. Woolf K, Potts H W W, McManus I C. Ethnicity and academic performance in UK trained doctors and medical students: systematic review and meta-analysis BMJ 2011; 342 :d901.

35. Medical Schools Council. Medicine Course Types [Internet]. 2018 [2021 November 11]. Available from: https://www.medschools.ac.uk/studying-medicine/course-types

36. Kumwenda B, Cleland J, Greatrix R, et al. Are efforts to attract graduate applicants to UK medical schools effective in increasing the participation of under-represented socioeconomic groups? A national cohort study. BMJ Open. 2018 14;8(2):e018946.

37. Profile of the Russell Group of Universities [Internet]. Russell Group; 2016 [cited 2021 November 11]. Available from: https://russellgroup.ac.uk/policy/publications/profile-of-the-russell-group-of-universities/

38. Boliver V. Are there distinctive clusters of higher and lower status universities in the UK? Oxf Rev Educ. 2015 Sep 3;41(5):608–27.

39. Coughlan S. Is the Russell Group really an 'oligarchy'? [Internet]. BBC News Education and Family.; 2014 [cited 2021 November 11]. Available from: https://www.bbc.co.uk/news/education-27399512

40. Fazackerley A. Should students be encouraged to set their sights on Russell Group universities? [Internet]. The Guardian; 2013 [cited 2021 November 11]. Available from: https://www.theguardian.com/education/2013/feb/18/russell-group-universities-students-ambitions

41. Lloyd-Jones, Margetson, Bligh. Problem-based learning: a coat of many colours. Med Educ. 1998;32(5):492–4.

42. Maudsley G. Do we all mean the same thing by 'problem-based learning'? A review of the concepts and a formulation of the ground rules. Acad Med J Assoc Am Med Coll. 1999 Feb;74(2):178–85.

43. British Medical Association. Course and teaching types at medical school. London, 2017. [cited 2021 November 11]; Available from: https://www.bma.org.uk/advice/career/studying-medicine/becoming-a-doctor/course-types

44. Guide to the intercollegiate MRCS examination [Internet]. Intercollegiate Committee for Basic Surgical Examinations; 2013 [cited 2021 November 11]. Available from: https://www.intercollegiatemrcsexams.org.uk/mrcs/candidate-guidance/

45. Surgical selection in the UK. [Internet]. Joint Committee on Surgical Training; [cited 2021 November 11]. Available from: https://www.jcst.org/introduction-to-training/selection-and-recruitment/

46. Rounding and suppression to anonymise statistics | HESA [Internet]. [cited 2021 November 11]. Available from: https://www.hesa.ac.uk/about/regulation/data-protection/rounding-and-suppression-anonymise-statistics

47. Harrell FE. Regression Modeling Strategies: With Applications to Linear Models, Logistic Regression, and Survival Analysis. 2nd edition. New York: Springer; 2006. 600 p.

48. Rubright JD, Jodoin M, Barone MA. Examining Demographics, Prior Academic Performance, and United States Medical Licensing Examination Scores. Acad Med J Assoc Am Med Coll. 2019;94(3):364–70.

49. Sutton E, Richardson JD, Ziegler C, et al. Is USMLE Step 1 score a valid predictor of success in surgical residency? Am J Surg. 2014 Dec;208(6):1029–34; discussion 1034.

50. Swanson DB, Sawhill A, Holtzman KZ, et al. Relationship between performance on part I of the American Board of Orthopaedic Surgery Certifying Examination and Scores on USMLE Steps 1 and 2. Acad Med J Assoc Am Med Coll. 2009 Oct;84(10 Suppl):S21-24.

51. Ghaffari-Rafi A, Lee RE, Fang R, et al. Multivariable analysis of factors associated with USMLE scores across U.S. medical schools. BMC Med Educ. 2019 May 20;19(1):154.

52. Twigg V, McNally S, Eardley I. What are the differences between medical schools that graduate more aspiring surgeons than others? Bull R Coll Surg Engl. 2020 Feb;102(2):e009.

53. McManus IC, Winder BC, Sproston KA, et al. Why do medical school applicants apply to particular schools? Med Educ. 1993;27(2):116–23.

54. Brown C. A qualitative study of medical school choice in the UK. Med Teach. 2007 Jan 1;29(1):27–32.

55. McManus I, Dewberry C, Nicholson S, et al. Construct-level predictive validity of educational attainment and intellectual aptitude tests in medical student selection: meta-regression of six UK longitudinal studies. BMC Med. 2013 Nov 14;11(1):243.

56. Garrud P, McManus IC. Impact of accelerated, graduate-entry medicine courses: a comparison of profile, success, and specialty destination between graduate entrants to accelerated or standard medicine courses in UK. BMC Med Educ. 2018 Nov 6;18(1):250.

57. Jones A, McArdle PJ, O'Neill PA. Perceptions of how well graduates are prepared for the role of pre-registration house officer: a comparison of outcomes from a traditional and an integrated PBL curriculum. Med Educ. 2002;36(1):16–25.

58. Miles S, Kellett J, Leinster SJ. Medical graduates' preparedness to practice: a comparison of undergraduate medical school training. BMC Med Educ. 2017 Dec;17(1):33.

59. Williams G, Lau A. Reform of undergraduate medical teaching in the United Kingdom: a triumph of evangelism over common sense. BMJ. 2004 Jul 8;329(7457):92–4.

60. Albanese MA, Mitchell S. Problem-based learning: a review of literature on its outcomes and implementation issues. Acad Med J Assoc Am Med Coll. 1993 Jan;68(1):52–81.

61. Garlick PB, Brown G. Widening participation in medicine. BMJ. 2008 May 15;336(7653):1111–3.

62. Curtis S, Blundell C, Platz C, et al. Successfully widening access to medicine. Part 2: Curriculum design and student progression. J R Soc Med. 2014 Oct;107(10):393–7.

63. Mahesan N, Crichton S, Sewell H, et al. The effect of an intercalated BSc on subsequent academic performance. BMC Med Educ. 2011 Oct 3;11:76.

64. Curtis S, Smith D. A comparison of undergraduate outcomes for students from gateway courses and standard entry medicine courses. BMC Med Educ. 2020 Jan 3;20(1):4.

65. Widening Participation it Matters! Our strategy and initial action plan [Internet]. Health Education England; 2014 [cited 2021 November 11]. Available from: https://www.hee.nhs.uk/sites/default/files/documents/Widening%20Participation%20it%20Matters_0.pdf

66. Specialty Recruitment Competition Ratios [Internet]. Health Education England; 2020 [cited 2021 November 11]. Available from: https://specialtytraining.hee.nhs.uk/Competition-Ratios

67. Puddey IB, Playford DE, Mercer A. Impact of medical student origins on the likelihood of ultimately practicing in areas of low vs high socio-economic status. BMC Med Educ. 2017 Jan 5;17(1):1.

68. Dowell J, Norbury M, Steven K, et al. Widening access to medicine may improve general practitioner recruitment in deprived and rural communities: survey of GP origins and current place of work. BMC Med Educ. 2015 Oct 1;15(1):165.

69. Puddey IB, Mercer A, Carr SE. Relative progress and academic performance of graduate vs undergraduate entrants to an Australian medical school. BMC Med Educ. 2019 May 22;19(1):159.

70. Manning G, Garrud P. Comparative attainment of 5-year undergraduate and 4-year graduate entry medical students moving into foundation training. BMC Med Educ. 2009 Dec 22;9(1):76.

71. Reports on the progress of doctors in training split by postgraduate body. General Medical Council. [Internet]. [cited 2021 November 11]. Available from: https://www.gmc-uk.org/education/reports-and-reviews/progression-reports

72. Pyne Y, Ben-Shlomo Y. Older doctors and progression through specialty training in the UK: a cohort analysis of General Medical Council data. BMJ Open. 2015 Feb 1;5(2):e005658.

73. Garrud P. Who applies and who gets admitted to UK graduate entry medicine? - an analysis of UK admission statistics. BMC Med Educ. 2011 Sep 26;11(1):71.

74. Goldacre MJ, Turner G, Lambert TW. Variation by medical school in career choices of UK graduates of 1999 and 2000. Med Educ. 2004;38(3):249–58.

75. Patterson F, Knight A, Dowell J, et al. How effective are selection methods in medical education? A systematic review. Med Educ. 2016 Jan;50(1):36–60.

76. Fielding S, Tiffin PA, Greatrix R, et al. Do changing medical admissions practices in the UK impact on who is admitted? An interrupted time series analysis. BMJ Open. 2018 Oct 1;8(10):e023274.

77. Patterson F, Roberts C, Hanson MD, et al. 2018 Ottawa consensus statement: Selection and recruitment to the healthcare professions. Med Teach. 2018 Nov;40(11):1091–101.

78. Ferguson E, James D, Yates J, et al. Predicting who applies to study medicine: implication for diversity in UK medical schools. Med Teach. 2012;34(5):382–91.

79. Kumwenda B, Cleland JA, Walker K, et al. The relationship between school type and academic performance at medical school: a national, multi-cohort study. BMJ Open. 2017 Aug 1;7(8):e016291.

80. Berger AP, Giacalone JC, Barlow P, et al. Choosing surgery as a career: Early results of a longitudinal study of medical students. Surgery. 2017 Jun 1;161(6):1683–9.

81. Cleland J, Johnston PW, French FH, et al. Associations between medical school and career preferences in Year 1 medical students in Scotland. Med Educ. 2012 May;46(5):473–84.

82. Goldacre MJ, Laxton L, Harrison EM, et al. Early career choices and successful career progression in surgery in the UK: prospective cohort studies. BMC Surg. 2010 Nov 2;10(1):32.

83. Adams T, Garden A. What influences medical school choice? Med Teach. 2006 Feb;28(1):83–5.

84. Kumwenda B, Cleland JA, Prescott GJ, et al. Relationship between sociodemographic factors and selection into UK postgraduate medical training programmes: a national cohort study. BMJ Open. 2018 Jun;8(6):e021329.

85. Scanlan GM, Cleland J, Johnston P, et al. What factors are critical to attracting NHS foundation doctors into specialty or core training? A discrete choice experiment. BMJ Open. 2018 Mar 1;8(3):e019911.

86. Cariaga-Lo LD, Richards BF, Hollingsworth MA, et al. Non-cognitive characteristics of medical students: entry to problem-based and lecture-based curricula. Med Educ. 1996 May;30(3):179–86.

87. Holen A, Manandhar K, Pant DS, et al. Medical students' preferences for problem-based learning in relation to culture and personality: a multicultural study. Int J Med Educ. 2015 Jul 19;6:84–92.

88. Bigsby E, McManus IC, Sedgwick P, et al. Which medical students enjoy problem-based learning? Educ Med J. 2013 Mar;5(1):e72-e76

89. Carter YH, Peile E. Graduate entry medicine: high aspirations at birth. Clin Med Lond Engl. 2007 Apr;7(2):143–7.

90. Broecke S. University rankings: do they matter in the UK? Educ Econ. 2015 Mar 4;23(2):137–61.

91. Tiffin PA, Paton LW. Differential attainment in the MRCPsych according to ethnicity and place of qualification between 2013 and 2018: a UK cohort study. Postgrad Med J. 2020 Sep 3;postgradmedj-2020-137913.

92. Dewhurst NG, McManus C, Mollon J, et al. Performance in the MRCP(UK) Examination 2003–4: analysis of pass rates of UK graduates in relation to self-declared ethnicity and gender. BMC Med. 2007 May 3;5:8.

93. Wakeford R, Denney M, Ludka-Stempien K, et al. Cross-comparison of MRCGP & MRCP(UK) in a database linkage study of 2,284 candidates taking both examinations: assessment of validity and differential performance by ethnicity. BMC Med Educ. 2015 Jan 16;15(1):1.

94. Hope D, Adamson K, McManus IC, et al. Using differential item functioning to evaluate potential bias in a high stakes postgraduate knowledge based assessment. BMC Med Educ. 2018 Apr 3;18(1):64.

95. McManus IC, Elder AT, Dacre J. Investigating possible ethnicity and sex bias in clinical examiners: an analysis of data from the MRCP(UK) PACES and nPACES examinations. BMC Med Educ. 2013 Dec;13(1):103.

96. Yeates P, Woolf K, Benbow E, et al. A randomised trial of the influence of racial stereotype bias on examiners' scores, feedback and recollections in undergraduate clinical exams. BMC Med. 2017 Dec;15(1):179.

97. Fyfe M, Horsburgh J, Blitz J, et al. Dos, Don'ts, Don't Knows: Redressing differential attainment related to race/ethnicity in medical schools. Perspect Med Educ. 2021 Oct;In Press.

98. Ellis R, Cleland J, Scrimgeour D, et al. The impact of disability on performance in a high-stakes postgraduate surgical examination: a retrospective cohort study. J R Soc Med. 2021 Jul 16;01410768211032573.

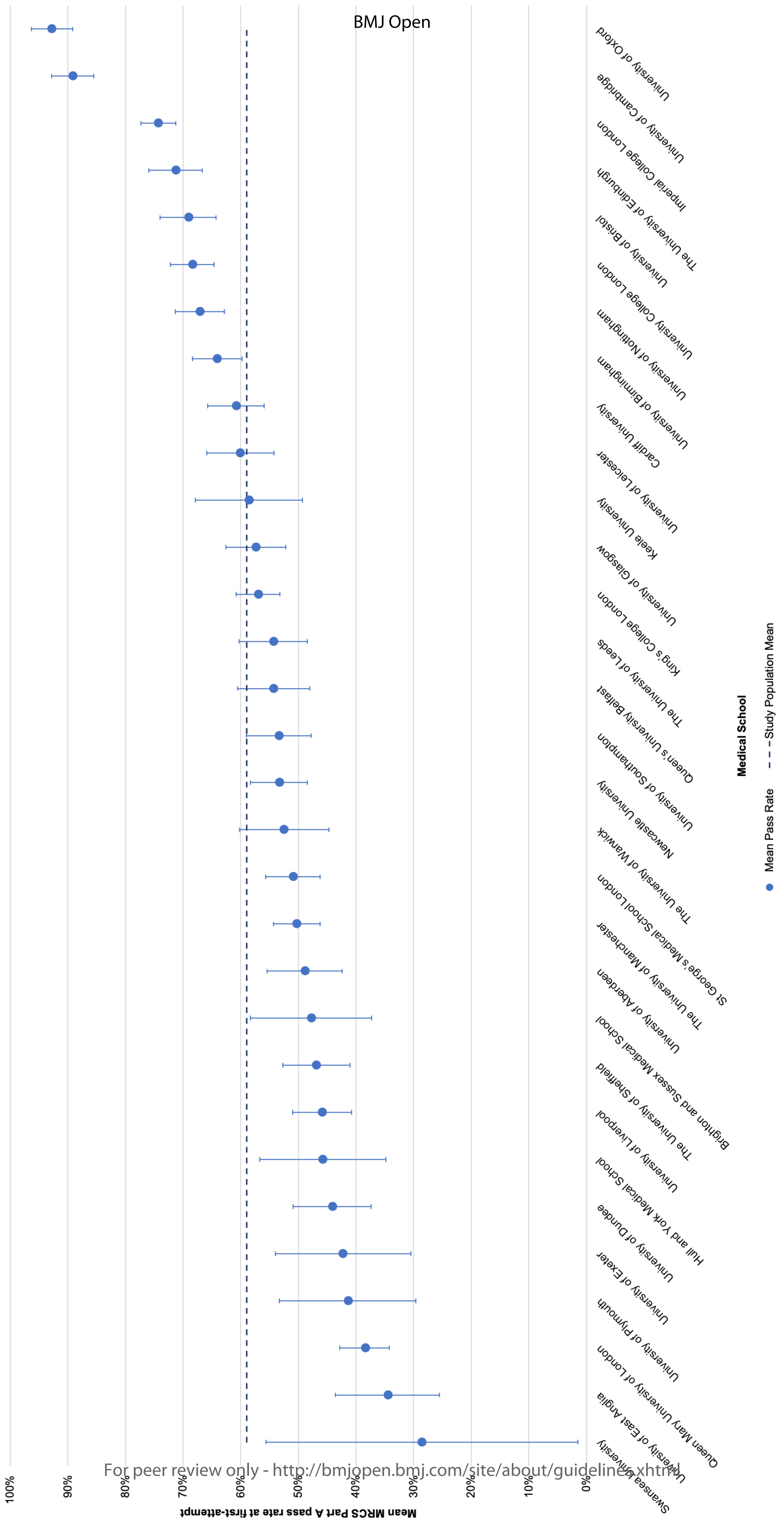
99. Ross PT, Hart-Johnson T, Santen SA, et al. Considerations for using race and ethnicity as quantitative variables in medical education research. Perspect Med Educ. 2020 Oct;9(5):318–23.

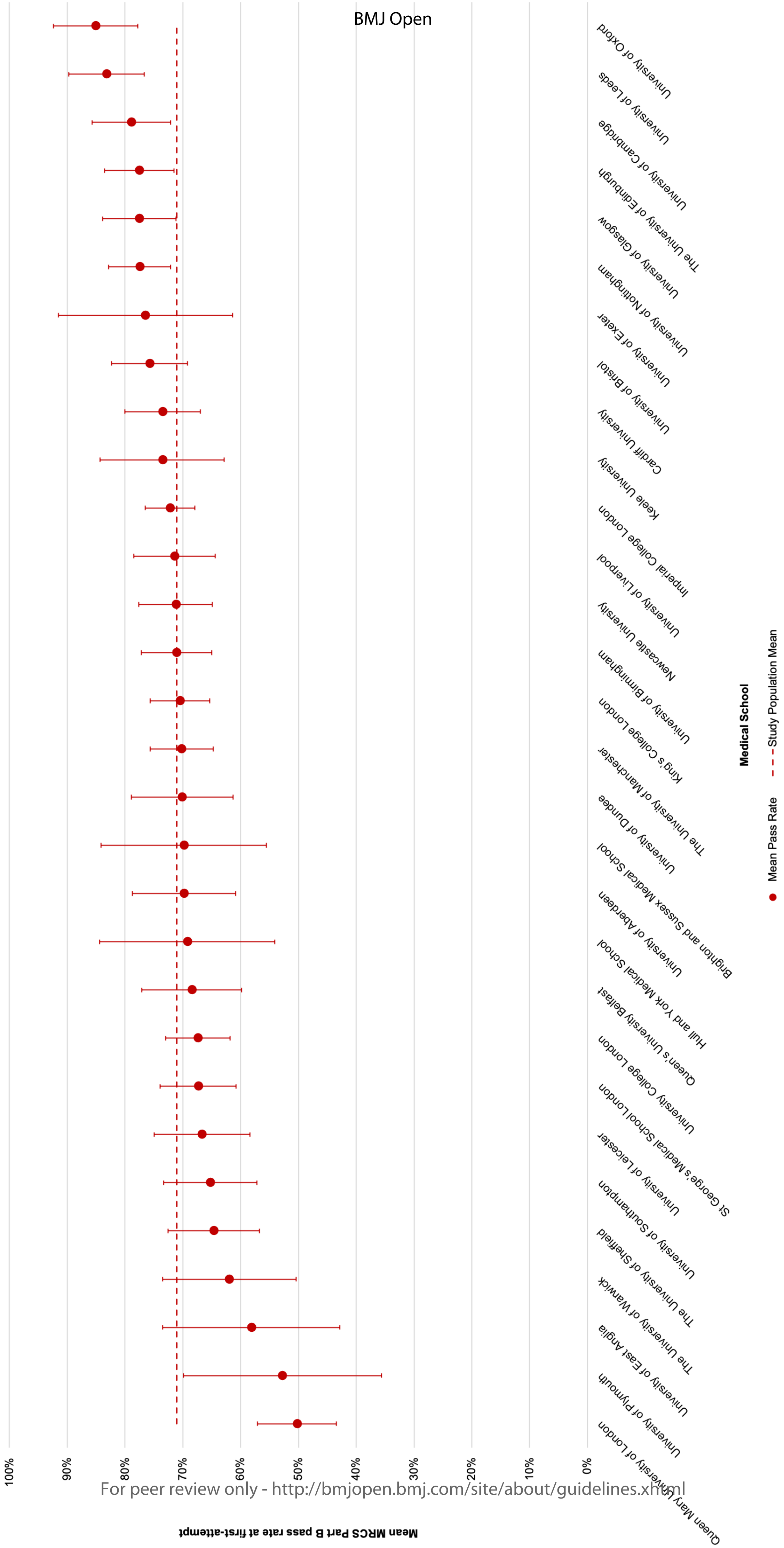
100. Cleland JA, Milne A, Sinclair H, Lee AJ. An intercalated BSc degree is associated with higher marks in subsequent medical school examinations. BMC Med Educ. 2009 Dec;9(1):24.

Figure 1. MRCS Part A first attempt pass rates by Medical School with 95% Confidence Interval.

Figure 2. MRCS Part B first attempt pass rates by Medical School with 95% Confidence Interval. Swansea University Part B results excluded due to small cohort (n=2).

Appendix 1. MRCS first attempt pass rates by Medical School, ranked according to the Complete University Guide as of 2020 with corresponding university code. All values presented from Chi-squared analysis; Part A X^2 = 626.05 *P*<0.001 and Part B X^2 =104.47 *P*<0.001. MRCS, Membership of the Royal College of Surgeons. C.I., Confidence Intervals to 95%.


University of Oxford
University of Cambridge
Imperial College London
The University of Edinburgh
University of Bristol
University College London
University of Nottingham
University of Birmingham
Cardiff University
University of Leicester
Keele University
University of Glasgow
King's College London
The University of Leeds
Queen's University Belfast
University of Southampton
Newcastle University
The University of Warwick
St George's Medical School London
The University of Manchester
University of Aberdeen
Brighton and Sussex Medical School
The University of Sheffield
University of Liverpool
Hull and York Medical School
University of Dundee
University of Exeter
University of Plymouth
Queen Mary University of London
University of East Anglia
Swansea University
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Mean MRCS Part A pass rate at first-attempt
Medical School
Mean Pass Rate
Study Population Mean


University of Oxford
University of Leeds
University of Cambridge
The University of Edinburgh
University of Glasgow
University of Nottingham
University of Exeter
University of Bristol
Cardiff University
Keele University
Imperial College London
University of Liverpool
Newcastle University
University of Birmingham
King's College London
The University of Manchester
University of Dundee
Brighton and Sussex Medical School
University of Aberdeen
Hull and York Medical School
Queen's University Belfast
University College London
St George's Medical School London
University of Leicester
University of Southampton
The University of Sheffield
The University of Warwick
University of East Anglia
University of Plymouth
Queen Mary University of London
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Mean MRCS Part B pass rate at first-attempt
Medical School
Mean Pass Rate
Study Population Mean

Rank	Medical School	Part A: Total Number of Candidates (n=9730)	Part A: Pass rate (n=5740)	Part A: 95% C.I.	Part B: Total Number of Candidates (n=4645)	Part B: Pass rate (n=3290)	Part B: 95% C.I.
1	The University of Oxford	210	92.8%	(89.2 – 96.3)	95	85.1%	(77.8 – 92.4)
2	The University of Cambridge	285	89.2%	(85.5 – 92.8)	140	78.9%	(72.1 – 85.7)
3	The University of Glasgow	350	57.4%	(52.2 – 62.6)	170	77.5%	(71.2 – 83.9)
4	The University of Swansea	15	28.6%	(1.5 – 55.6)	0	0%	-
5	The University of Edinburgh	365	71.3%	(66.7 – 76.0)	190	77.5%	(71.5 – 83.5)
6	The University of Dundee	215	44.1%	(37.4 – 50.9)	105	70.1%	(61.3 – 78.9)
7	Imperial College London	815	74.3%	(71.3 – 77.3)	415	72.2%	(67.9 – 76.5)
8	Queen Mary University of London	475	38.4%	(34.1 – 42.8)	210	50.2%	(43.4 – 57.1)
9	The University of Keele	110	58.6%	(49.3 – 67.9)	70	73.5%	(62.8 – 84.3)
10	The University of Exeter	70	42.3%	(30.5 – 54.0)	35	76.5%	(61.4 – 91.5)
11	The University of Aberdeen	230	48.9%	(42.4 – 55.4)	105	69.8%	(60.9 – 78.7)
12	The University of Bristol	355	69.1%	(64.3 – 74.0)	170	75.7%	(69.2 – 82.3)
13	University College London	575	68.4%	(64.6 – 72.2)	275	67.4%	(61.8 – 73.0)
14	University of Newcastle-upon-Tyne	390	53.3%	(48.4 – 58.3)	200	71.2%	(64.9 – 77.6)
15	Cardiff University	390	60.8%	(55.9 – 65.7)	180	73.5%	(67.0 – 80.0)
16	King's College London	665	57.0%	(53.2 – 60.8)	305	70.5%	(65.3 – 75.6)
17	The University of Sheffield	285	46.9%	(41.0 – 52.7)	145	64.6%	(56.7 – 72.5)
18	The University of Leeds	275	54.3%	(48.4 – 60.3)	130	83.2%	(76.7 – 89.7)
19	University of Plymouth	70	41.4%	(29.6 – 53.3)	35	52.8%	(35.6 – 69.9)
20	The University of East Anglia	110	34.5%	(25.5 – 43.6)	45	58.1%	(42.8 – 73.5)
21	Brighton and Sussex Medical School	90	47.8%	(37.3 – 58.3)	45	69.8%	(55.5 – 84.1)
22	The Queen's University of Belfast	245	54.3%	(48.0 – 60.5)	115	68.4%	(59.8 – 77.1)
23	University of Nottingham	465	67.1%	(62.8 – 71.4)	235	77.4%	(72.1 – 82.8)
24	The University of Manchester	580	50.3%	(46.2 – 54.3)	275	70.2%	(64.7 – 75.6)
25	Hull and York Medical School	85	45.8%	(34.8 – 56.7)	40	69.2%	(54.1 – 84.4)
26	The University of Birmingham	480	64.1%	(59.8 – 68.4)	220	71.1%	(65.0 – 77.2)
27	The University of Warwick	160	52.5%	(44.7 – 60.2)	70	62.0%	(50.4 – 73.5)
28	The University of Leicester	275	60.1%	(54.2 – 65.9)	130	66.7%	(58.4 – 74.9)
29	The University of Southampton	305	53.4%	(47.8 – 59.0)	140	65.2%	(57.2 – 73.3)
30	The University of Liverpool	365	45.9%	(40.8 – 51.0)	160	71.4%	(64.4 – 78.5)
31	St George's Medical School London	430	50.9%	(46.2 – 55.7)	200	67.3%	(60.8 – 73.9)

STROBE Statement—Checklist of items that should be included in reports of ***cohort studies***

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract (*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	1-4
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	5-6
Objectives	3	State specific objectives, including any prespecified hypotheses	5-6
Methods			
Study design	4	Present key elements of study design early in the paper	6-11
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6-11
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up (*b*) For matched studies, give matching criteria and number of exposed and unexposed	6-11
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6-11
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	6-11
Bias	9	Describe any efforts to address potential sources of bias	6-11
Study size	10	Explain how the study size was arrived at	6-11
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6-11
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding (*b*) Describe any methods used to examine subgroups and interactions (*c*) Explain how missing data were addressed (*d*) If applicable, explain how loss to follow-up was addressed (*e*) Describe any sensitivity analyses	6-11
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed (b) Give reasons for non-participation at each stage (c) Consider use of a flow diagram	11-20
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders (b) Indicate number of participants with missing data for each variable of interest (c) Summarise follow-up time (eg, average and total amount)	11-20
Outcome data	15*	Report numbers of outcome events or summary measures over time	11-20

Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included (*b*) Report category boundaries when continuous variables were categorized (*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	11-20
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	11-20
Discussion			
Key results	18	Summarise key results with reference to study objectives	21-25
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	21-25
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	21-25
Generalisability	21	Discuss the generalisability (external validity) of the study results	21-25
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	26

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at http://www.strobe-statement.org.