DiffErential attainment and Factors AssoCiated with Training applications and Outcomes (DE FACTO) study: Trauma & Orthopaedic surgery in the UK

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Aims

The aims of this study were to describe the demographic, socioeconomic, and educational factors associated with core surgical trainees (CSTs) who apply to and receive offers for higher surgical training (ST3) posts in Trauma & Orthopaedics (T&O).

Methods

Data collected by the UK Medical Education Database (UKMED) between 1 January 2014 and 31 December 2019 were used in this retrospective longitudinal cohort study comprising 1,960 CSTs eligible for ST3. The primary outcome measures were whether CSTs applied for a T&O ST3 post and if they were subsequently offered a post. A directed acyclic graph was used for detecting confounders and adjusting logistic regression models to calculate odds ratios (ORs), which assessed the association between the primary outcomes and relevant exposures of interest, including: age, sex, ethnicity, parental socioeconomic status (SES), domiciliary status, category of medical school, Situational Judgement Test (SJT) scores at medical school, and success in postgraduate examinations. This study followed STROBE guidelines.

Results

Compared to the overall cohort of CSTs, females were significantly less likely to apply to T&O (OR 0.37, 95% CI 0.30 to 0.46; n = 155/720 female vs n = 535/1,240 male; $p < 0.001$). CSTs who were not UK-domiciled prior to university were nearly twice as likely to apply to T&O (OR 1.99, 95% CI 1.39 to 2.85; n = 50/205 vs not UK-domiciled vs n = 585/1,580 UK-domiciled; $p < 0.001$). Age, ethnicity, SES, and medical school category were not associated with applying to T&O. Applicants who identified as 'black and minority ethnic' (BME) were significantly less likely to be offered a T&O ST3 post (OR 0.70, 95% CI 0.51 to 0.97; n = 165/265 BME vs n = 265/385 white; $p = 0.034$). Differences in age, sex, SES, medical school category, and SJT scores were not significantly associated with being offered a T&O ST3 post.

Conclusion

There is an evident disparity in sex between T&O applicants and an ethnic disparity between those who receive offers on their first attempt. Further high-quality, prospective research in the post-COVID-19 pandemic period is needed to improve equality, diversity, and inclusion in T&O training.

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Take home message

- This study highlights the demographic, socioeconomic, and educational factors associated with core surgical trainees (CSTs) who apply for and successfully obtain higher surgical training (ST3) posts in Trauma & Orthopaedics (T&O) on their first attempt.
- Compared to the overall cohort of CSTs, female CSTs were less likely to apply for T&O ST3, highlighting an evident disparity in sex between applicants.
- There was also an ethnic disparity between those who received offers on their first attempt as applicants who identified as 'black and minority ethnic' were less likely to be offered a T&O ST3 post.
- Further high-quality, prospective research in the post-COVID-19 pandemic period is warranted to improve equality, diversity, and inclusion in T&O.

Introduction

Core surgical training is a 24-month-long programme that is the first hurdle in surgical training in the UK for most surgical specialties. Becoming a core surgical trainee (CST) continues to be highly competitive with more applicants than posts available each year. In 2023, there were a total of 2,539 applicants for 609 posts resulting in a completion ratio of 4.17, a rise from 3.70 in 2022 and 2.93 in 2019.[1,2] During the second year of core surgical training, CSTs typically apply for higher surgical training (ST3) posts, such as Trauma & Orthopaedics (T&O).

T&O is currently the second-largest surgical speciality, comprising 28% of the consultant surgical workforce in the UK.[3] It continues to be a popular, but competitive, speciality for trainees, with 483 ST3 applications submitted for 160 available posts in 2023, a competition ratio of 3.02.[2] However, there is an obvious disparity between the sexes in progression through surgical training. While 59% of medical students and 54% of foundation trainees are female,[4] only 41% of CSTs and 12% of consultant surgeons are female.[5] T&O has historically been a male-dominated surgical speciality. In 2020, only 25% of all T&O trainees and 6.7% of all T&O consultants were female.[6,7]

This disparity has been highlighted in many studies, but few have investigated or addressed the role of demographic and socioeconomic factors on trainees in T&O.[8,9] It has been documented that 'black and minority ethnic' (BME) individuals comprise 41.9% of all doctors within the NHS; however, there is little information about the proportion of T&O trainees in this category.[10] It is also unclear whether there is a relationship between socioeconomic status and becoming a surgical trainee in T&O.

The aim of this study, therefore, was to contribute to the literature by describing the demographic, socioeconomic, and education factors that are associated with CSTs who apply to T&O and those who are offered ST3 posts in T&O between 1 January 2014 and 31 December 2019, which reflects the pre-COVID-19 pandemic period.

This work forms part of a larger series, titled "DiffErential attainment and Factors AssoCiated with Training applications and Outcomes" or the DE FACTO study, which aims to investigate the same research question across multiple higher surgical training programmes in the UK. At the time of writing, the DE FACTO study on urology has been published.[11]

Methods

This retrospective cohort study used routinely collected data from the UK Medical Education Database (UKMED).[12] UKMED links data from existing routine collections of data for all medical students and trainee doctors in the UK. The General Medical Council (GMC) is the data controller for UKMED and permission to use these data was granted by the UKMED advisory board. The protocol for this study can be found under the online Supplementary Material. The overall methodology is the same as other studies in the DE FACTO series, such as the DE FACTO study on urology.[11] The data were derived from the UKMEDP134 extract generated on 16 June 2021 and approved for publication by UKMED on 1 December 2023. The findings are reported according to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines.[13]

Participants

Our study population included doctors who had completed the foundation programme and core surgical training, and were eligible to submit an application for higher surgical training in the UK between 1 January 2014 and 31 December 2019.

Study variables

A description of the variables is outlined in Table I. Further details for the names of variables can be found in the UKMED data dictionary.[14]

The exposures of interest included: demographic factors, such as age, sex and ethnicity; socioeconomic factors, such as parental socioeconomic status (SES); and educational factors, such as medical school category (Russell group vs non-Russell group),[15] Situational Judgement Test (SJT) scores[16] at medical school, and Membership of the Royal College of Surgeons (MRCS) success (Part A and B).

The primary outcomes were whether CSTs applied for a T&O ST3 post, and if they were subsequently offered a post on their first application for a T&O ST3 post. Data between 1 January 2014 and 31 December 2019 were recorded, consolidating applications from these years for analysis. Data regarding candidates' initial applications for higher speciality training in T&O were considered to ensure uniform comparisons between candidates on their first attempt. Data on simultaneous applications to other specialities were included and considered in the analysis.

In order to adhere to the statistical disclosure controls of UKMED and the Higher Education Statistics Agency (HESA),[14,17] all figures were rounded to the nearest multiple of five. Percentages derived from a sample size < 22.5 individuals and averages based on < seven individuals were suppressed. While the statistical analyses were performed with the raw data, certain figures and percentages may appear imprecise due to restrictions imposed by HESA disclosure control.

Various demographic measures were assessed as binary variables including pre-medical school domicile (UK vs non-UK domicile). Participation of local areas (POLAR) (min = 1, max = 5) and Index of Multiple Deprivation (IMD)[14] (min = 1, max = 5) were recorded as ordinal variables (Table I).

Pre-medical school domicile, POLAR, and IMD provide an indication of where the trainee resided and the degree of social deprivation in that area. Parental occupation was also

Table I. Description of variables from the UK Medical Education Database (UKMED).

Variable group	Factor	Level	Description	Missing data, n (%)
Demographics	Year of birth	Continuous	Min = 1960s Max = 1990s	0 (0)
	Sex	Binary	Male vs female	0 (0)
	Ethnicity	Binary	Black and minority ethnic (BME) vs white	105 (5.36)
	Pre-medical school domicile	Binary	UK vs non-UK domicile	180 (9.18)
	Parental Socioeconomic Status (SES)	Discontinuous	Occupation titles	190 (9.69)
	Participation of local areas (POLAR)	Continuous	Min = 1 Max = 5	390 (19.90)
	Indices of multiple deprivation (IMD)	Continuous	Min = 1 Max = 5	390 (19.90)
Pre-medical school educational status	Higher Education Statistics Agency (HESA) tariff points	Continuous	Min = 0 Max = 999	185 (9.43)
	University degree attained prior to medical school	Binary	Degree attained vs no degree	180 (9.18)
Medical school educational status	FPAS Situational Judgement Test score	Continuous	Min = < 35 Max = > 45	725 (36.9)
	Medical school category	Binary	Russell Group vs Non-Russell Group	180 (9.18)
Pre-surgical training status	First attempt score on the MRCS Part A exam (relative to average pass mark)	Continuous	Min = < 20 Max = 40 to 59	0 (0)
	First attempt score on the MRCS Part B exam (relative to average pass mark)	Continuous	Min = < 20 Max = 60+	20 (1.02)
Speciality training application (ST3)	Eligible to apply to speciality training	Binary	Achieving outcome 6 on ARCP vs not achieving outcome 6 on ARCP	90 (4.59)
	Applied to at least one of the seven uncoupled surgical training programmes	Binary	Applied vs not applied	0 (0)
	Offered at least one of the seven uncoupled surgical training programmes	Binary	Offered vs not offered	0 (0)
	Applied to T&O higher surgical training	Binary	Applied vs not applied	0 (0)
	Offered a T&O higher surgical training post	Binary	Offered vs not offered	0 (0)

BME, black and minority ethnic; MRCS, Membership of the Royal College of Surgeons; T&O, Trauma & Orthopaedics.

assessed as a measure of wealth via parental SES based on profession.

Pre-medical school education status was interpreted by the HESA tariff points, which is an allocation of points to prospective medical students based on their performance in their aged post-16 years exams (typically A-levels).

HESA tariff points are allocated to prospective medical students based on their performance in exams when aged > 16 years (typically A-levels). The calculation of a score involves assigning numerical values to both the type of qualification and the grades achieved. The total tariff score includes only the highest scoring qualification for each subject, with any duplicate qualifications in the same subject being excluded from the calculation.[17]

Medical school educational status included the medical school attended (Russell Group vs non-Russell Group).[15] The Russell Group represents the leading 24 UK universities that are known for high-quality research and academia.[15]

Along with medical school education status, the Foundation Programme Application System (FPAS)[14] SJT was used as a continuous variable. The SJT is an exam that medical students take at the end of medical school before progressing to foundation training. It is scored out of 50 points and uses scenario-based questions to assess domains such as teamwork, communication, coping with pressure, and ethical judgement at the foundation programme level.[18] Applicants were categorized into four groups based on the following SJT scores: < 35, 35 to 39, 40 to 44, and ≥ 45. The number of SJT attempts made were also extracted, categorizing whether applicants had one or two attempts.

The status of pre-surgical training was addressed by first-attempt scores relative to the pass mark for both the MRCS Part A and Part B exams as continuous variables, given that Part A is a prerequisite to undertake the Part B examination. The Annual Review of Competency Progression (ARCP)[19] outcomes were also assessed, with an 'outcome 6'

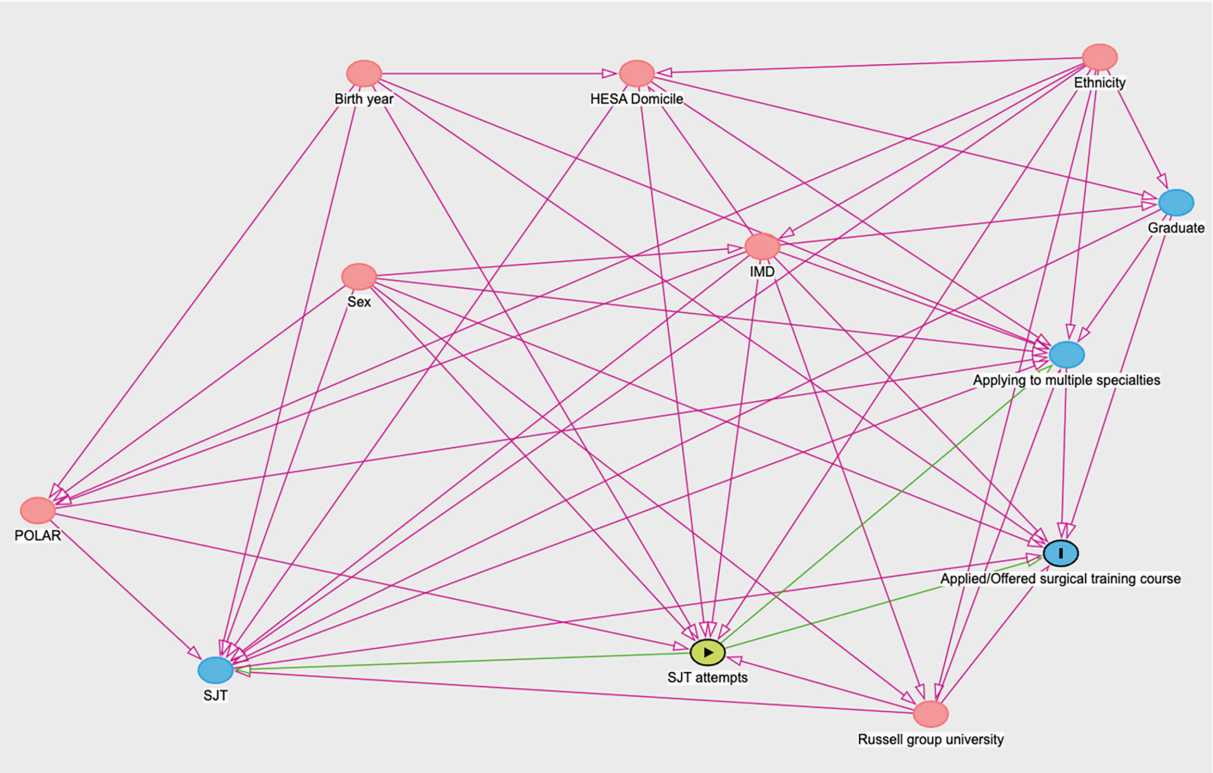

Fig. 1
Directed acyclic graph (DAG) to determine the confounding factors.

Table II. Exposures and the minimal adjustments required.

Exposure	Minimal adjustments required according to DAG
Birth year	No adjustments needed
Sex	No adjustments needed
Ethnicity	No adjustments needed
IMD (quintile)	Ethnicity, sex
HESA domicile	Birth year, ethnicity, IMD
Graduate on entry	Ethnicity, HESA, IMD
POLAR (quintile)	Birth year, ethnicity, sex
Russell Group medical school	Ethnicity, IMD, sex
SJT score	Birth year, graduate, Russell group, IMD, SJT attempts, sex, ethnicity, HESA, POLAR
SJT number of attempts	Birth year, ethnicity, HESA, POLAR, Russell group, IMD, sex
Reapplication	Birth year, graduate, IMD, Russell group, SJT score, SJT attempt, sex

DAG, directed acyclic graph; HESA, Higher Education Statistics Agency; IMD, Index of Multiple Deprivation; POLAR, participation of local areas; SJT, Situational Judgement Test.

given to doctors who have achieved the required competencies to progress to the next stage of training. The analysis of the ST3 speciality training application involved looking at the following binary variables, including: whether the trainee had applied to T&O higher speciality training; whether they had submitted applications to other specialities during the recruitment cycle; and whether they received an offer for a T&O ST3 post.

Statistical analysis

The characteristics of the cohort were described in a descriptive manner. Univariate logistic regression models were first carried out to calculate the odds ratios (OR) for the association between each exposure of interest and the outcomes of interest: applying to and being offered a T&O ST3 post. A directed acyclic graph (DAG) was then used to explore causal inferences and identify the appropriate confounders to adjust for. Each factor was individually set as the main variable in the model when determining the minimal adjustments required (Figure 1 and Table II). Logistic regression was then run again for all exposures to calculate the adjusted ORs accounting for confounders as directed by the DAG. A 95% CI was used to signify significance. All analysis was carried out using Stata v. 15.1 (StataCorp, USA).

Ethics and data access

Access to the data was restricted to select team members in a secure environment to maintain high standards of security, governance, and confidentiality. Ethical approval was not needed for this study since it involved analyzing anonymized data with established research agreements and access arrangements by the GMC, the data controller for UKMED. The Medical Schools Council (MSC)[12] confirmed that approved research projects using exclusively UKMED-held data would be

Table III. Demographics and socioeconomic factors analyzed for the core surgical trainee cohort (n = 1,960).

Variable	Total (n = 1,960), n (%)
Birth decade	
1960 to 1969	0 (N/A)*
1970 to 1979	15 (N/A)*
1980 to 1989	1,355 (69.13)
1990 onwards	585 (29.85)
Sex	
Male	1,240 (63.27)
Female	720 (36.73)
Ethnicity	
White	1,120 (57.14)
BME	735 (37.50)
Missing	105 (5.36)
Domicile	
UK	1,580 (80.61)
Non-UK	205 (10.46)
Missing	180 (9.18)
Parent's SES	
Higher managerial and professional occupations	645 (32.91)
Intermediate occupations	155 (7.91)
Lower managerial and professional occupations	320 (16.33)
Lower supervisory and technical occupations	30 (1.53)
Never worked and long-term unemployed	0 (N/A)*
Routine occupations	25 (1.28)
Semi-routine occupations	100 (5.10)
Small employers and own account workers	70 (3.57)
Other	425 (21.68)
Missing	180 (9.18)
POLAR	
1	55 (2.81)
2	130 (6.63)
3	245 (12.50)
4	370 (18.88)
5	770 (39.29)
Missing	390 (19.90)
IMD	
1	105 (5.36)
2	160 (8.16)
3	290 (14.80)
4	395 (20.15)

(*Continued*)

exempt from the requirement of ethics approval. No sources of funding were required to conduct this study.

Results

The characteristics of the cohort are shown in Table III. A total of 1,960 CSTs applied for higher surgical training. Overall, 1,720 (87.75%) successfully achieved ARCP outcome 6 and were eligible to progress through training. Of these, 1,195 applicants (60.97%) were offered a higher surgical training post in any speciality. From the CST cohort, 690 applicants (35.20%) were eligible to apply submitted an application for T&O, of which 460 (66.66%) were offered a T&O ST3 post.

Most CSTs were born between 1980 and 1989 (69.13%), most were male (63.27%), resided in the UK prior to going to medical school (80.61%), and more than half (57.14%) were white.

For CSTs, parents' SES was assessed as an indication of overall socioeconomic status by categorizing parents' occupations. A third of parents (32.91%) were involved in higher managerial and professional occupations. Investigation of the IMD showed that a third of all CSTs (31.63%) were from the 'least deprived area' (index 5). POLAR quintile showed that 770 (39.29%) CSTs were categorized in the POLAR quintile 5 area, which represents 'extreme likelihood' of younger people entering higher education.

Furthermore, most CSTs (76.79%) did not hold a previous degree when applying for medical school and most (68.9%) attended a Russell Group university. The HESA tariff points were analyzed for CSTs as a pre-medical school educational measure. Over half of the CSTs (53.32%) had between 400 and 599 points, and 9.95% had between 600 and 799 points (Table IV). Finally, MRCS Part A and Part B results were also analyzed for CSTs. For MRCS Part A, 73.21% of trainees scored < 20 above the average score required to pass, and 3.57% scored between 40 and 59 points above the average score required to pass. For MRCS Part B, 12.24% of trainees scored < 20 above the average score required to pass; however, 13.01% scored > 60 above the average score required to pass.

Factors associated with applying to T&O speciality training

Compared with the overall cohort of CSTs, male trainees were significantly more likely to apply for an ST3 post in T&O (OR 0.37, 95% CI 0.30 to 0.46; n = 155/720 female vs n = 535/1,240 male; $p < 0.001$; Table V). However, age and ethnicity were not associated with the odds of applying to T&O speciality training. Additionally, CSTs who resided outside of the UK before attending medical school were nearly twice as likely to apply to T&O than the entire cohort of UK-based CSTs (OR 1.99, 95% CI 1.39 to 2.85; n = 50/205 not UK-domicile vs n = 585/1,580 UK-domicile; $p < 0.001$; Table V).

Neither the IMD nor the POLAR quintile was associated with the odds of applying for a higher surgical training post in T&O. In terms of educational factors, holding a university degree prior to applying to medical school and attending a Russell Group university were not associated with increased odds of applying for a T&O ST3 post. Neither the SJT score nor the number of SJT attempts were associated with increased odds of applying to T&O.

(*Continued*)

Variable	Total (n = 1,960), n (%)
5	620 (31.63)
Missing	390 (19.90)

*Not applicable as this would denote a percentage based on fewer than 22.5 individuals, which must be suppressed as per HESA statistical disclosure controls.
IMD, Index of Multiple Deprivation; N/A, not applicable; POLAR, participation of local areas; SES, socioeconomic status.

Factors associated with being offered a T&O ST3 post

For first-time applications to T&O, neither age nor sex was associated with increased odds of being offered a T&O ST3 post. However, there was an significant association between ethnicity and receiving an offer for first-time applications to T&O ST3 in favour of candidates who identified as 'white' (OR 0.70, 95% CI 0.51 to 0.97; n = 165/265 BME vs n = 265/385 white; p = 0.034). Domicile status was not associated with differing odds of receiving an offer for a T&O ST3 post on first attempt.

Akin to those who applied for an ST3 post, differences in the IMD index and differences in the POLAR quintile were not significantly associated with increased odds of being offered an ST3 post in T&O. Similarly, holding a university degree prior to medical school or attending a Russell Group university were not significantly associated with increased odds of being offered a post. There were no significant differences in SJT scores or SJT attempts between applicants who were offered ST3 posts on their first attempt and unsuccessful applicants (Table VI).

Multiple applications

Only 25 CSTs (3.76%) who applied to T&O simultaneously applied to more than one speciality, and 15 of these applicants received an offer for a T&O ST3 post compared with 445 of 665 CSTs (66.92%) who received offers after applying to only T&O. A total of ten CSTs also applied to plastic surgery, with five receiving offers in both specialities; 15 simultaneously applied to general surgery, and five secured offers in both specialities. Applications to multiple specialities was not associated with increased odds of receiving a post in T&O.

Discussion

To the best of our knowledge, this is the first study to assess the demographic, socioeconomic, and educational factors that are associated with CSTs applying to and being offered higher surgical training posts in T&O. We identified significant differences in the sex and domicile of candidates who apply for an ST3 post in T&O, and a significant disparity in ethnicity between successful candidates.

We found an association between sex and applying for T&O in favour of male candidates. T&O is a speciality that is commonly perceived to be 'male-dominated' and one survey-based study reported that 95% of female medical students have this perception.[20] A third of the respondents at a "Women in Surgery" event who also initially considered a career in T&O were dissuaded by perceived sex disparities.[21] These perceptions about T&O, whether true or false, have often been attributed to the 'hidden curriculum,' that is the unofficial and unwritten social, cultural, and often stereotypical perception of certain specialities that trainees and medical students are exposed to throughout training,

Table IV. Educational factors analyzed for the core surgical trainee cohort (n = 1,960).

Variable	Total (n = 1,960), n (%)
HESA tariff points	
0 to 199	385 (19.64)
200 to 399	150 (7.65)
400 to 599	1,045 (53.32)
600 to 799	195 (9.95)
800 to 999	5 (N/A)*
Missing	180 (9.18)
Graduate on entry	
Graduate on entry	270 (13.78)
Not graduate on entry	1,505 (76.79)
Missing	9.44
Russell Group medical school	
Non-Russell Group	430 (21.94)
Russell Group	1,350 (68.88)
Missing	180 (9.18)
Number of SJT attempts	
1	1,525 (77.81)
2	10 (N/A)*
Missing	420 (21.43)
SJT score	
< 35	85 (4.34)
35 to 39	555 (28.32)
40 to 44	545 (27.81)
≥ 45	45 (2.30)
Missing	725 (36.99)
MRCS part A	
< 20	1,435 (73.21)
20 to 39	460 (23.47)
40 to 59	70 (3.57)
MRCS part B	
< 20	240 (12.24)
20 to 39	720 (36.73)
40 to 59	730 (37.24)
60 +	255 (13.01)
Missing	20 (N/A)*

*Not applicable as this would denote a percentage based on fewer than 22.5 individuals, which must be suppressed as per HESA statistical disclosure controls.
HESA, Higher Education Statistics Agency; MRCS, Membership of the Royal College of Surgeons; SJT, Situational Judgement Test.

Table V. Odds ratios and 95% CIs for factors associated with applying to a higher surgical training post in T&O surgery (n = 690).

Variable	Applicants, n	OR*	95% CI
Age decade			
1960s	5	1.00	Ref
1970s	5	0.31	(0.15 to 6.12)
1980s	480	0.55	(0.34 to 8.81)
1990s	205	0.54	(0.33 to 8.65)
Sex			
Male	535	1.00	Ref
Female	155	0.37†	(0.30 to 0.46)
Ethnicity			
White	385	1.00	Ref
BME	265	1.08	(0.89 to 1.32)
IMD			
1	45	1.00	Ref
2	50	0.74	(0.43 to 1.29)
3	115	1.13	(0.69 to 1.85)
4	140	0.86	(0.53 to 1.40)
5	235	0.97	(0.61 to 1.54)
Domicile			
UK	585	1.00	Ref
Non-UK	50	1.99†	(1.39 to 2.85)†
Graduate on entry to medical school			
Graduate	100	1.00	Ref
Not a graduate	535	1.27	(0.84 to 1.94)
POLAR quintile			
1	20	1.00	Ref
2	45	0.94	(0.46 to 1.90)
3	90	0.98	(0.50 to 1.87)
4	130	0.94	(0.50 to 1.78)
5	300	1.01	(0.55 to 1.88)
Russell Group medical school			
Non-Russell Group	150	1.00	Ref
Russell Group	485	0.96	(0.74 to 1.24)
SJT score			
< 35	35	1.00	Ref
35 to 39	200	0.75	(0.42 to 1.35)
40 to 44	190	0.74	(0.41 to 1.35)
≥ 45	10	0.40	(0.15 to 1.04)
SJT attempts			
1	535	1.00	Ref
2	10	4.44	(0.84 to 23.43)
Multiple applications			
Applied to 1 speciality	665	N/A‡	N/A‡
Applied to > 1 speciality	25	N/A‡	N/A‡

*Denotes adjusted odds ratio(s) as defined by the directed acyclic graph (Figure 1).
†Denotes statistical significance i.e. $p < 0.05$.
‡Denotes cases where the presence of collinearity rendered precise estimation unattainable.
BME, black and minority ethnic; IMD, Index of Multiple Deprivation; OR, odds ratio; POLAR, participation of local areas; SJT, Situational Judgement Test; T&O, Trauma & Orthopaedics.

particularly in the hospital environment. In order to address this issue, societies and organizations could play a pivotal role by increasing awareness through educational initiatives and leveraging their platforms to educate trainees. This heightened awareness could then permeate through individual medical schools and communities. Furthermore, T&O can draw lessons from other specialities that have successfully tackled similar challenges by fostering an inclusive environment for all aspiring surgeons.[3]

Moreover, it has been shown that one of the most common reasons for females not to pursue orthopaedics is the "perceived inability to have a good work-life balance".[22] A career in T&O, like other surgical specialities, requires several years of training with unpredictable and unsociable working hours, alongside additional academic and portfolio work. When femles in surgical specialities have children, it has been found that they take "shorter periods of maternity leave and work closer to full time-hours after returning" than their counterparts in medicine or other specialities. However, despite this personal sacrifice, there is still a gap in progression rates when compared with their childless male colleagues.[23] Poon et al[24] reported that 53% of female T&O surgeons intentionally delayed starting a family because of their choice of career. Orthopaedic surgery has also been reported to be one of the top three fields with the highest risk of female infertility and complications with pregnancy, potentially due to a combination of the obstacles during training and the physical demands of the speciality.[25]

Interestingly, there was no significant difference between the sexes in terms of receiving offers for T&O ST3 posts. This highlights the fairness of the recruitment system in terms of appointing individuals, suggesting that bias based on sex is not a significant factor in the decision to appoint applicants. Instead, the main challenge lies in attracting female applicants to surgical training programmes, such as T&O. These results are in contrast with the DE FACTO study on urology, which found an association between sex and receiving an offer for ST3 in favour of female applicants.[11] It has been shown that a greater proportion of female surgeons help to provide culturally competent care and as there are still proportionally fewer female surgeons, there has been a drive to encourage more women to apply for surgical training.[26,27] In 2014, the British Orthopaedic Association (BOA) recognized the "sex imbalance in orthopaedics lagging behind other medical specialities" and stated their vision for a "representative orthopaedic community".[28] As more societies

Table VI. Odds ratios and 95% CIs for factors associated with being offered a higher surgical training post in T&O surgery (n = 460).

Variable	Number offered	OR*	95% CI
Age decade			
1960s	0	-	-
1970s	0	-	-
1980s	320	1.00	Ref
1990s	135	1.00	(0.71 to 1.42)
Sex			
Male	360	1.00	Ref
Female	95	0.77	(0.54 to 1.12)
Ethnicity			
White	265	1.00	Ref
BME	165	0.70†	(0.51 to 0.97)
IMD			
1	25	1.00	Ref
2	30	1.43	(0.59 to 3.46)
3	75	1.65	(0.76 to 3.58)
4	100	1.60	(0.74 to 3.42)
5	170	2.00	(0.97 to 4.13)
Domicile			
UK	405	1.00	Ref
Non-UK	35	0.85	(0.44 to 1.67)
Graduate on entry to medical school			
Graduate	70	1.00	Ref
Not a graduate	370	0.87	(0.42 to 1.81)
POLAR quintile			
1	15	1.00	Ref
2	30	1.17	(0.36 to 3.85)
3	60	0.99	(0.33 to 2.93)
4	95	1.23	(0.32 to 3.56)
5	205	1.06	(0.38 to 2.93)
Russell Group medical school			
Non-Russell Group	95	1.00	Ref
Russell Group	340	1.24	(0.81 to 1.89)
SJT score			
< 35	25	1.00	Ref
35 to 39	140	1.01	(0.40 to 2.53)
40 to 44	135	1.04	(0.40 to 2.67)
≥ 45	10	2.75	(0.26 to 28.59)
SJT attempts			
1	380	1.00	Ref
2	5	0.18	(0.30 to 1.05)
Multiple applications			
Applied to 1 speciality	445	1.00	Ref
Applied to > 1 speciality	15	0.58	(0.14 to 2.38)

*Denotes adjusted odds ratio(s) as defined by the directed acyclic graph (Figure 1)
†Denotes statistical significance i.e. $p < 0.05$.
BME, black and minority ethnic; IMD, Index of Multiple Deprivation; OR, odds ratio; POLAR, participation of local areas; SJT, Situational Judgement Test; T&O, Trauma & Orthopaedics.

and organisations, such as Women in Orthopaedics Worldwide (WOW),[29] have begun to address this disparity, more attention has been paid to the importance of increasing the proportion of female surgeons. Alongside this, initiatives such as 'less than full-time training' (LTFT) have been implemented in several specialities in the NHS to offer all trainees the option of working in a more flexible manner.

We also found an association between ethnicity and being offered a post in T&O, favouring those who identified as 'white' in their first application for an ST3 post in T&O. Those from ethnic minority backgrounds who responded to a survey in a study set in orthopaedic departments in the UK on bullying were more likely than white respondents to report to having experienced bullying.[30] The issues regarding racial differences exist not only in T&O, but throughout the NHS, with ongoing evidence of racial prejudice in the workplace. The Association of Surgeons in Training (ASiT) and British Orthopaedic Trainees' Association (BOTA) conducted a survey in 2017 that showed that 21% of respondents had witnessed or personally experienced racist language or attitudes.[31] More recently, it has been reported that ethnic minorities are at a disadvantage when it comes to achieving the requirements necessary for progression to higher surgical training. For example, Ellis et al[32] have recently shown that 'white' candidates were almost twice as likely to pass MRCS A at the first attempt in comparison to 'BME' candidates.[32] Furthermore, 'BME' trainees are more likely to experience "difficulties in the workplace" with recent data concluding that both 'BME' UK graduates (UKGs) and international medical graduates (IMGs) can "face additional difficulties in training" which can "impede learning and performance".[33] The authors reported that 'BME' UKGs and IMGs commented most frequently that lack of support from their seniors led to disadvantages faced in the workplace.[33]

It is unclear why CSTs who were domiciled outside of the UK prior to medical school were nearly twice as likely to apply to T&O when compared to the rest of the CST cohort. This specific category includes doctors who may have lived outside of the UK prior to attending medical school in the UK (i.e. international UKGs) as well as doctors who lived and graduated from medical schools abroad (i.e. IMGs). International medical students in the UK only comprise around 7% of all UK medical students.[34] Regardless, there was no significant difference in domicile status between CSTs who were and were not offered a T&O ST3 post. Minimal research has

been conducted on UK-based international medical students, their choice of speciality, and their performance compared to UK-based medical students with 'home' status. It is therefore difficult to speculate or infer why CSTs who were not domiciled in the UK prior to medical school were more likely to apply to T&O.

We also confirmed that there was no significant difference between SJT scores or attempts and the odds of applying for or being offered a T&O ST3 post. SJT scores do not consistently forecast success in the MRCS exams considering that the SJT was initially designed to assess medical students applying for the foundation programme.[35] While considerable research has explored the role of the SJT as a predictor of success in the foundation programme, comparatively less attention has been directed toward its effectiveness in predicting success in surgical training.[36,37] As of 2024, the SJT has been removed entirely from the UK foundation programme allocation process in favour of a "preference informed allocation" process whereby students are randomly allocated a rank which is computer-generated,[38] and could indicate a shift in focus towards other metrics or methods of evaluating candidates for the foundation programme and potentially surgical training in the future.

Finally, of the 690 CSTs who applied for T&O, only 25 applied to multiple specialities. As the data for applicants to multiple specialities were limited, conducting a meaningful logistic regression analysis was not possible. Consequently, there appears to be no statistically significant relationship between submitting multiple applications and the likelihood of success in obtaining an offer for higher surgical training in T&O.

The strengths of this study include its very large sample size, using data for 1,960 trainees. The longitudinal nature of the data provided by UKMED meant that it was possible to identify long-term trends for many factors, comparing those who applied for a training post and those who were subsequently offered a post in T&O. As the UKMED database, which is composed of data collected by the GMC as part of their statutory duty to regulate medical education in the UK, was used, we did not have to rely on the voluntary completion of surveys, as previous studies have done.[35] Quantitative data were used and processed via logistic regression analysis to establish relevant associations while accounting for confounders.

Limitations of this study include the fact that it is a case-control retrospective study and is therefore not sufficiently granular or able to ascertain causations. The results are thus presented solely as associations. Second, the cohort only consisted of applications submitted by doctors who had completed CST in the UK, thereby excluding a proportion of IMGs or doctors who may have applied directly to higher surgical training via alternative routes, such as Certificate of Readiness to Enter Higher Surgical Training (CREHST).[39] Another limitation was the exclusion of repeat applicants from our analysis. It is worth mentioning that, anecdotally, the highly competitive nature of the ST3 application process means that unsuccessful candidates may have to reapply in subsequent application cycles. The findings in this study are only applicable for first-time applications for T&O ST3.

Furthermore, there were varying degrees of missing data for each assessed factor as these were not recorded on the UKMED database. There were also no data regarding the CST programmes completed by trainees and whether these programmes were 'themed' to a particular speciality, which may potentially influence applicants' choices for higher surgical training. The data used in the study were also aggregated and averaged across several application cycles, thereby precluding direct year-by-year comparisons, which may not account for changes in application requirements or national selection processes. Moreover, due to governance processes and internal peer-review within UKMED, there was a prolonged lead time between the completion of the study and receiving permission for publication. All data analyzed in this study also predates the onset of the COVID-19 pandemic. The pandemic brought about substantial changes in the surgical recruitment process in the UK, such as the adoption of virtual interviews and online portfolios in the most recent application cycles, the data for which were not incorporated in this analysis.

Future studies could analyze more recent data to add to the evidence base and investigate whether the virtual format has led to any changes in the characteristics of applicants and successful candidates. Further high-quality, prospective studies on those who made several applications and the number of attempts are also needed to add to the quality of the evidence. The findings may not be applicable beyond the UK, which also represents an avenue for potential future research in other healthcare systems.

In conclusion, there is an evident disparity in applying to T&O ST3 posts between the sexes in favour of male candidates, but this does not translate to differences in receiving offers between the sexes. However, there is an ethnic disparity for those who are offered T&O ST3 posts on their first attempt, which is present despite equality, diversity and inclusion efforts by national organisations. This warrants further investigation. As these conclusions are based on findings from the pre-COVID-19 pandemic period, further high-quality, prospective research and interventions in the post-pandemic period are needed to understand and overcome this disparity and ensure equal progression into T&O training.

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Data sharing

UK Medical Education Database ("UKMED") UKMEDP134 extract generated on 16/06/2021. Approved for publication on 01/12/2023. We are grateful to UKMED for the use of these data (UK Medical Education Database ("UKMED") UKMEDP134 extract generated on 16/06/2021. However, UKMED bears no responsibility for their analysis or interpretation. The data includes information derived from that collected by the Higher Education Statistics Agency (HESA) and provided to the GMC (HESA Data). HESA 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. Data files used in the study are securely held by the UKMED Database and cannot be shared by the authors, however this data is available via application (see www.ukmed.ac.uk). Further details for the names of variables can be found in the UKMED data dictionary which is available to the public. The study protocol for this study will be made available with publication in the Supplementary Material.

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Ethical review statement

Ethical approval was not deemed necessary for this study as it involved the analysis of anonymized data. There are existing established research agreements and access arrangements authorised by the General Medical Council. The Medical Schools Council has also previously stated that research projects utilizing solely UKMED-held data would be exempt from requiring ethical approval.

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