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# **Factors Associated with Progression in Higher Surgical Specialty Training**

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Thesis submitted to the University of Nottingham for the degree of  
Doctor of Philosophy

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This thesis is dedicated to JJ, my family and Trixie for all that they do.

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## **Abstract**

The demographics of surgical trainees have seen huge changes over the last decade. The proportion of female trainees, non-UK graduates and older trainees have all increased. The impact of trainee demographics and protected characteristics on progression throughout surgical training is unknown. Progression in surgical training can be measured by annual assessments, completion of training and clinical assessments. The aim of this thesis was to identify factors associated with progression throughout Higher Surgical Training.

The first study in this thesis (Chapter 2) is a systematic review and meta-analysis investigating factors associated with attrition and performance throughout surgical training worldwide. Attrition, defined as voluntary or involuntarily discontinuation of surgical training, remains a challenge. The pooled overall attrition rate was 17% with women having a significantly higher rate (24% vs 16%,  $p < 0.001$ ). Attrition rates for Higher Surgical Training in the UK are not well documented and have not been published.

During the course of this thesis, the COVID-19 pandemic caused huge disruption to the NHS and health services globally. Subsequently, surgical trainees were redeployed and elective operating lists were cancelled. Chapter 3 is a systematic review on the impact of COVID-19 on surgical training worldwide. Twenty nine studies comprising more than 5,000 surgical trainees across more than 20 countries were included in the review. The first wave of the COVID-19 pandemic

caused huge disruption to the operative and non-operative clinical experience of trainees. The mental health and wellbeing of trainees was also adversely affected. Some positives to come out of the pandemic were increased research output reported in some studies and more time for self-directed study.

Two studies (Chapter 4 & 5) used the United Kingdom Medical Education Database (UKMED) to perform cohort studies of General Surgery and Trauma and Orthopaedics. The aim was to identify factors affecting progression in both specialities. The outcome measure was Annual Review of Competency Panel (ARCP) outcome on an ordinal scale. In General Surgery, older age at ARCP and those from more deprived social background were significantly more likely to receive a non-standard outcome while female sex and less than full time training were protective factors. In contrast, female sex was a risk factor for non-standard ARCP outcome in Trauma and Orthopaedics along with older age. International medical graduates were found to have lower odds of non-standard outcome compared to UK graduates in Trauma and Orthopaedics.

The final chapter (Chapter 6) utilising data from UKMED aimed to identify demographic factors and protected characteristics associated with non-standard ARCP outcome across specialities and to identify variation in ARCP outcomes. Across all specialities, female sex and older age were associated with higher odds of non-standard outcome. There was significant variation in ARCP outcomes between specialities

with General Surgery having the highest proportion of non-standard outcomes and Urology the lowest.

This thesis provides new evidence regarding factors affecting progression and performance in Higher Surgical Training. It highlights areas that require further investigation in UK surgical training. Attrition in UK surgical programmes should be formally documented on a national scale and reasons for attrition identified. The longstanding impact of COVID-19 on surgical training will require follow up studies, in particular ensuring that no group of trainees are disproportionately disadvantaged and a recovery plan to recoup training losses. The pandemic has exacerbated pre-existing social inequalities with differences in disease burden between and within countries [1-3], it is possible these patterns are reflected in surgical training outcomes. Causes behind the differential attainment found in these studies need to be urgently investigated and the ARCP process reviewed.

## **Presentations arising from doctoral studies**

- Factors Associated with Attrition and Performance throughout Surgical Training: a Meta-Analysis

Association of Surgeons of Great Britain and Ireland, Dec 2020

- Personal Characteristics Associated with Progression in General Surgical Specialty Training: A Longitudinal Cohort Study

Association of Surgeons of Great Britain and Ireland, Dec 2020

- Factors associated with ARCP outcome in surgical specialities

Joint Committee on Surgical Training, Jan 2021

- Differential Attainment in Surgical Training

Association of Surgeons In Training, March 2021

- The impact of COVID-19 on surgical training: a systematic review

Association of Surgeons of Great Britain and Ireland East

Midlands Journal club, March 2021

- Differences in ARCP outcome by surgical speciality: a longitudinal cohort study

Surgical Research Society, April 2021

- Differential attainment throughout Higher Surgical Training

ISCP Management Committee, April 2021

- Differential Attainment- why it matters to us all

British Association of Urological Surgeons, Dec 2021

## **Publications arising from doctoral studies**

- C. Hope, JJ. Reilly, G. Griffiths, J. Lund, D. Humes. Factors Associated with Attrition and Performance Throughout Surgical Training: A Systematic Review and Meta-Analysis. World Journal of Surgery. 2020. DOI: 10.1007/s00268-020-05844-0
- C. Hope, JJ. Reilly, G. Griffiths, J. Lund, D. Humes. The Impact of Covid-19 on Surgical Training: a Systematic Review. Techniques in Coloproctology. 2021. DOI: 10.1007/s10151-020-02404-5
- C. Hope. Differential attainment and the changing surgical workforce. Journal of the Association of Surgeons of Great Britain and Ireland. 2020. 57:39-40.  
<https://www.asgbi.org.uk/userfiles/file/journals/jasgbi-summer-2020-issue.pdf>
- Personal characteristics associated with progression in General Surgery training: a longitudinal cohort study. The Bulletin. 2021. doi.org/10.1308/rcsbull.TB2021.14
- Personal Characteristics Associated with Progression in Trauma and Orthopaedic Specialty Training: A Longitudinal Cohort

Study. Journal of Surgical Education. 2021. DOI:  
10.1016/j.jsurg.2021.06.027

- Differences in progression by surgical specialty: a national cohort study. 2022. BMJOpen. DOI: 10.1136/bmjopen-2021-05339

## **Glossary of Terms**

- ABS: American Board of Surgery
- ACGME: Accreditation Council on Graduate Medical Education
- ARCP: Annual Review of Competency Progression
- BAME: Black, Asian and Minority Ethnic
- BAPIO: British Association of Physicians of Indian Origin
- BME: Black and Minority Ethnic
- CCT: Certificate of Completion of Training
- CI: Confidence Interval
- CST: Core Surgical Training
- CT: Core Trainee
- EEA: European Economic Area
- ENT: Ear, Nose and Throat
- EU: European Union
- FRCS: Fellowship of Royal College of Surgeons
- GMC: General Medical Council
- HEE: Health Education England
- HST: Higher Surgical Training
- IMD: Index of Multiple Deprivation
- IMG: International Medical Graduate

- ISB: Intercollegiate Specialty Board
- ISCP: Intercollegiate Surgical Curriculum Programme
- JCIE: Joint Committee for Intercollegiate Examination
- JCST: Joint Committee for Surgical Training
- LETB: Local Education and Training Boards
- LTFT: Less Than Full Time
- MRCS: Membership of Royal College of Surgeons
- NHS: National Health Service
- NTN: National Training Number
- OMFS: Oral and Maxillofacial Surgery
- OOP: Out of Programme
- OOPE: Out of Programme for Clinical Experience
- OOPR: Out Of Programme for Research
- OOPT: Out of Programme for Training
- OR: Odds Ratio
- OSF: Open Science Framework
- PLAB: Professional and Linguistic Assessment Board
- PMQ: Primary Medical Qualification
- PRISMA: Preferred Reporting Items for Systematic Reviews and  
Meta-Analyses

- RTT: Run Through Training
- SAC: Specialty Advisory Committees
- SpR: Specialist Registrar
- ST: Specialty Trainee
- T&O: Trauma and Orthopaedics
- TPD: Training Programme Director
- UKMED: United Kingdom Medical Education Database
- WBA: Work-place Based Assessment

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# **Chapter 1            Introduction**

## **Section 1.1            Background**

The surgical workforce is increasingly diverse and relies on graduates from many different countries and backgrounds. In recent years, the demographics of surgical trainees has changed, with more females and non-UK trained graduates now entering the specialty. The impact of the changing surgical cohort on progression through training is unknown. Since 2012 there has been a 5.9% decrease in the number of surgeons in training [4]. This is a worrying trend considering the population growth and the number of operations performed increasing by 40% between 2005/6 to 2015/6 [5]. There is incentive to ensure surgeons progress adequately through training and to minimise the drop-out rate.

The impact of protected characteristics and socioeconomic background on postgraduate medical outcomes has been of interest for many years. This is often termed differential attainment. In 1993, Esmail and Everington found that male doctors with Asian surnames were less likely to be shortlisted for job applications than those with English surnames [6]. Further attention was generated in 2014 when the Membership of the Royal College of General Practitioners (MRCGP) examination and the GMC were brought to judicial review over reports of differential attainment for non-White candidates [7]. The General Medical Council (GMC) commissioned a piece of work 'Fair Training Pathways for All: Understanding Experiences of Progression'

investigating the perceptions of fairness in postgraduate medical education [8]. This qualitative study identified multiple factors that pose a risk to progression of Black and Minority Ethnic (BME) and international medical graduates (IMG) (Appendix 1). The follow up piece focused on the causes of differential attainment and potential barriers to change [9].

One of the priorities of the General Medical Council (GMC) is to ensure all groups of doctors reach their potential, and GMC standards require training pathways and processes to be fair for all [10]. With the changing demographic profile of doctors, it is important that the processes we use to assess doctors in training are robust and fair.

The review into diversity and inclusion in the Royal College of Surgeons of England professional leadership by Baroness Kennedy released in March 2021 found that not enough is being done to address these issues and to stamp out discrimination [11]. The review was commissioned “in the wake of the Black Lives Matter movement, and following the election of four White men to senior College leadership positions” [12]. The review concluded that the lack of diversity within College leadership roles was ‘not going to sort itself out over time’ and more needed to be done to cultivate a sense of belonging for every surgeon [11], describing a sixteen point plan to address imbalances. It is possible that the inequalities described in this report are also present throughout surgical training.

A further piece of work by the GMC, reported that “differential attainment is often not perceived as an issue, or is something that

educators or others are not aware of, until data is presented” [13].

Across surgical specialities, there is little published literature based on quantitative evidence regarding differences in attainment once already in a training programme.

The process of training to become a surgical consultant is lengthy, with a minimum of ten years of training after graduation from medical school. The time for completion of Higher Surgery Training is approximately six years. However, over recent years an increasing number of trainees are taking time out of surgical training, often for a period of formal research, which increases the total training time. One study found that 52.8% of General Surgery trainees who had completed training or were still ‘in-training’ had taken a period out of training [14]. A substantial amount of resources and time are invested into training a surgeon, with the total cost of surgical training over £400,000 per trainee [15]. There is therefore also a financial incentive to ensure trainees progress adequately and complete training. To date, there is very little literature focusing on factors affecting progression or performance in surgical training in the UK.

#### 1.1.1 Surgical training in the UK

There are ten distinct surgical specialties:

1. General Surgery
2. Trauma and Orthopaedics (T&O)
3. Plastic Surgery

4. Urology
5. Neurosurgery
6. Otolaryngology
7. Paediatric Surgery
8. Cardiothoracic Surgery
9. Oral and Maxillofacial Surgery (OMFS)
10. Vascular Surgery

#### 1.1.2 Training Timeline

Current UK medical graduates enter a mandatory two year Foundation Training Programme which typically involves six four month placements across a range of specialities [16]. Following completion of Foundation Training, those wishing to pursue a surgical career follow a standardised pathway (Figure 1.1). Surgical training is generally divided into two parts: Core Surgical Training (CST) and Higher Surgical Training (HST).

Figure 1.1 Surgical Training Pathways [17]

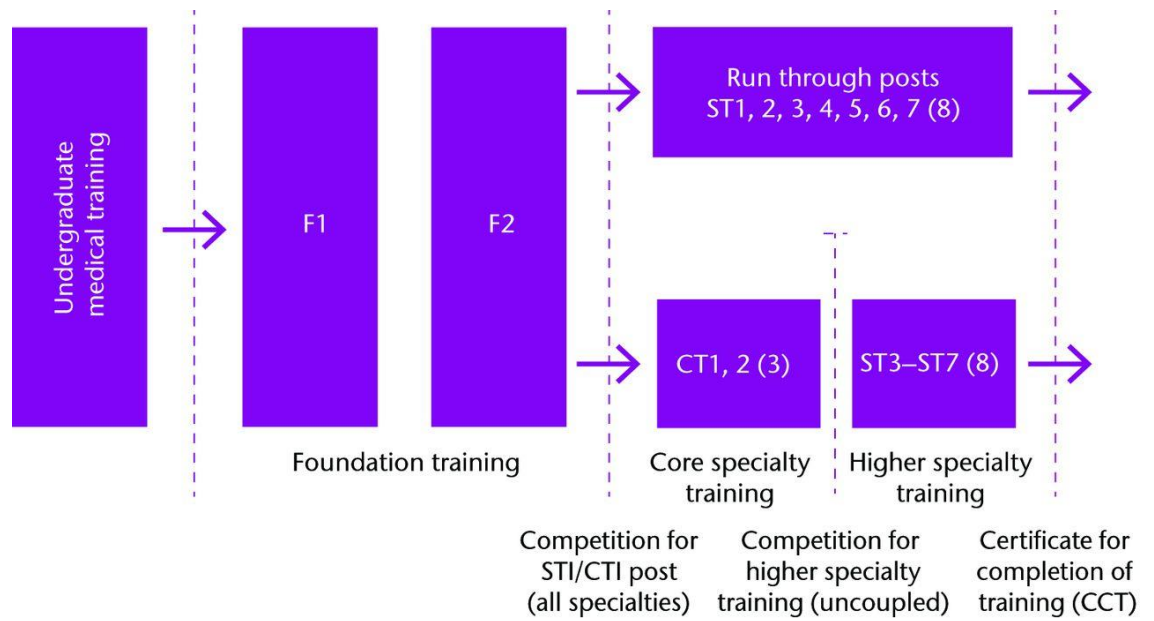


Figure summarising the surgical training pathway. Run through posts include Neurosurgery, Cardiothoracic Surgery, OMFS. General Surgery and Vascular Surgery have a combination of run through posts and uncoupled Core Surgical Training.

### 1.1.3 Core Surgical Training

Appointment to a CST post is via a national selection process which consists of applicant longlisting followed by an interview. In the vast majority of cases, CST has an indicative duration of 24 months, during which time the trainee will rotate through various surgical specialities [18]. A trainee in the first year of CST is referred to as a Core Trainee year 1 (CT1). CST can be themed around a surgical speciality of interest or consist of generic surgical training. The Intercollegiate Membership of the Royal College Surgeons (MRCS) examination is an exit requirement for completion of CST [18] and a prerequisite for entering HST. The aim of CST is to allow the acquisition of basic skills common to all surgical specialities alongside some speciality-specific competencies [19].

### 1.1.4 Higher Surgical Training

Upon completion of CST or equivalent, applicants undergo a further competitive national selection process to enter Higher Surgical Training (HST), comprising an application form followed by interview for the longlisted candidates. Successful candidates are awarded a Specialty Trainee (ST) post and allocated a National Training Number (NTN). A first year specialty trainee is referred to as a Specialty Trainee year 3 (ST3). HST is a normally five to six year programme matched to a national curriculum which defines the levels of speciality specific knowledge and skills required for completion of training.

### 1.1.5 Run-through training

Some surgical specialities, such as Neurosurgery, Cardiothoracic Surgery and OMFS operate a 'run-through' training (RTT) programme. RTT programmes allow automatic progression to the next level of training, providing that all required competencies are satisfied [20]. In 2018, more surgical specialities began to offer 'run-through' training posts as part of the Improving Surgical Training pilot [21]. General Surgery, Urology, Vascular and Trauma and Orthopaedics have begun to offer run through posts alongside traditional CST posts. All remaining surgical specialities aside from Plastic Surgery are planning a RTT pathway in the near future.

#### 1.1.6 Alternative Routes of Entry

The training pathway for overseas graduates or those completing training abroad varies [22]. It is possible to enter surgical training in the UK at the level of CT/ST1 or ST3 national selection providing certain criteria can be met. All candidates must be registered with the GMC and demonstrate acquisition of equivalent competencies.

#### 1.1.7 Training Pathway Types

Alongside the traditional training pathway, there are other routes open to trainees that accommodate the need for less than full time working, an interest in academia or time away from the training programme to pursue other interests.

#### 1.1.8 Less than Full Time Training

Less than full time training (LTFT) results in a longer overall training time. The requirements at each stage of training and for certification are the same for LTFT as for full time training. According to the Gold Guide, the only requirement to be permitted to train less than full time is a 'well-rounded individual reason' [20]. Requests for LTFT are dependent on individual training programme capacity however trainees with a disability or illness, child care or caregiving responsibilities take priority [20].

#### 1.1.9 Academic training

Trainees wishing to pursue a career in academia can apply for academic training in conjunction with their clinical training [20].

Integrated academic and clinical posts are available at entry to CST and HST. These trainees are required to meet the same clinical standards as non-academic trainees and in addition will have an academic annual assessment.

#### 1.1.10 Time Out of Programme

For trainees with a National Training Number, there are a number of options in order to take time out of programme (OOP) [23]. This allows

a trainee to temporarily leave HST whilst retaining their training number.

All OOP requests require approval by the Postgraduate Dean [20].

#### 1.1.11 Out of Programme for Clinical Experience

The purpose of Out of Programme for Clinical Experience (OOPE) is to gain skills that would enhance future practice. The posts in an OOPE are not approved by the GMC and therefore do not count towards Certification of Completion of training (CCT), therefore the CCT date will need to be extended [20]. These posts range from 12 months to 2 years.

#### 1.1.12 Out of Programme for Research

Research is a key component of all surgical specialities. Trainees wishing to undertake research are able to apply for Out of Programme for Research (OOPR) which provides a dedicated period for research and the opportunity to achieve a higher research degree. The duration is generally three years, but can be extended to a maximum of four years in exceptional circumstances [20].

#### 1.1.13 Out of Programme for Career Breaks

A planned Out of Programme for Career breaks (OOPC) allows a trainee to take time out of the training programme for a pre-agreed period of time. Any trainee is able to request OOPC with priority given

to those needing a break to care for dependants, personal illness and the achievement of life goals that cannot be deferred. In most circumstances this will not exceed two years.

#### 1.1.14 Out of Programme for Approved Clinical Training

Out of Programme for Approved Clinical Training (OOPT) allows the trainee to undertake clinical training in a post that does not constitute part of the existing training programme. The posts in an OOPT are approved and therefore count towards CCT without extending the overall training time. Posts can be within a different unit in the UK or overseas. All posts must be prospectively approved by the GMC.

The number of posts and subsequent competition ratios for each surgical specialty is varied (Table 1.1). The figures reflect the variation in the structure of surgical provision in the UK, with some specialities having been centralised [24]. Each speciality has a unique curriculum and CCT requirements, with variation in the demographics of consultants and trainees (Table 1.2). The ethnic background of consultant and trainees differs across specialities (Table 1.2). For comparison, in the general population of England and Wales 86% identify as White, 7.5% Asian and 3.3% Black ethnic groups [25]. Similarly, the training experience differs across each surgical specialty.

Table 1.1 Competition ratios for Higher Surgical Training (ST3 entry). General Surgery and Vascular Surgery have common application to a jointly run selection process, with trainees selecting whether to be considered for either or both specialty at the point of application. Competition ratio represents the number of applicants per post.

| <b>Specialty</b>                    | <b>2019</b> | <b>2020</b> |
|-------------------------------------|-------------|-------------|
| <b>General and Vascular Surgery</b> | 2.16        | 4.67        |
| <b>Trauma and Orthopaedics</b>      | 3.11        | 5.72        |
| <b>Plastic Surgery</b>              | 3.92        | 4.63        |
| <b>Urology</b>                      | 2.07        | 2.28        |
| <b>Neurosurgery*</b>                | 7.00        | 8.46        |
| <b>Otolaryngology</b>               | 2.57        | 5.70        |
| <b>Paediatric Surgery</b>           | 2.56        | 8.33        |
| <b>Cardiothoracic Surgery*</b>      | 5.00        | 9.92        |
| <b>OMFS*</b>                        | 0.96        | 3.20        |

Based on data from Health Education England 2020 [26]. OMFS= oral and maxillofacial surgery. \*Competition ratio based at entry into CT/ST1 as these specialities offer run-through training and few enter at ST3.

Table 1.2. Number and proportion of doctors by grade in each surgical speciality as of 2020.

| Specialty                      | Consultants | Specialty registrar | Overall satisfaction<br>(national training survey) |
|--------------------------------|-------------|---------------------|----------------------------------------------------|
| <b>General Surgery</b>         | 2575 (28%)  | 1631 (27%)          | 82%                                                |
| % Women                        | 17%         | 38%                 |                                                    |
| % White                        | 55%         | 38%                 |                                                    |
| % Asian                        | 29%         | 26%                 |                                                    |
| % Black                        | 2%          | 5%                  |                                                    |
| <b>Trauma and Orthopaedics</b> | 2685 (29%)  | 1776 (29%)          | 84%                                                |
| % Women                        | 6%          | 20%                 |                                                    |
| % White                        | 58%         | 41%                 |                                                    |
| % Asian                        | 28%         | 29%                 |                                                    |
| % Black                        | 1.5%        | 5%                  |                                                    |
| <b>Plastic Surgery</b>         | 541 (6%)    | 420 (7%)            | 81%                                                |
| % Women                        | 21%         | 42%                 |                                                    |
| % White                        | 62%         | 52%                 |                                                    |
| % Asian                        | 20%         | 17%                 |                                                    |
| % Black                        | 2%          | 3%                  |                                                    |
| <b>Urology</b>                 | 979 (11%)   | 471 (8%)            | 82%                                                |
| % Women                        | 11%         | 31%                 |                                                    |
| % White                        | 51%         | 43%                 |                                                    |

|                               |          |          |     |
|-------------------------------|----------|----------|-----|
| % Asian                       | 31%      | 21%      |     |
| % Black                       | 3%       | 8%       |     |
| <b>Neurosurgery</b>           | 357 (4%) | 394 (6%) | 80% |
| % Women                       | 8%       | 23%      |     |
| % White                       | 58%      | 44%      |     |
| % Asian                       | 26%      | 28%      |     |
| % Black                       | 2%       | 4%       |     |
| <b>Otolaryngology</b>         | 782 (9%) | 546 (9%) | 86% |
| % Women                       | 16%      | 48%      |     |
| % White                       | 54%      | 41%      |     |
| % Asian                       | 27%      | 26%      |     |
| % Black                       | 2%       | 6%       |     |
| <b>Paediatric Surgery</b>     | 191 (2%) | 159 (3%) | 84% |
| % Women                       | 27%      | 48%      |     |
| % White                       | 58%      | 52%      |     |
| % Asian                       | 29%      | 12%      |     |
| % Black                       | 3%       | 6%       |     |
| <b>Cardiothoracic Surgery</b> | 409 (4%) | 321 (5%) | 84% |
| % Women                       | 10%      | 16%      |     |
| % White                       | 56%      | 38%      |     |
| % Asian                       | 25%      | 32%      |     |
| % Black                       | 2%       | 4%       |     |

|                         |          |          |     |
|-------------------------|----------|----------|-----|
| <b>OMFS*</b>            | 369 (4%) | 206 (3%) | 86% |
| % Women                 | 12%      | 25%      |     |
| <b>Vascular Surgery</b> | 246 (3%) | 115 (2%) |     |
| % Women                 | 12%      | 27%      |     |
| % White                 | 59%      | 43%      |     |
| % Asian                 | 21%      | 18%      |     |
| % Black                 | 2%       | 4%       |     |
| <b>Total</b>            | 9134     | 6039     |     |

Based on NHS Digital Data 2020 [27]. OMFS= oral and maxillofacial surgery.

\*Ethnicity data not available for OMFS.

### 1.2.1 General Surgery

General Surgery is one of the largest surgical specialties in the UK, comprising 28% of the consultant surgical workforce (Table 1.2). There are a range of special interests that lie within the remit of General Surgery: upper gastrointestinal, colorectal, breast, transplant, trauma, endocrine, surgery of childhood and remote and rural surgery.

Regardless of the special interest of choice, all General Surgery trainees are required to meet the same standards of emergency General Surgery to deal with an unselected emergency take.

In the National Training Survey performed by the GMC, General Surgery trainees had an overall satisfaction rate of 82% [28]. Clinical supervision out of hours was positively rated by 93% and this was significantly above the national average [28]. Local teaching was viewed favourably by only 60% of trainees, and this was significantly below the national average [28]. The GMC collates data on bullying, undermining and patient safety. In 2020, General Surgery fell below the national average in two domains: how to report patient safety incidents and concerns relating to patient safety being taken seriously by the organisation.

Higher General Surgery trainees had significantly higher rates of burnout compared to the national average in the 2020 report by the GMC [28]. A study including 65 core trainees and 31 specialty registrars in General Surgery [29], investigated the presence of burnout using the Maslach Burnout Inventory for Medical Personnel [30].

Burnout was common amongst General Surgery trainees and 59% demonstrated burnout in  $\geq 1$  domain [29].

### 1.2.2 Trauma and Orthopaedics

Trauma and Orthopaedics (T&O) is the largest surgical specialty in the UK, making up 29% of the entire surgical consultant workforce (Table 1.2). T&O is the most male dominated of the surgical specialities; only 6% of consultants are female [27]. However, the proportion of female trainees is increasing, now making up around 20% of T&O specialty registrars [27], compared to 14% in 2010 [31].

Eighty four percent of T&O trainees are satisfied overall with training, 83% feel they are able to gain adequate experience and 75% report working in a supportive environment [28]. Sixty one percent of T&O trainees reported feelings of burnout due to work, and this was significantly higher than the national average [28].

### 1.2.3 Plastic Surgery

There were 541 Plastic Surgery consultants in the UK in 2020 and 420 specialty registrars (Table 1.2), making up 6% of the surgical consultant workforce. Sixty two per cent of Plastic Surgery consultants identify as White, which is the highest across the surgical specialities, this is echoed in the trainee population (Table 1.2).

In the 2019 National Training Survey, 81% of higher Plastic Surgery trainees report overall satisfaction with training, 72% feel that there is a supportive working environment and 80% feel the training programme provides them with adequate experience [28]. In 2020, Plastic Surgery trainees did not have significantly higher rates of burnout compared to the national average according to a GMC survey [28].

#### 1.2.4 Urology

Urologists made up 11% of the surgical consultant workforce in 2019 (Table 1.2), making it the third largest surgical speciality. Urology consultants make up the most ethnically diverse surgical consultant group (Table 1.2), with 49% of consultants identifying as Other than White [27].

Eighty two percent of higher Urology trainees report overall satisfaction with the training programme, 83% feel they are provided with adequate experience and 75% state they work in a supportive environment [28]. Urology trainees did not report higher rates of burnout compared to the national average in 2020 [28].

#### 1.2.5 Neurosurgery

Neurosurgeons make up 4% of the surgical consultant workforce (Table 1.2). Neurosurgery has an established run-through training pathway and is the second most competitive surgical specialty at entry to ST1,

with 8.46 applicants per position in 2020 compared to 7.00 in 2019 (Table 1.1).

Eighty percent of higher Neurosurgery trainees report overall satisfaction with the training programme and 94% state the out of hours clinical supervision is good [28]. Sixty eight percent feel that the training environment is supportive [28]. In the 2020 GMC survey, Neurosurgery trainees did not report higher rates of burnout compared to the national average [28].

#### 1.2.6 Otolaryngology

ENT consultants make up 9% of surgical consultants (Table 1.2). ENT has the joint largest proportion of trainees that are women at 48% (Table 1.2). Eighty six percent of higher ENT trainees are satisfied with training overall according to the 2019 National Training Survey [28]. Regional teaching is reported positively by 85%, which is significantly above the national average [28]. The majority (77%) feel that training is a supportive environment and 85% feel they have adequate experience. Sixty five percent of ENT trainees reported feeling burnt out due to work in 2020, significantly higher than the national average [28].

#### 1.2.7 Paediatric Surgery

Paediatric Surgery is one of the smallest surgical specialities comprising only 2% of the consultant surgeon workforce, with 191 consultants and 159 specialty registrars in 2020 (Table 1.2). Paediatric Surgery has the greatest proportion of women consultants at 27% (Table 1.2).

Eighty four percent of higher Paediatric Surgery trainees were satisfied with training overall in the 2019 National Training Survey [28]. Ninety five percent report adequate clinical supervision out of hours, significantly higher than the national average. Seventy two percent report a supportive working environment and 83% feel that training provides adequate experience [28]. Sixty three percent of Paediatric Surgery trainees reported burnout secondary to work in 2020, significantly higher than the average [28].

#### 1.2.8 Cardiothoracic Surgery

Cardiothoracic Surgery is one of the smallest specialities, with 409 Cardiothoracic consultants and 321 specialty registrars working in the UK (Table 1.2). Cardiothoracic Surgery consultants account for 4% of the surgical consultant workforce (Table 1.2). At entry into Cardiothoracic Surgery at ST1 level in 2020, the competition ratio was 9.92 which is the highest across the surgical specialities (Table 1.1). Women make up 10% of Cardiothoracic consultants and 16% of specialty trainees, which is the lowest proportion of women trainees across the surgical specialities (Table 1.2).

According to the National Training Survey conducted by the GMC, 84% of Cardiothoracic trainees were satisfied overall with their training in 2019 [28]. 70% reported working in a supportive environment and 83% felt that training provided them adequate experience [28].

Cardiothoracic trainees had the highest level of burnout across surgical specialties according to the 2020 GMC survey; 67% reported burnout secondary to work [28].

### 1.2.9 Oral and Maxillofacial Surgery

Oral and Maxillofacial Surgery (OMFS) training is unique in that all trainees must be dual qualified with both an undergraduate medical and dental degree. OMFS is a run-through speciality with a competition ratio of 3.20 for entry at ST1 in 2020 (Table 1.1). OMFS consultants make up 4% of the surgical consultant workforce (Table 1.2). Ethnicity breakdown of OMFS consultants and trainees was not available at the time of writing this thesis.

Eighty six per cent of higher OMFS trainees are satisfied with training, 76% report a supportive working environment and 87% feel that training provides them with adequate experience according to the National Training Survey [28]. OMFS trainees had a significantly higher level of burnout compared to the national average, with 63% reporting burnout in 2020 [28].

### 1.2.10 Vascular Surgery

Vascular Surgery is the newest surgical specialty, evolving from a special interest within General Surgery in 2012 (28). Three per cent of the surgical consultant workforce is made up of vascular surgeons (Table 1.2). The workload of Vascular surgeons in the UK is increasing and there is a shortage of staff relative to demand [32]. The Vascular Society of Great Britain and Ireland has recommended an urgent increase in the number of National Training Numbers allocated to Vascular Surgery [32].

Despite Vascular Surgery now being a separate speciality, there are no competition ratios available for Vascular Surgery alone as selection is run jointly with General Surgery. Only 8% of Vascular consultants work part-time, interestingly there is no apparent difference between the number of men and women working part-time [32].

Overall satisfaction with training is reported by 82% of higher Vascular trainees [28]. 82% feel they gain adequate experience and 73% feel they work in a supportive environment [28]. Sixty percent rate local teaching positively, which is significantly below the national average. Burnout was reported by 64% of Vascular trainees in 2020, significantly higher than the national average [28].

#### 1.2.11 Cohort Selection

The surgical specialities vary in size, demographics and training satisfaction. General Surgery and Trauma and Orthopaedic Surgery were selected for the individual cohort studies in this thesis as they are

the largest of the specialities, providing more power for statistical analysis. Also, Trauma and Orthopaedics is the speciality with the lowest proportion of women and therefore the impact of progression for female trainees is of vital interest. These two specialities are similar in trainee numbers and unlike some of the smaller specialities are not centralised, meaning that the training experience is likely to be more comparable with trainees rotating through multiple hospitals and supervisors.

The remaining specialities are much smaller in terms of trainee numbers and therefore a combined analysis across all surgical specialities will be performed. Given the differences in demographics, specialty size and curriculum requirements, it is possible there will be inter-specialty variation.

## Section 1.3 Assessment during Higher Surgical Training

### 1.3.1 Annual Review of Competency Panel

The Annual Review of Competency Progression (ARCP) is the way in which doctors are reviewed to ensure they meet standards of safe patient care and are progressing adequately in their training [20].

ARCP was introduced in 2007 and replaced the Record of in Training Assessment (RITA) as the annual assessment process. Each trainee has an ARCP at least once per year, however, informal reviews can be performed more frequently if required. This is a deanery led process and the trainee's electronic portfolio of evidence forms the basis of the assessment. The Intercollegiate Surgical Curriculum Programme (ISCP) forms the electronic trainee portfolio and was launched in 2007 [33]. It is a secure 'training management system' which allows trainees to record evidence to demonstrate progression and achievement of curriculum requirements. All training assessments, evidence and ARCP outcomes are recorded here for each surgical trainee in the UK. Successful progression onto the next stage of training is dependent on the trainee meeting a number of curriculum defined goals as evidenced by requisite number of workplace based assessments, attendance at relevant courses and operative logbook experience on ISCP. These targets are based on the curriculum for each specialty as set by the Royal Colleges. ARCP is an objective measure of postgraduate clinical performance that takes into account a trainee's body of work over a

period of time. ARCP can be used as a measure of progression throughout training.

### 1.3.2 ARCP Panel

The panel must consist of at least three members, one of which must be either the Postgraduate Dean, Head of School or Training Programme Director [20]. It is the responsibility of the Chair of the panel to ensure there are no conflicts of interest between panel members and the trainee. Lay and external advisors ensure good conduct of the panel, review recommendations regarding performance concern and to ensure due process is followed.

### 1.3.3 ARCP Outcomes

The ARCP panel recommends an outcome to be awarded to each trainee based on the evidence provided. Table 1.3 details all the available ARCP outcomes. ARCP outcome 1 and 6 are “standard outcomes”, allowing the trainee to progress into the next year of training, having achieved the development of competences at the expected rate in the case of outcome 1, or signifies completion of the training programme, in the case of outcome 6. Outcome 8 is given to signify a trainee is taking time out of programme. Other outcomes (2, 3 and 4) are “non-standard” and are awarded when the trainee has not achieved the required competencies of that training year.

Outcomes 7.1-4 are the same as 1-4 but given to trainees in locum for training (LAT) posts, which still are available in Scotland and Northern Ireland.

Table 1.3. ARCP Outcomes

| AR CP Outcome | Outcome Explanation                                                                                                                                                                                                                                                                                                      |
|---------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Outcome 1     | Satisfactory progress – Achieving progress and the development of competences at the expected rate                                                                                                                                                                                                                       |
| Outcome 2     | Development of specific competences required – Additional training time not required                                                                                                                                                                                                                                     |
| Outcome 3     | Inadequate progress – Additional training time required                                                                                                                                                                                                                                                                  |
| Outcome 4     | Released from training programme – With or without specified competences                                                                                                                                                                                                                                                 |
| Outcome 5     | Incomplete evidence presented – Additional training time may be required                                                                                                                                                                                                                                                 |
| Outcome 6     | Gained all required competencies for the programme                                                                                                                                                                                                                                                                       |
| Outcome 7     | <p>7.1 Satisfactory progress in or completion of the LAT / FTSTA placement</p> <p>7.2 Development of specific competences required – additional training time not required</p> <p>7.3 Inadequate progress by the trainee – additional training time</p> <p>7.4 Incomplete evidence presented – LAT / FTSTA placement</p> |
| Outcome 8     | Out of programme for clinical experience, research or a career break (OOPE/OOPR/OOPC)                                                                                                                                                                                                                                    |

Taken from The Gold Guide 2019 [20].

#### 1.3.4 Certificate of Completion of Training (CCT)

The award ARCP Outcome 6 at the end of Higher Specialty Training a Certificate of Completion of Training (CCT) is awarded, allowing a trainee to apply to have their name added to the GMC Specialist Register. The CCT requirements for each of the surgical specialties vary and are summarised in Table 1.4.

Table 1.4. CCT requirements by speciality before the introduction of the 2021 surgical curricula

|                                               | General Surgery                                                                                                                                                                                           | Trauma and orthopaedics                          | Plastic Surgery         | Urology                                                                      | Neurosurgery                                                                                                                  | ENT                                                                                      | OMFS | Cardiothoracic Surgery                         | Paediatric Surgery      |
|-----------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------|-------------------------|------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------|------|------------------------------------------------|-------------------------|
| <b>Clinical experience</b>                    |                                                                                                                                                                                                           |                                                  |                         |                                                                              |                                                                                                                               |                                                                                          |      |                                                |                         |
| Number of centres trainee must rotate through | N/A                                                                                                                                                                                                       | N/A                                              | 2                       | N/A                                                                          | N/A                                                                                                                           | 3                                                                                        | 2    | N/A                                            | 2                       |
| Other                                         | ST3/4: 1 year GI + 6months vascular + 6 months breast/ transplant/ endocrine/GI<br><br>ST5/6: 1 year UGI + 1 year colorectal OR 1 year GI + 1 year special interest<br><br>ST7/8: 2 year special interest | Minimum 3 operating lists and 2 clinics per week | Range of subspecialties | Minimum 40 days paediatric urology<br><br>Range of urological subspecialties | Range of subspecialties. Exposure to neurology, intensive care, accident and emergency medicine and allied surgical specialty | Manage 1000 emergencies/ 300 nights on call. Rotate through all main subjects within ENT |      | Exposure to adult cardiac and thoracic surgery | Range of subspecialties |

|                                |                                                                              |                                               |                                |                                |                      |      |                           |                 |      |
|--------------------------------|------------------------------------------------------------------------------|-----------------------------------------------|--------------------------------|--------------------------------|----------------------|------|---------------------------|-----------------|------|
| Assessments                    | CBDs: 10 in emergency GS, 10 in special interest, 10 in different conditions | WBAs in critical conditions                   |                                |                                |                      |      |                           |                 |      |
| <b>Operative experience</b>    |                                                                              |                                               |                                |                                |                      |      |                           |                 |      |
| Number of cases                | 1600                                                                         | 1800                                          | 2100                           | 915                            | 1200 (70 paediatric) | 2000 | 1201                      | 250 major cases | 790  |
| Operative competence           | 3 PBAs by 3 different assessors of indicative procedures                     | PBAs for index procedures showing progression | PBAs for indicative procedures | PBAs for indicative procedures | PBAs                 | PBAs | PBAs for index procedures | PBAs            | PBAs |
| <b>Research</b>                |                                                                              |                                               |                                |                                |                      |      |                           |                 |      |
| Number of peer reviewed papers | 3                                                                            | 2                                             | 2                              | 2                              | 2                    | 2    | -                         | 4               | 4    |
| Number of presentations        | 3                                                                            | 2                                             | -                              | 2                              | 2                    | -    | -                         | 6               | 2    |

|                                 |     |                                                                                                                                                                   |                              |     |     |                       |                                                                                                                                                                 |                                                            |     |
|---------------------------------|-----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|-----|-----|-----------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------|-----|
| Good clinical practice required | Yes | Yes                                                                                                                                                               | Yes                          | Yes | Yes | Yes                   | Yes                                                                                                                                                             | Yes                                                        | Yes |
| Research methodology course     | No  | Yes                                                                                                                                                               | Yes                          | Yes | No  | Yes                   | Yes                                                                                                                                                             | Yes                                                        | Yes |
| Other                           |     | Journal club activity<br>Higher degree (MSc, MPhil, MD, PhD)<br>Evidence of recruiting patients into study<br>Member of trainee research collaborative >24 months | 1 piece of evidence per year |     |     | Journal club activity | 5 pieces of evidence out of: first author publications, presentations at national/international meetings, literature review and presentations at local meetings | Evidence of study of research methodology or higher degree |     |

|                                       |     |                                            |                                                                 |                                                                  |     |                                                                 |                                                                 |                    |                                     |
|---------------------------------------|-----|--------------------------------------------|-----------------------------------------------------------------|------------------------------------------------------------------|-----|-----------------------------------------------------------------|-----------------------------------------------------------------|--------------------|-------------------------------------|
|                                       |     | Membership of<br>NIHR study<br>group       |                                                                 |                                                                  |     |                                                                 |                                                                 |                    |                                     |
|                                       |     | Co-applicant<br>on clinical trial<br>grant |                                                                 |                                                                  |     |                                                                 |                                                                 |                    |                                     |
| <b>Quality improvement</b>            |     |                                            |                                                                 |                                                                  |     |                                                                 |                                                                 |                    |                                     |
| No. of audits                         | 3   | 1 per year                                 | 1 per year                                                      | 3                                                                | 1   | 1 per year                                                      | 1 per year                                                      | 1                  | 1 per year                          |
| Complete<br>cycle                     | 1   | 2                                          | -                                                               | 1                                                                | 1   | -                                                               | -                                                               | 1                  | 2                                   |
| Other                                 |     |                                            | Present all<br>audits<br><br>1 audit of<br>personal<br>outcomes | Present all<br>audits<br><br>1 quality<br>improvement<br>project |     | Present all<br>audits<br><br>1 audit of<br>personal<br>outcomes | Present all<br>audits<br><br>1 audit of<br>personal<br>outcomes |                    | 1 quality<br>improvement<br>project |
| <b>Medical education and training</b> |     |                                            |                                                                 |                                                                  |     |                                                                 |                                                                 |                    |                                     |
| Train the<br>trainers<br>course       | Yes | Yes                                        | Yes                                                             | Yes                                                              | Yes | Yes                                                             | Yes                                                             | No named<br>course | Yes                                 |

|                                  |                                                                          |                                             |                                                                             |     |     |                                                                             |                                                                             |     |     |
|----------------------------------|--------------------------------------------------------------------------|---------------------------------------------|-----------------------------------------------------------------------------|-----|-----|-----------------------------------------------------------------------------|-----------------------------------------------------------------------------|-----|-----|
| Evidence of teaching             | Provide structured feedback                                              | 1 lecture per year with structured feedback | Evidence of teaching skills                                                 |     |     |                                                                             |                                                                             |     |     |
| Teaching attendance              |                                                                          |                                             | 70%                                                                         | 70% |     | 70%                                                                         | 70%                                                                         | 70% | 70% |
| <b>Management and leadership</b> |                                                                          |                                             |                                                                             |     |     |                                                                             |                                                                             |     |     |
| Management course                | Yes                                                                      | Yes                                         | No                                                                          | Yes | Yes | No                                                                          | Yes                                                                         | Yes |     |
| Evidence of management           | Rota administration, trainee representative, membership of working party |                                             | Running rotas, management committees, writing protocols, improving services |     |     | Running rotas, management committees, writing protocols, improving services | Running rotas, management committees, writing protocols, improving services |     |     |
| <b>Additional courses</b>        |                                                                          |                                             |                                                                             |     |     |                                                                             |                                                                             |     |     |
| ATLS                             | Yes                                                                      | Yes                                         | Yes                                                                         | No  | Yes | No                                                                          | Yes                                                                         | No  | No  |

|                                |                  |           |           |                  |      |           |                  |            |           |
|--------------------------------|------------------|-----------|-----------|------------------|------|-----------|------------------|------------|-----------|
| Other                          | Special interest |           | APLS      | Special interest | PALS |           | Special interest |            | APLS      |
| <b>Educational conferences</b> |                  |           |           |                  |      |           |                  |            |           |
| No. of conferences             | 4                | No number | No number | 1 every 2 years  | 4    | No number | No number        | 1 per year | No number |

ENT= Ear, Nose & Throat; OMFS= Oral & Maxillofacial Surgery; CBD= case based discussion; WBA= work based assessment; PBA= procedure based assessment;

NIHR= National Institute of Health Research; ATLS= Advanced Trauma & Life Support; APLS= Advanced Paediatric Life Support; PALS= Paediatric Advanced Life

## Section 1.4 Differential attainment

### 1.4.1 Protected characteristics

The UK Equality Act (2010) legally protects people from discrimination in the workplace on the basis of protected characteristics [34]. The Act defines protected characteristics as:

- Age
- Sex
- Gender reassignment
- Race
- Disability
- Religion or belief
- Sexual orientation
- Marriage and civil partnership
- Pregnancy and maternity

### 1.4.2 Differential attainment in medicine

Differential attainment refers to the differences in performance between different demographic groups [35]. Differences in attainment related to ability are expected, however, differences because of age, sex, ethnicity, or other protected characteristics are unfair. The impact of

differential attainment on postgraduate medical outcomes has been of concern for many years, highlighted in 2012 by the British Association of Physicians of Indian Origin (BAPIO) who challenged the Royal College of General Practitioners and the General Medical Council about the low pass rates for Black and Minority ethnic (BME) candidates in the Membership of the Royal College of General Practitioners Examination [36].

The General Medical Council (GMC) commissioned 'Fair Training Pathways for All: Understanding Experiences of Progression' investigating the perceptions of fairness in postgraduate medical education [8]. This qualitative study identified multiple factors that pose a risk to progression of BME and international medical graduates (IMG). These included poor relationships with seniors, anxiety about potential bias, less job choice due to lower recruitment scores and exam performance, not reporting concerns due to the fear of seeming problematic and a lack of recognition from trainers about environmental stressors. The follow up piece focused on the causes of differential attainment amongst IMG and BME trainees and the potential barriers to change [9]. One of the perceived risks for IMGs was being 'different' from the majority of trainees. Sensitivity around race was perceived as a barrier to change and a lack of knowledge of good practice.

#### 1.4.3 Differential attainment around the world

Evidence of differential attainment in surgery is present worldwide. Within surgical training evidence of differential attainment can be seen

in the proportion of those completing training, the selection and matching process and operative autonomy. A 2019 study found that in the US National Resident Matching Program, surgical interviews were more likely to discuss age and gender, which is unlawful in the USA, and may introduce discrimination [37]. Across the United States, there are differences in attrition for surgical residents by ethnicity and gender [38]. Hispanic residents demonstrated significantly higher attrition than non-Hispanic residents (21.1% vs 12.4%,  $p=0.04$ ) and women were more likely to leave surgical training than men (23.3% vs 17.4%,  $p=0.05$ ) [38]. Non-White ethnicity was associated with significantly lower likelihood of interview selection amongst those applying to General Surgery residency programmes in the US [39]. Analysis of the Neurosurgery residency match process between 1990 and 2007 found that female applicants were significantly less likely to match to a residency programme than men (OR 0.57, 95% CI 0.34-0.94) [40]. In a study of matching to Otolaryngology residency, older applicants and those born outside of the US were less likely to match [41]. A Canadian study identified that female applicants to surgical disciplines were less likely than men to be matched to their first choice (RR 0.95, 95% CI 0.91-1.00) [42]. Amongst Cardiothoracic trainees, faculty gave significantly less operative autonomy to female residents compared to men [43]. Similarly, a study by the same author looking at operative autonomy amongst General Surgery residents found that female residents received less operative autonomy than men after adjusting for potential confounders [44].

Despite the interest in, and concern regarding, differential attainment within postgraduate medical training, the impact of protected characteristics and working pattern (less than full time training, academic/military trainees) on progression through Surgical Specialty training in the UK has not been studied.

## Section 1.5      Changing demographics

### 1.5.1 Changing demographics of medical students

Over recent years the UK medical school population has diversified, with women and ethnic minorities now well represented [45]. Over time, these changes will likely be reflected in the future medical workforce and it is important that members of all demographic groups, with and without protected characteristics, progress fairly through training.

Since 1996, more women than men have entered medical school and in 2018, women made up 57% of those accepted to medical school [46]. The changes in the proportion of female medical students will eventually filter through to postgraduate medical training and we can expect a larger proportion of female doctors in specialty training.

Despite an increase in the diversity of the ethnic background of medical students, the majority are still White [47]. However, there has been an increase in the proportion of other ethnic groups applying to medicine. Between 2017/18 and 2018/19 academic years, there was a 20% increase in students from the Middle East and 23% increase in those from the European Union [48]. Since 2011, students from an Asian background have started to increase and now make up a quarter of the medical student population [47]. Similarly since 2013, there has been a steady increase in the number of BME applicants to medical school [46]. Compared to other subjects, Medicine and Dentistry was one of

the subjects with the highest proportion of BME students in 2016/2017 [49].

In an attempt to increase medical student numbers and to broaden access to medicine, the UK Medical Workforce Standing Advisory Committee recommended recruiting graduates into medical school [50]. Around a quarter of medical school places are made up of Graduate Entry programmes [51] and receive 10,000 applications per year [52]. Similar to undergraduate medical programmes, women make up a significant majority of graduate-entry places [52]. Graduate-entry programmes have increased the number of older applicants to medicine with 42.8% of graduate-entry applicants aged between 22 and 24 years [52], this is in contrast to non-graduate courses that start at 18 years in the UK. Graduate-entry programmes attract higher proportions of White and Black ethnic groups than Asian students [52]. Compared to a standard medical course in the UK, where 20% of students are of Asian ethnicity, only 11.9% were Asian in the graduate-entry medicine course [53]. To some extent, graduate-entry programmes have increased the diversity of medical students with older applicants and lack applicants better represented than in traditional undergraduate medical programmes [52].

Despite efforts to widen participation, those from less affluent socioeconomic backgrounds remain underrepresented in medical school [46 54]. A retrospective analysis of medical school application data between 2009 and 2012, found that 19.7-34.5% of applicants to medical school in the UK live in the most affluent tenth of postcodes,

compared to 1.8-5.7% from the least affluent tenth [45]. Applicants who lived in the most deprived postcodes and attended non-selective state schools were less likely to have an accepted offer of a place at medical school [45], this is consistent with low rates of application to medical school by those from less affluent areas. Similarly, in 2010/11 only 7% of medical undergraduates were from the bottom three socio-economic classes which was minimal change from previous years [55].

Socioeconomic status and the link to performance at medical school is a complex issue. Relationships may be confounded by academic achievement within certain socioeconomic groups, the home environment and parental occupation.

### 1.5.2 Changing demographics of doctors in training

Alongside the changing demographics of medical students, the medical workforce and career intentions of doctors in training is also diversifying. Given the rising demand for healthcare and challenges due to lead time in the supply of new doctors and expansion of medical school capacity, one of the priorities of the NHS is retaining existing doctors. The proportion of doctors who progress directly into speciality training following completion of the Foundation Programme has decreased year on year since 2016, with 63% of the 2018 F2 cohort choosing to pause their training in 2019 [56]. Furthermore, a third of doctors in training are considering reducing their working hours in the

next three years and a fifth are planning to leave the UK to work abroad [4].

There has been a significant increase in the number of International Medical Graduates applying to the UK medical register since 2018 [56]. In 2020, over 10,000 IMGs joined the UK workforce which was more than UK and European Economic Area (EEA) graduates combined [48]. Given the reliance on non-UK graduates it is important to ensure barriers to progression amongst these groups of doctors are identified.

The number of doctors in training that work less than full time (LTFT) has increased over time. In 2019, 13% of doctors in training across all specialties were working on a less than full time basis, which is an increase from 10.7% in 2017 [57]. Childcare was the main reason for LTFT (34%) followed by disability or illness (17%) [56].

In an effort to better understand the impact of protected characteristics on the medical workforce, the General Medical Council added religion and sexual orientation to the information they collect about doctors. In 2018, 36% of doctors on the medical register identified as Christian, 15% Muslim and 26% declared no religion [4]. Eighty seven percent of doctors identified as heterosexual compared to 2% homosexual and 1% bisexual [4]. As this data has only recently been collected by the GMC, there has not been any analysis of whether these factors impact on progression through training.

### 1.5.3 Potential impact on the surgical workforce

Changes in demographics of medical students and the career aspirations of doctors in training will be reflected in the future surgical workforce.

Surgery is still a predominantly male specialty and 88% of all consultant surgeons are men [58]. However, the number of women in surgery is increasing; over a third of surgeons in training are women [14], which, with time, will substantially increase the proportion of consultant surgeons who are female, currently at 16% in General Surgery [59]. With women now outnumbering men at medical school, the proportion of women in surgery could be expected to further increase.

The majority of less than full time trainees tend to be female, with one study reporting that 92.5% of those working less than full time across all surgical specialities were women [60]. Surgical specialities currently have lower proportions of less than full time trainees than other specialities; in 2011 there were only 151 surgical trainees working less than full time in the UK [61] and in 2017 only 4% of surgical trainees were LTFT compared to 9% of all doctors [62]. A 2015 survey of 876 surgical trainees across all ten specialities reported that 53.8% of respondents had experienced undermining behaviour due to undertaking LTFT [60]. It is reasonable to assume that with an increasingly female workforce, the proportion of surgical trainees that intend to work less than full time may increase. Therefore, further research investigating the impact of less than full time training on progression through speciality training is required.

Compared to other specialities, the number of older doctors in surgery is increasing. Between 2012-2017, the GMC reported there was a 16% increase in older surgeons in training [58]. 'Older' was not defined in the report. This may in part be due to an increase in those taking time out of programme or the increased accessibility of less than full time training.

Surgery, along with most other specialities, is reliant on graduates from outside the UK to bring the workforce up to levels required for the service to function. A fifth of surgeons in the UK are graduates from the European Economic Area (EEA) countries [4]. With the uncertainty surrounding Brexit and working arrangements, this may result in increased reliance on doctors from outside the European Union (EU).

Surgery employs more doctors from more affluent socioeconomic backgrounds and has a lower proportion of doctors educated at state school [63] compared to other specialities. Some prior studies have suggested an association between socioeconomic status and educational attainment [64 65]. Medical students who attended selective schools performed less well than those educated in non-selective schools [64]. Upon further analysis this was found to be related to the average A-level attainment of the school, with students attending a higher achieving school performing less well at medical school. As surgical trainees from lower socioeconomic classes are in the minority it is of interest to analyse the potential impact of socioeconomic status once in Higher Surgical Training.

## Section 1.6 Factors Associated with Progression

### 1.6.1 Factors shown to affect ARCP

The effect of certain demographic factors and protected characteristics affecting progression through postgraduate medical training has been investigated in a number of studies. However, there are few studies investigating the impact of demographic factors and protected characteristics on surgical ARCPs. To our knowledge, there are two studies that attempt to analyse surgical specific ARCP outcomes in broad terms or in relation to examination success [66 67].

#### 1.6.1.1 Age

Some studies have found that older doctors progress less well throughout postgraduate medical training than their younger counterparts. A study of over 38,000 doctors in training from all specialities, with details regarding ARCP outcomes provided by the GMC, found that older doctors are more likely to have fewer satisfactory ARCP outcomes than their younger counterparts [68]. Mature graduates were classed as those older than 29 years at time of graduation. The study additionally reported that older trainees were more likely to be released from training [68]. The finding that older trainees receive fewer satisfactory ARCP outcomes has been supported by other studies. A study by Smith and Tiffin assessed the validity of selection measures for the Foundation Programme and found that older trainees were less likely to receive a standard outcome at ARCP than younger trainees [69]. Increasing age and experience were

associated with worse ARCP outcomes, with the odds of receiving a worse outcome increasing by 5% per year [66]. Given that the number of older doctors in surgery is increasing, the findings that older age is associated with less satisfactory ARCP outcomes may have an impact on the progression of the current surgical cohort.

#### 1.6.1.2 Sex

Male gender in some studies has been associated with increased odds of receiving a less satisfactory ARCP outcome [66 70]. Male sex was associated with a 29% increased risk of less satisfactory ARCP outcome than women across medical specialties and General Practice [70]. In a study of over 34,000 specialty trainees across all specialties by Tiffin et al, it was found that male trainees were 43% more likely to receive a less satisfactory ARCP outcome than women (OR 1.43, 95% CI 1.38-1.49) [66]. A study looking at the predictive validity of the MRCS, found no significant difference in surgical ARCP outcomes for women compared to men (OR 0.63, 95% CI 0.63-1.04) [67].

#### 1.6.1.3 Ethnicity

On univariate analysis of doctors in medical specialties and general practice in the UK, ethnicity Other than White was associated with a significantly increased odds of less satisfactory ARCP outcome (OR 1.98, 95% CI 1.88-2.08) [70]. After adjustment, this finding was no longer significant (OR 0.72, 95% CI 0.49-1.06). However, the authors reported a significant interaction between age and ethnicity, in which the effect of non-White ethnicity on less satisfactory ARCP outcome

was accentuated in older doctors. A 2020 study compared ARCP outcomes amongst core surgical trainees by ethnicity and place of medical qualification [71]. This included 264 trainees from a single UK regional post graduate medical region in Wales. There was no significant difference in ARCP outcome between White UK graduates, BME UK graduates or international medical graduates (60.7% vs 62.1% vs 53.3% respectively). This may have been influenced by the small sample size. A study of 2683 UK medical graduates who had passed the MRCS examination found that non-White trainees were more likely to receive an unsatisfactory ARCP outcome compared to White trainees Odds Ratio (OR) 1.36 95% Confidence Interval (CI) 1.08-1.71 [72].

#### 1.6.1.4 Place of medical qualification

Country of medical qualification has been shown to affect ARCP outcomes. A study of more than 53,000 doctors investigating the use of Professional and Linguistic Assessments Board (PLAB) examination as a predictor for satisfactory ARCP outcome amongst international medical trainees (IMGs) found that IMGs were 63% more likely to receive a non-satisfactory outcome at ARCP than UK graduates [70]. This finding remained significant after removing failed ARCP outcome due to examination failure. IMGs who received the highest marks in PLAB did not receive significantly different ARCP outcomes than UK graduates.

Overseas graduates were less likely to receive a satisfactory ARCP outcome than UK graduates and other graduate groups [66]. This study also studied the impact of country of graduation by specialty. When looking at surgery, there was no difference in the odds of receiving a satisfactory ARCP outcome between UK graduates and overseas graduates [66]. This is the only study to analyse surgical ARCP outcomes by country of qualification, and given that the proportion of non-UK trained surgical graduates has increased, further research is warranted.

#### 1.6.1.5 Socioeconomic factors

There are multiple tools that measure socioeconomic status and the Higher Education Statistics Agency (HESA) collects data on socioeconomic status at time of application to university. The Index of Multiple Deprivation (IMD) is the official measure of relative deprivation in England [73]. IMD is comprised of seven categories: income, employment, health deprivation and disability, education/skills training, crime, barriers to housing and services and living environment. The score is calculated for each neighbourhood in each country of the United Kingdom and then ranked according to their level of deprivation relative to other areas. IMD can then be divided into quintiles where 1 is the most deprived and 5 the least deprived [74]. A 2015 report using data from HESA involving core medical trainees found that those from the most deprived socioeconomic background received the highest proportion of unsatisfactory ARCP outcomes (12.6% vs 5.2%) [65]. Similarly, pass rates for all specialty exams for doctors in training

decreased as deprivation levels increased, with a 10% point difference in pass rates between the most and least deprived groups [65]. To our knowledge, the impact of socioeconomic status on progression through surgical training has not been assessed.

#### 1.6.1.6 Postgraduate surgical examination success

Some studies have found demographic differences predicting success in postgraduate surgical examinations. The Intercollegiate Membership of the Royal College of Surgeons (MRCS) is a postgraduate examination designed to be taken before the end of Core Surgical Training. Successful completion of MRCS is obligatory for completion of core training in surgery and an essential criterion for selection or progression into Higher Surgical Training. Later on in Higher Specialty Training, completion of the Intercollegiate Specialty Board Examination (commonly referred to as FRCS as a pass in the exam allows the use of those postnominals as long as Royal College fees are paid) is compulsory in order to successfully complete training [75]. This is a speciality specific examination and consists of two parts: a multiple-choice question written exam (Section 1) and a face to face exam consisting of patient based stations, academic and clinical interviews (Section 2).

In a study of core surgical trainees from a single postgraduate medical region MRCS pass rates were retrospectively analysed. IMGs were significantly less likely to pass compared to UK graduates (50% vs 71.4%,  $p=0.042$ ) [71]. A large proportion of doctors in training have

attended a non-UK medical school and the findings that IMGs are less likely to pass the MRCS examination may adversely affect progression through surgical training.

A larger study of 7896 UK graduates who had attempted the MRCS found that men had significantly higher pass rates in Part A than women (OR 2.78, 95% CI 1.83-4.19) and that White candidates were more likely to pass than BME doctors (OR 1.70, 95% CI 1.52-1.89) [76]. In line with studies investigating the impact of older age in surgical training, the authors found younger graduates were more likely to pass than older graduates (OR 2.60, 95% CI 1.81-3.63).

A 2021 study utilising data from the United Kingdom Medical Education Database (UKMED) aimed to identify factors predicting success in the MRCS [77]. Higher A-Levels and university admission tests (University Clinical Aptitude Test, Biomedical Admissions Test, Graduate Medical Schools Admission Test) independently predicted success in MRCS Part A.

A study by Scrimgeour et al [78] investigating predictors of success in the FRCS revealed that men were more likely to pass Section 1 of the FRCS than women (OR 2.32, 95% CI 1.43-3.76). Candidates less than 29 years at time of graduation had more than a threefold higher chance of passing (OR 3.22, 95% CI 1.09-1.89). White candidates were significantly more likely to pass Section 1 than non-White candidates on chi square testing, however after adjustment there was not a statistically significant relationship between ethnicity and pass rates.



## Section 1.7      Coronavirus disease 2019

### 1.7.1   Coronavirus disease 2019

In December 2019, the first case of coronavirus disease 2019 (COVID-19) was identified in China. This started a global pandemic and the first cases in the UK were detected in January 2020. In response to the pandemic the National Health Service reprioritised services with the cancellation of elective surgical operations beginning in March 2020 [79]. There were other significant changes throughout the first wave of the pandemic which included the redeployment of staff to support the increased pressures caused by COVID-19, switch to telemedicine clinics and cancellation of educational activity and conferences. The evolving impact of COVID-19 on training has been recognised globally. The opportunities available to surgical trainees and those in other craft specialities were significantly reduced.

### 1.7.2   Changes to ARCP Outcomes

In response to the pandemic and in light of the dramatic impact on surgical training, the four UK Statutory Education Bodies devised a new ARCP outcome. The aim was to provide a no-fault outcome for trainees affected by COVID-19 and to ensure continued progression through clinical training. ARCP Outcome 10 recognises that overall progress has been satisfactory but due to the pandemic the acquisition of some competencies has been affected and additional training may

be necessary. The JCST has outlined how Outcome 10 should be applied to surgical trainees [80]:

- Outcome 10.1: Progress is satisfactory but the acquisition of competencies/capabilities by the trainee has been delayed by COVID-19 disruption. The trainee is not at a critical progression point in their programme and can progress to the next stage of their training.
- Outcome 10.2: Progress is satisfactory but the acquisition of competences/capabilities by the trainee has been delayed by COVID-19 disruption. The trainee is at a critical progression point in their programme and additional training time is required.

### 1.7.3 Potential impact on surgical training

Surgical training in the UK is already a lengthy process which currently is largely based on time in training as opposed to competency based. The interruption caused by COVID-19 is likely to have a large impact on all aspects of surgical training. Trainees rely on elective operative lists to gain the necessary skills to meet curriculum competencies and complete the requisite number of work based assessments. While it is important to consider the operative impact as a major part of the disruption to surgical trainees, surgery is multi-faceted and it is likely that the impact will be felt across all areas of surgical training. The introduction of the new COVID-19 related ARCP outcomes may prolong training, particularly for those in the latter years of training. The

suspension of examinations may also cause delays to progression at key training stages. At the time of writing this thesis, there were no published papers looking at the impact of COVID-19 across surgical specialities worldwide.

## Section 1.8      Data sources

### 1.8.1   United Kingdom Medical Education Database

The studies presented in Chapters 4, 5 and 6 utilise data from the United Kingdom Medical Education Database (UKMED) [81]. UKMED is a free database containing longitudinal sociodemographic and educational information for UK and international medical students [82]. The GMC is the data controller for UKMED data. Access to the database is granted via an approval process based on the merit of the proposed study [83]. Once approval has been granted, the data is accessed via a controlled and secure service environment for undertaking research, this is termed a safe haven.

The database includes data relating to students entering UK medical schools from 2002 onwards. From 2012 onwards, students graduating from non-UK medical schools and entering UK postgraduate training at any level are included. It was developed with support from the GMC, Medical Schools Council and United Kingdom Clinical Aptitude Test (UKCAT) UKCAT consortium. As of November 2017, the database contains information on 110,783 medical students starting studies between 2002 and 2017. The data in UKMED links with information held by the GMC allowing ARCP outcomes to be available for each graduate. Phase 1 of the database commenced in 2015, collecting data on all medical school entrants. Significant developments have been implemented since Phase 1; these include capturing all students commencing medical school in the UK since 2002, all those in

postgraduate medical training since 2012 and the data is now updated annually.

To date, none of the published studies using UKMED focus on Higher Surgical Training [84-86]. The UKMED data can be modelled to assess the relationship between predictors of success and progression throughout surgical training using ARCP as an outcome measure. The use of UKMED has been suggested as a source to investigate differential attainment in a piece commissioned by the GMC [13].

The initial data extraction was made on 26<sup>th</sup> November 2018. Ethical approval for research using UKMED is covered by a blanket exemption granted by the Medical Schools Council (Appendix 2).

## Section 1.9      Rationale for thesis

Surgical training has evolved over time with changing entry and assessment criteria. Along with changes to the structural aspects of training, the demographic of surgical trainees has also changed dramatically. However, research relating to the progression of specific groups of surgical trainees is outdated and often based on cohorts from over twenty years ago. There is a lack of studies based on UK surgical cohorts and data regarding attrition is lacking.

It is well known that attrition in surgical training is a problem in the US with high rates reported across studies. Attrition in other countries, including the UK, is poorly recorded. With increasing demands on healthcare and the cost of training a consultant surgeon as well as for workforce planning, it is important that causes of attrition are identified and prevented where possible.

During the course of this thesis, the COVID-19 pandemic emerged as a major factor that may impact surgical training. The COVID-19 pandemic had huge impacts on the delivery of healthcare and consequently surgical training was disrupted considerably. As surgery is a practical specialty and operating lists were cancelled or reduced, it is important to identify the impact of lost training opportunities and to identify strategies to remediate this.

It is not known how demographic factors and protected characteristics affect progression through surgical training. This means that it is

unknown whether certain groups of trainees may require additional support throughout training in order to meet their potential.

General Surgery and Trauma and Orthopaedic Surgery are the largest of the surgical specialities, yet work regarding differential attainment is lacking. Stereotypes around Trauma and Orthopaedic Surgery being a 'male' specialty are still present and can deter certain groups of doctors from pursuing it as a career. It is important to identify any attainment gap in these specialities.

The aim of Higher Surgical Training is to produce competent day one consultants, regardless of the speciality. Therefore, it could be assumed that the proportion of trainees receiving a non-standard outcome should be similar, assuming equivalent skills are required across specialties and entrants are at a comparable standard. To date there is no research comparing outcomes across surgical specialities in terms of trainee progression or factors impacting ARCP outcomes across all surgical specialities combined.

In order to retain a highly skilled workforce within surgery and to increase diversity, it is important to promote inclusivity. Fair progression and equal assessment should be possible for all trainees, regardless of protected characteristics or working pattern. If the factors predicting success can be identified it will enable further work to support trainees at risk of non-standard outcome and potentially reduce overall training time and attrition.

### 1.9.1 Aims of thesis

1. To identify factors associated with attrition and performance throughout surgical training.
2. To describe the impact of COVID-19 on surgical training worldwide.
3. To identify demographic factors, including protected characteristics and training specific factors which predict a non-standard ARCP outcome during General Surgical Specialty training.
4. To identify demographic factors, including protected characteristics and training specific factors which predict a non-standard ARCP outcome during Trauma and Orthopaedic Speciality training.
5. To describe differences in ARCP outcome by surgical specialty and factors affecting progression across all surgical specialities combined.

### 1.9.2 Chapter outline

- Chapter 2 “Factors Associated with Attrition and Performance throughout Surgical Training: a Meta-Analysis”: This systematic review and meta-analysis sought to identify factors associated with attrition and performance within General Surgery worldwide.
- Chapter 3 “The Impact of COVID-19 on Surgical Training: A Systematic Review”. This systematic review described the

impact of the COVID-19 pandemic on surgical training worldwide.

- Chapter 4 “Personal Characteristics Associated with Progression in General Surgical Specialty Training: A Cohort Study”: This study aimed to identify which factors predict non-standard ARCP outcome amongst General Surgery trainees in the UK.
- Chapter 5 “Personal Characteristics Associated with Progression in Trauma and Orthopaedic Specialty Training: A Cohort Study”: This study aimed to identify which factors predict non-standard ARCP outcome amongst Trauma and Orthopaedic trainees in the UK.
- Chapter 6 “Differences in ARCP outcome by surgical specialty: A Cohort Study”: This cohort study identified variation in ARCP outcomes across the surgical specialities and described factors associated with ARCP outcome across all specialities combined.

## **Chapter 2 Factors Associated with Attrition and Performance throughout Surgical Training: a Meta-Analysis**

### **Section 2.1 Introduction**

Attrition within surgical training is a challenge, in the United States (US) attrition rates are as high as 20%-26% [87 88]. Surgical residency is the US equivalent of Higher Surgical Training in the UK. Evidence of differential attainment within surgical specialities includes different rates of attrition based on protected characteristics (Chapter 1, Section 1.4.3). It is a priority to retain surgical residents to meet the increasing healthcare demand and to reduce the significant costs associated with attrition.

Discrimination in the workplace is protected by US law [89]. Age, sex, disability, race, religion, gender reassignment, pregnancy and maternity and marriage and civil partnerships are termed 'protected characteristics' and relate to personal characteristics or attributes. In contrast to the UK Equality Act (Chapter 1, section 1.4) sexual orientation and gender identity are not classed as a protected characteristic at the US federal level, although individual states may provide equivalent protection. The impact of protected characteristics on attrition and performance in General Surgery residency is poorly understood.

The impact of sex on attrition from General Surgery residency remains unclear. Two meta-analyses reported conflicting findings regarding

differences in attrition between male and female General Surgery residents [90 91]. The focus of these meta-analyses was on attrition prevalence and timing as opposed to the impact of protected characteristics. The need for further studies to clarify the role these characteristics play in attrition and performance in General Surgical training was highlighted in the 2019 American College of Surgeons (ACS) statement on Harassment, Bullying and Discrimination [92]. Similarly the UK regulatory body, the General Medical Council (GMC), is working to identify areas of inequality to ensure all doctors are treated fairly regardless of protected characteristics [93].

As described in Chapter 1 (Section 1.5) there has been a push to increase the diversity of medical students [94]. Consequently, there is a change in the upcoming surgeons of the future, with women now representing over a third of US surgeons in training [95]. Most studies focus on dated cohorts and do not reflect the change in the demographics of present surgical residents.

In order to reduce attrition and ensure that all trainees are facilitated to meet their maximum potential and maintain a successful surgical career, factors affecting failure to complete training or those that adversely affect performance need to be identified.

### 2.1.1 Aim

The aim is to identify factors that influence progression through or completion of surgical training and will address the following:

1. Are there any factors that predict attrition within postgraduate surgical training?
2. Are there any factors that predict performance during postgraduate surgical training?

## Section 2.2 Methods

### 2.2.1 Protocol registration

This systematic review was performed in line with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) [96]. The protocol is available on the Open Science Framework (OFS) at <https://osf.io/p5cbv> (Appendix 3).

### 2.2.2 Eligibility criteria

The review sought to identify papers evaluating factors that affect attrition or progression through Surgical Training or identify factors affecting performance within Surgical Training. We included all types of study published as full papers with no restrictions on the language of or date of publication.

### 2.2.3 Exclusion criteria

1. Studies not investigating specialty surgical trainees e.g., consultants/faculty, non-medical staff, undergraduate training.
2. Studies focused on selection into training.

### 2.2.4 Information sources, search and study selection

MEDLINE Ovid, Embase Ovid, PubMed and the Cochrane Central Register of Controlled Trials (CENTRAL) were searched electronically using a mixture of keywords and MeSH terms. The subject strategies for databases were modelled on the search strategy designed for MEDLINE Ovid (Table 2.1). We searched the reference lists of included studies for further eligible studies.

Two review authors (CH and JJR) independently and in duplicate performed the title and abstract screening. The full text of all eligible and potentially eligible studies were further evaluated to identify studies meeting the inclusion criteria. Any disagreement was resolved by discussion, or where necessary a third reviewer opinion.

Table 2.1 Search strategy for Medline

|    |                                                                                                                                                                |
|----|----------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 38 | (surgeon or "surgical trainee" or "surgical training" or "surgical residency").mp. [mp=ti, ab, hw, tn, ot, dm, mf, dv, kw, fx, dq, nm, kf, ox, px, rx, ui, sy] |
| 39 | (surgical registrar or "specialty trainee" or "core trainee").mp. [mp=ti, ab, hw, tn, ot, dm, mf, dv, kw, fx, dq, nm, kf, ox, px, rx, ui, sy]                  |
| 40 | exp "Internship and Residency"/ or exp Clinical Competence/                                                                                                    |
| 41 | "specialty training".mp. or exp Specialization/ or exp Education, Medical, Graduate/ or exp Clinical Competence/                                               |
| 42 | exp Educational Measurement/st [Standards]                                                                                                                     |
| 43 | underperform*.mp.                                                                                                                                              |
| 44 | (differential attainment or "attainment gap").mp. [mp=ti, ab, hw, tn, ot, dm, mf, dv, kw, fx, dq, nm, kf, ox, px, rx, ui, sy]                                  |
| 45 | (extend* or additional training).mp. [mp=ti, ab, hw, tn, ot, dm, mf, dv, kw, fx, dq, nm, kf, ox, px, rx, ui, sy]                                               |
| 46 | (difficulty or struggl*).mp. [mp=ti, ab, hw, tn, ot, dm, mf, dv, kw, fx, dq, nm, kf, ox, px, rx, ui, sy]                                                       |
| 47 | exp Bias/ or bias.mp.                                                                                                                                          |
| 48 | (ethnicity or race).mp. [mp=ti, ab, hw, tn, ot, dm, mf, dv, kw, fx, dq, nm, kf, ox, px, rx, ui, sy]                                                            |
| 49 | (ethnicity or race).mp. [mp=ti, ab, hw, tn, ot, dm, mf, dv, kw, fx, dq, nm, kf, ox, px, rx, ui, sy]                                                            |
| 50 | prejudice.mp. or exp Prejudice/                                                                                                                                |

|    |                                                                                                                                                                                       |
|----|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 51 | (matriculation or completion).mp. [mp=ti, ab, hw, tn, ot, dm, mf, dv, kw, fx, dq, nm, kf, ox, px, rx, ui, sy]                                                                         |
| 52 | attrition.mp.                                                                                                                                                                         |
| 53 | ("annual review of competency progression" or "arcp" or "rita" or "record of in training assessment").mp. [mp=ti, ab, hw, tn, ot, dm, mf, dv, kw, fx, dq, nm, kf, ox, px, rx, ui, sy] |
| 54 | 38 or 39                                                                                                                                                                              |
| 55 | 40 or 41 or 42                                                                                                                                                                        |
| 56 | 43 or 44 or 45 or 46 or 47 or 50 or 51 or 52 or 53                                                                                                                                    |
| 57 | 54 and 55 and 56                                                                                                                                                                      |
| 58 | remove duplicates from 57                                                                                                                                                             |

### 2.2.5 Data collection process

Two review authors independently extracted the data. If clarification was needed for any aspect of the included studies, the authors were contacted by email. The primary outcome measures were attrition and performance through training. Attrition included voluntarily and involuntary attrition. Protected characteristics (age, sex, ethnicity, marital and parental status), other factors (personal, workplace/programme, medical school/academic) and factors related to performance (exam performance, personality/learning style, operative volume) were extracted from each study. Publication year, country of origin, study size and population, methodology and data source were recorded.

### 2.2.6 Risk of bias in individual studies

Methodology checklists for both cohort and case control studies were reviewed, and used to critically appraise and grade the evidence of included studies. Quality was assessed using the Newcastle-Ottawa scale [97].

### 2.2.7 Synthesis of results

The results were divided into studies that investigated factors affecting attrition and studies that focussed on factors that affected performance. A random effects meta-analysis was performed to generate a pooled estimate of attrition prevalence. Two sensitivity analyses were performed including only multi-institutional studies and studies published after 2008. Between study heterogeneity was measured with

the  $I^2$  statistic.  $I^2$  of greater than 75% was taken as a high level of heterogeneity. Random effects meta-analysis was conducted for sex. In the event of more than one study including the same population of residents, the study with the largest sample was included in the meta-analysis. Subgroup differences were tested using the z test. It was not possible to perform a meta-analysis on any other factors due to variation in outcome measurement and study design. It was also not possible to look at attrition worldwide due to the lack of non-US studies. All analyses were performed in Stata v 15 (Stata Corp LP), with a  $p < 0.05$  significance level.

## Section 2.3 Results

### 2.3.1 Study selection

The searches identified 3,486 articles (Figure 2.1). The main reason for exclusion on title and abstract screening was wrong outcome or wrong population. Thirty one studies met the inclusion criteria (Table 2.2).

Twenty nine of the studies were from the US, one from Pakistan and one from the UK. In regards to study quality, five studies were at high risk of bias, fifteen moderate risk and eleven low risk (Table 2.3 & 2.4).

Twenty six studies reported attrition prevalence and were included in the meta-analysis, comprising 17,407 residents. The pooled estimate of overall attrition was 17% (95% CI 14-20%) with significant heterogeneity ( $I^2 = 96.84\%$ ,  $p < 0.001$ ) (Figure 2.2). The pooled estimate of attrition was 14% (95% CI 10%-17%) on sensitivity analysis of only multi-institutional studies with greater heterogeneity ( $I^2 = 98.10\%$ ,  $p = 0.00$ ) and therefore initial analyses are presented (Figure 2.3). After only including studies published after 2008, the overall attrition remained 17% (95% CI 13-20%,  $I^2 = 97.06\%$ ,  $p = 0.00$ ) (Figure 2.4).

Figure 2.1. PRISMA flow diagram

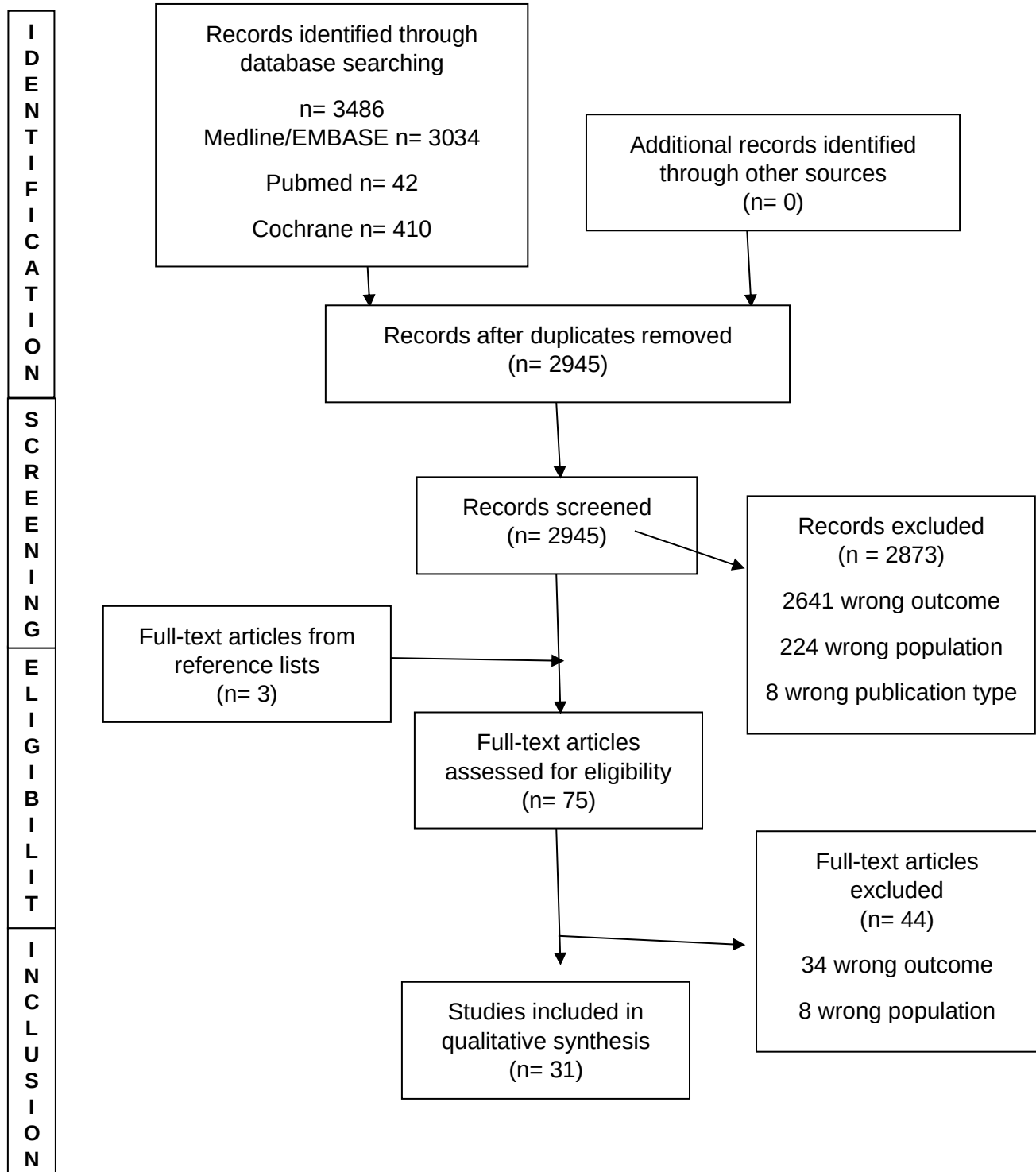
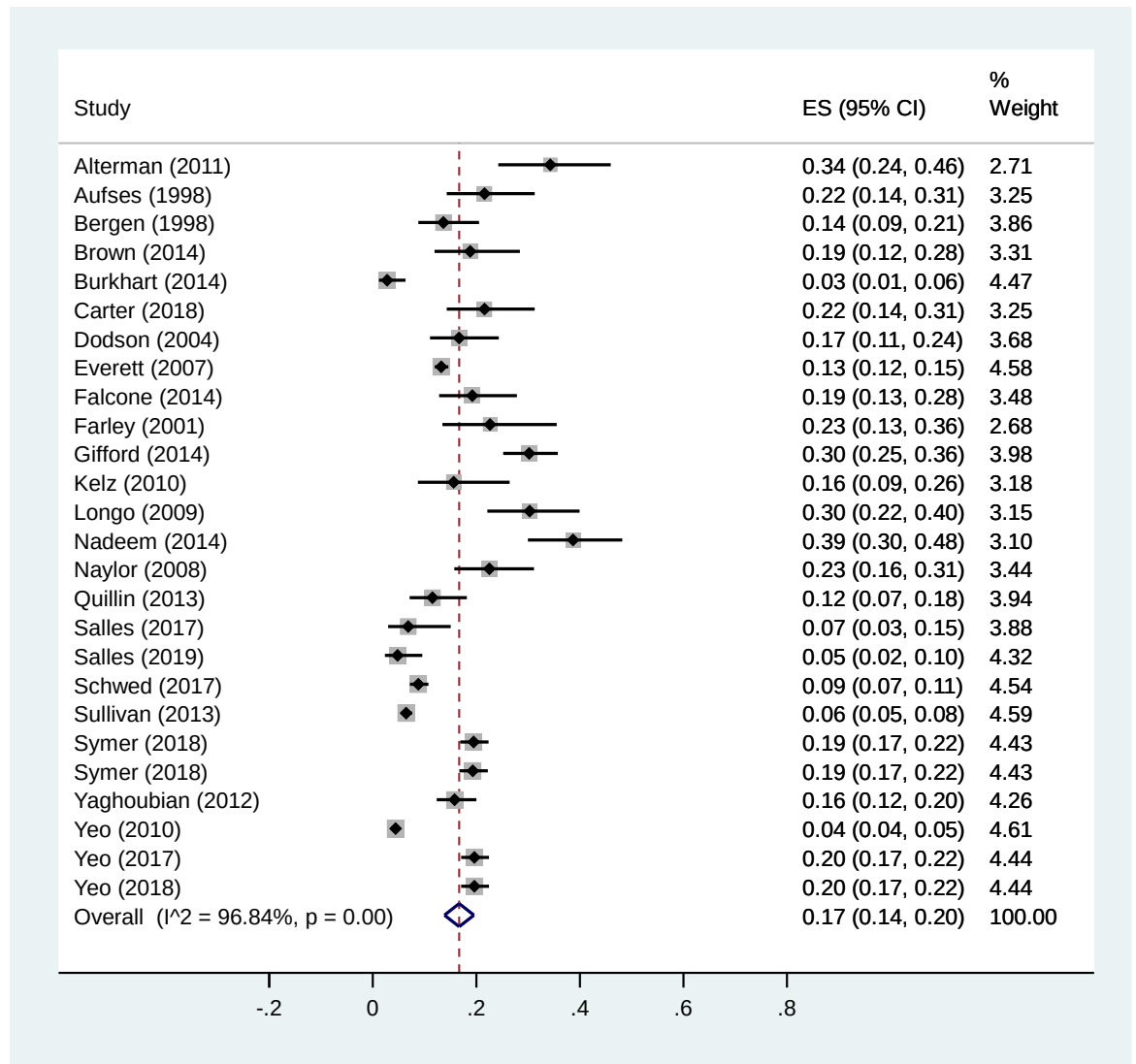


Figure 2.2. Pooled attrition by study.



The pooled overall attrition estimate was 17% (95% CI 14-20%) across studies. ES= estimate of attrition. Weight %= influence of the study on the overall meta-analysis.  $I^2$ = level of heterogeneity.

Table 2.2. Summary of all included studies.

| Author   | Title                                                                                                              | Year | Country | Study Size | Population                                                     | Methodology                                                | Source                                                        | Attrition rate reported |
|----------|--------------------------------------------------------------------------------------------------------------------|------|---------|------------|----------------------------------------------------------------|------------------------------------------------------------|---------------------------------------------------------------|-------------------------|
| Alterman | The predictive value of general surgery application data for future resident performance                           | 2011 | USA     | 101        | General surgery residents<br>1990-2008<br>Single institution   | Retrospective review                                       | Resident files<br>ABSITE<br>ACGME                             | Yes                     |
| Aufses   | The nature and fate of categorical surgical residents who 'drop out'                                               | 1998 | USA     | 88         | General surgery residents<br>1982-1995<br>Single institution   | Retrospective review                                       | Resident files<br>Medical school data                         | Yes                     |
| Bergen   | Gender-related attrition in a general surgery training program                                                     | 1998 | USA     | 132        | General surgery residents<br>1984-1996<br>Single institution   | Retrospective review                                       | National Residency Matching Program                           | Yes                     |
| Brown    | Pregnancy-related attrition in general surgery                                                                     | 2014 | USA     | 85         | General surgery residents<br>1999-2009<br>Single institution   | Retrospective review                                       | Resident files                                                | Yes                     |
| Burkhart | Grit: A marker of residents at risk for attrition?                                                                 | 2014 | USA     | 180        | General surgery residents<br>2012-2013<br>Multi- institutional | Survey                                                     | Grit survey<br>Resident files                                 | Yes                     |
| Carter   | Women in surgery: A longer term follow-up                                                                          | 2018 | USA     | 108        | General surgery residents<br>1996-2009<br>Single institution   | Retrospective review                                       | Resident files                                                | Yes                     |
| Dodson   | Why do residents leave general surgery? The hidden problem in today's programs                                     | 2004 | USA     | 120        | General surgery residents<br>1990-2003<br>Single institution   | Retrospective review                                       | Resident files                                                | Yes                     |
| Everett  | General surgery resident attrition and the 80-hour workweek                                                        | 2007 | USA     | 2555       | General surgery residents<br>2001-2004<br>Multi-institutional  | Survey to directors of General Surgery residency programme | Survey                                                        | Yes                     |
| Falcone  | Home school dropout: a twenty-year experience of the matriculation of categorical general surgery residents        | 2014 | USA     | 104        | General surgery residents<br>1992-2011<br>Single institution   | Retrospective review                                       | Resident files                                                | Yes                     |
| Farley   | Whatever happened to the General Surgery graduating class of 2001?                                                 | 2001 | USA     | 53         | General surgery residents<br>1996-2001<br>Multi-institutional  | Cross sectional                                            | Resident files                                                | Yes                     |
| Gifford  | Factors associated with general surgery residents' desire to leave residency programs: A multi-institutional study | 2014 | USA     | 288        | General surgery residents<br>Multi-institution<br>2004-2013    | Survey across residents                                    | Survey<br>Resident files                                      | Yes                     |
| Hayward  | Is there gender bias in the evaluation of surgical residents?                                                      | 1987 | USA     | 144        | General surgery residents<br>1967-1985<br>Single institution   | Retrospective review of faculty evaluations                | Resident files                                                | N/A                     |
| Kelz     | Prevention of Surgical Resident Attrition by a Novel Selection Strategy                                            | 2010 | USA     | 64         | General surgery residents<br>2005-2009<br>Single institution   | Retrospective review                                       | Electronic Resident Application System<br>Resident interviews | Yes                     |

|             |                                                                                                                                                                        |      |          |                |                                                                                                                                                           |                                                    |                                                                                                        |     |
|-------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|----------|----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------|--------------------------------------------------------------------------------------------------------|-----|
| Kim         | The effect of surgical resident learning style preferences on American board of surgery in-training examination scores                                                 | 2015 | USA      | 53             | General surgery residents<br>2012-2013<br>Single institution                                                                                              | Retrospective review                               | Fleming VARK learning styles inventory<br>ABS in-training examination score                            | N/A |
| Leibrant    | Has the 80-hour work week had an impact on voluntary attrition in general surgery residency programs?                                                                  | 2006 | USA      | 215 programmes | General surgery residents<br>2003-2004<br>Multi-institutional                                                                                             | Questionnaire to programme directors               | Questionnaire                                                                                          | N/A |
| Longo       | Attrition of categorical general surgery residents: results of a 20-year audit                                                                                         | 2009 | USA      | 99             | General surgery residents<br>1986-2006<br>Single institution                                                                                              | Retrospective review                               | Resident files                                                                                         | Yes |
| Nadeem      | Attrition in surgical residency programmes: Causes and effects                                                                                                         | 2014 | Pakistan | 106            | General surgery, orthopaedics, neurosurgery, ENT and urology residents<br>2005-2011<br>Single institution                                                 | Questionnaire to residents and programme directors | Resident files<br>Survey                                                                               | Yes |
| Naylor      | Factors Related to Attrition in Surgery Residency Based on Application Data                                                                                            | 2008 | USA      | 111            | Surgery- doesn't define<br>1991-2000<br>Single institution                                                                                                | Retrospective review                               | Residency application form<br>Annual performance evaluations<br>ABSITE                                 | Yes |
| Quillin     | How residents learn predicts success in surgical residency                                                                                                             | 2013 | USA      | 130            | General surgery residents<br>1999-2012<br>Single institution                                                                                              | Retrospective review                               | ACGME<br>Operative log data<br>ABSQE and ABSCE<br>Resident files                                       | Yes |
| Salles      | Grit as a predictor of risk of attrition in surgical residency                                                                                                         | 2017 | USA      | 73             | General surgery residents<br>2014-2015<br>Single institution                                                                                              | Survey to residents                                | Survey<br>Short grit scale<br>Resident files                                                           | Yes |
| Salles      | Social Belonging as a Predictor of Surgical Resident Well-being and Attrition                                                                                          | 2019 | USA      | 146            | General surgery, cardiothoracic, ENT, vascular, orthopaedics, plastic surgery, urology & neurosurgery residents<br>2010 2011, 2015<br>Multi-institutional | Survey to residents                                | Survey<br>Resident files                                                                               | Yes |
| Schwed      | Association of general surgery resident remediation and program director attitudes with resident attrition                                                             | 2017 | USA      | 966            | General surgery residents<br>2010-2015<br>Multi-institutional                                                                                             | Survey to programme directors                      | Survey<br>General Surgery Qualifying Examination and General Surgery Qualifying Examination of the ABS | Yes |
| Scrimgeour  | Does the Intercollegiate Membership of the Royal College of Surgeons (MRCS) examination predict 'on-the-job' performance during UK higher specialty surgical training? | 2018 | UK       | 2750           | Higher surgical residents<br>2007-2016<br>Multi-institutional                                                                                             | Longitudinal cohort study                          | Membership of Royal College of Surgeons exam<br>ARCP outcomes                                          | N/A |
| Sullivan    | Surgical residency and attrition: Defining the individual and programmatic factors predictive of trainee losses                                                        | 2013 | USA      | 2033           | General surgery<br>2008-2009<br>Multi-institutional                                                                                                       | Prospective study                                  | National Study of expectations and Attitudes of Residents in Surgery<br>Survey<br>ABS resident roster  | Yes |
| Symer       | The Surgical Personality: Does Surgery Resident Motivation Predict Attrition?                                                                                          | 2018 | USA      | 801            | General surgery<br>2007-2008<br>Multi-institutional                                                                                                       | Survey to residents, data review 2016              | Behavioural Inhibition/Behaviour Approach scale<br>ABS resident roster                                 | Yes |
| Symer, Wong | Impact of medical school experience on attrition from general surgery residency                                                                                        | 2018 | USA      | 792            | General surgery<br>2007-2008<br>Multi-institutional                                                                                                       | Prospective cohort study                           | ABS<br>Survey assessing medical school experience                                                      | Yes |

|            |                                                                                                             |      |     |      |                                                               |                                                                   |                                                                                             |     |
|------------|-------------------------------------------------------------------------------------------------------------|------|-----|------|---------------------------------------------------------------|-------------------------------------------------------------------|---------------------------------------------------------------------------------------------|-----|
| Wade       | Evaluations of surgery resident performance correlate with success in board examinations                    | 1993 | USA | 48   | General surgery<br>1976-1988<br>Single institution            | Retrospective review                                              | ABSITE<br>Resident files                                                                    | N/A |
| Yaghoubian | General surgery resident remediation and attrition: A multi-institutional study                             | 2012 | USA | 348  | General surgery residents<br>1999-2010<br>Multi-institution   | Retrospective analysis                                            | USMLE<br>ABSITE scores<br>3 <sup>rd</sup> year medical school surgery<br>performance scores | Yes |
| Yeo        | A national study of attrition in general surgery training: Which residents leave and where do they go?      | 2010 | USA | 3959 | General surgery residents<br>2007-2008<br>Multi-institutional | Retrospective analysis                                            | National Study of Expectations and Attitudes of Residents in Surgery survey                 | Yes |
| Yeo        | Who Makes It to the End?: A Novel Predictive Model for Identifying Surgical Residents at Risk for Attrition | 2017 | USA | 836  | General surgery residents<br>2007<br>Multi-institutional      | Prospective cohort study<br>with 8 year follow up                 | ABS<br>ABSITE                                                                               | Yes |
| Yeo        | Association of time to attrition in surgical residency with individual resident and programmatic factors    | 2018 | USA | 836  | General surgery residents<br>2007-2008<br>Multi-institutional | Prospective cohort study<br>With 9 year follow up data<br>linkage | National Expectations and Attitudes of Residents in Surgery Survey                          | Yes |

ABS= American Board of Surgery, ABSITE= American Board of Surgery In-Training examination, ACGME= Accreditation Council for Graduate Medical Education, ARCP= Annual Review of Competency Panel, USMLE= United States Medical Licensing Exam

Table 2.3. Quality assessment of cohort studies using Newcastle-Ottawa Scale.

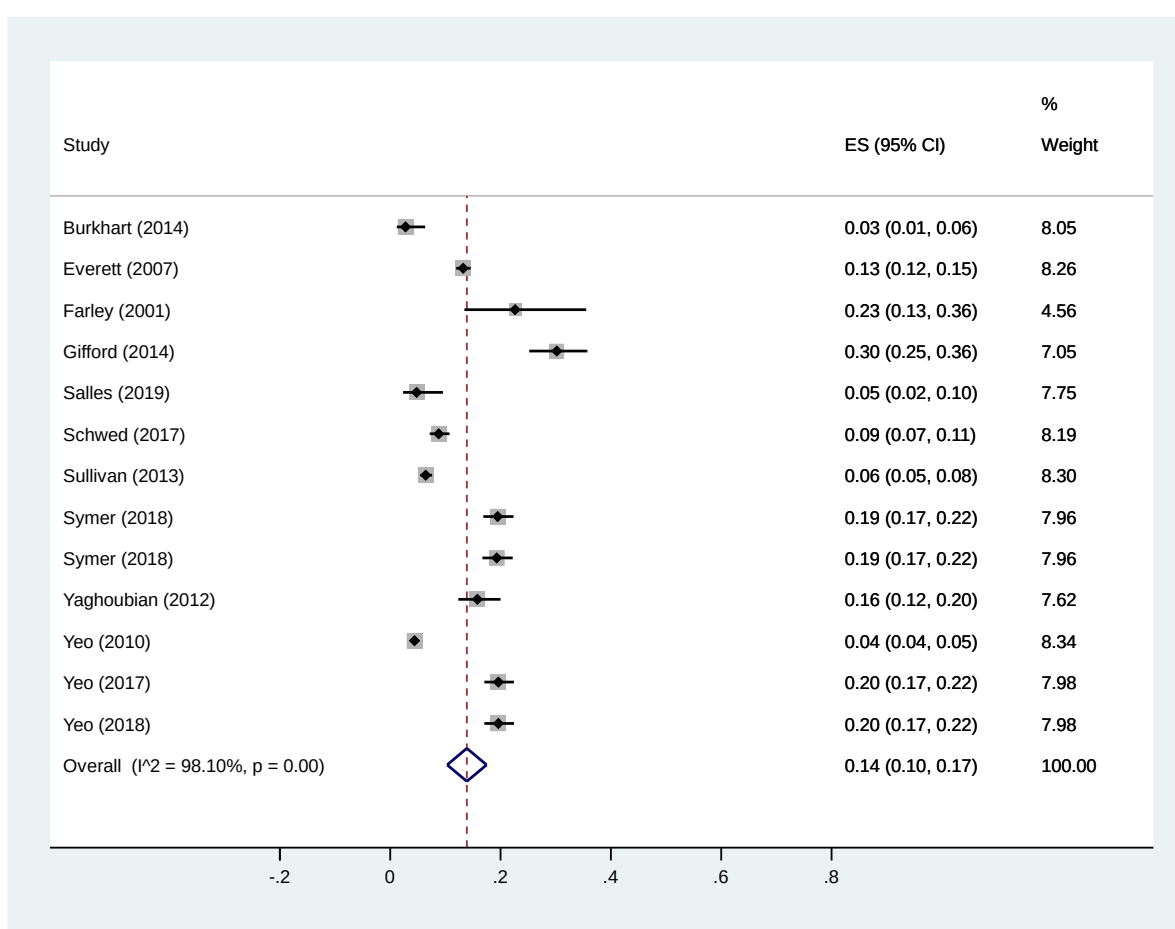
| Study    | Representativeness of the exposed cohort | Selection of the non-exposed cohort | Ascertainment of exposure | Demonstration that outcome of interest was not present at start of study | Comparability of cohorts on the basis of the design or analysis | Assessment of outcome | Was follow-up long enough for outcomes to occur | Adequacy of follow up of cohorts | Total score |
|----------|------------------------------------------|-------------------------------------|---------------------------|--------------------------------------------------------------------------|-----------------------------------------------------------------|-----------------------|-------------------------------------------------|----------------------------------|-------------|
| Alterman | C                                        | A                                   | A                         | A                                                                        | C                                                               | B                     | A                                               | A                                | 6           |
| Aufses   | C                                        | A                                   | A                         | A                                                                        | C                                                               | B                     | A                                               | A                                | 6           |
| Bergen   | C                                        | A                                   | A                         | A                                                                        | C                                                               | B                     | A                                               | B                                | 6           |
| Brown    | C                                        | A                                   | A                         | A                                                                        | A                                                               | B                     | A                                               | A                                | 7           |
| Burkhart | C                                        | A                                   | C                         | A                                                                        | B                                                               | B                     | B                                               | C                                | 4           |
| Carter   | C                                        | A                                   | A                         | A                                                                        | B                                                               | B                     | A                                               | A                                | 7           |
| Falcone  | C                                        | A                                   | A                         | A                                                                        | C                                                               | B                     | A                                               | A                                | 6           |
| Hayward  | C                                        | A                                   | A                         | A                                                                        | B                                                               | B                     | A                                               | B                                | 6           |
| Kelz     | C                                        | A                                   | A                         | A                                                                        | A                                                               | B                     | A                                               | A                                | 7           |
| Kim      | C                                        | A                                   | B                         | A                                                                        | B                                                               | B                     | B                                               | B                                | 6           |
| Longo    | C                                        | A                                   | A                         | A                                                                        | C                                                               | B                     | A                                               | A                                | 6           |
| Naylor   | C                                        | A                                   | A                         | A                                                                        | A                                                               | B                     | A                                               | B                                | 7           |
| Quillin  | C                                        | A                                   | A                         | A                                                                        | A                                                               | B                     | A                                               | A                                | 7           |

|               |   |   |   |   |   |   |   |   |   |
|---------------|---|---|---|---|---|---|---|---|---|
| Salles (2017) | C | A | C | A | B | D | B | C | 3 |
| Salles (2019) | C | A | C | A | B | D | B | B | 4 |
| Schwed        | A | A | A | A | A | B | B | B | 7 |
| Scrimgeour    | A | A | A | A | A | B | A | A | 8 |
| Sullivan      | A | A | A | A | C | B | A | B | 7 |
| Symer         | A | A | A | A | A | B | A | A | 8 |
| Symer, Wong   | A | A | B | A | A | B | A | A | 8 |
| Wade          | C | A | A | A | B | B | A | A | 7 |
| Yaghoubian    | C | A | A | A | C | B | A | D | 5 |
| Yeo (2010)    | A | A | A | A | A | B | A | B | 8 |
| Yeo (2017)    | A | A | A | A | A | B | A | A | 8 |
| Yeo (2018)    | A | A | A | A | A | B | A | A | 8 |

Table 2.4. Quality assessment of Cross Sectional Studies using Newcastle-Ottawa Scale

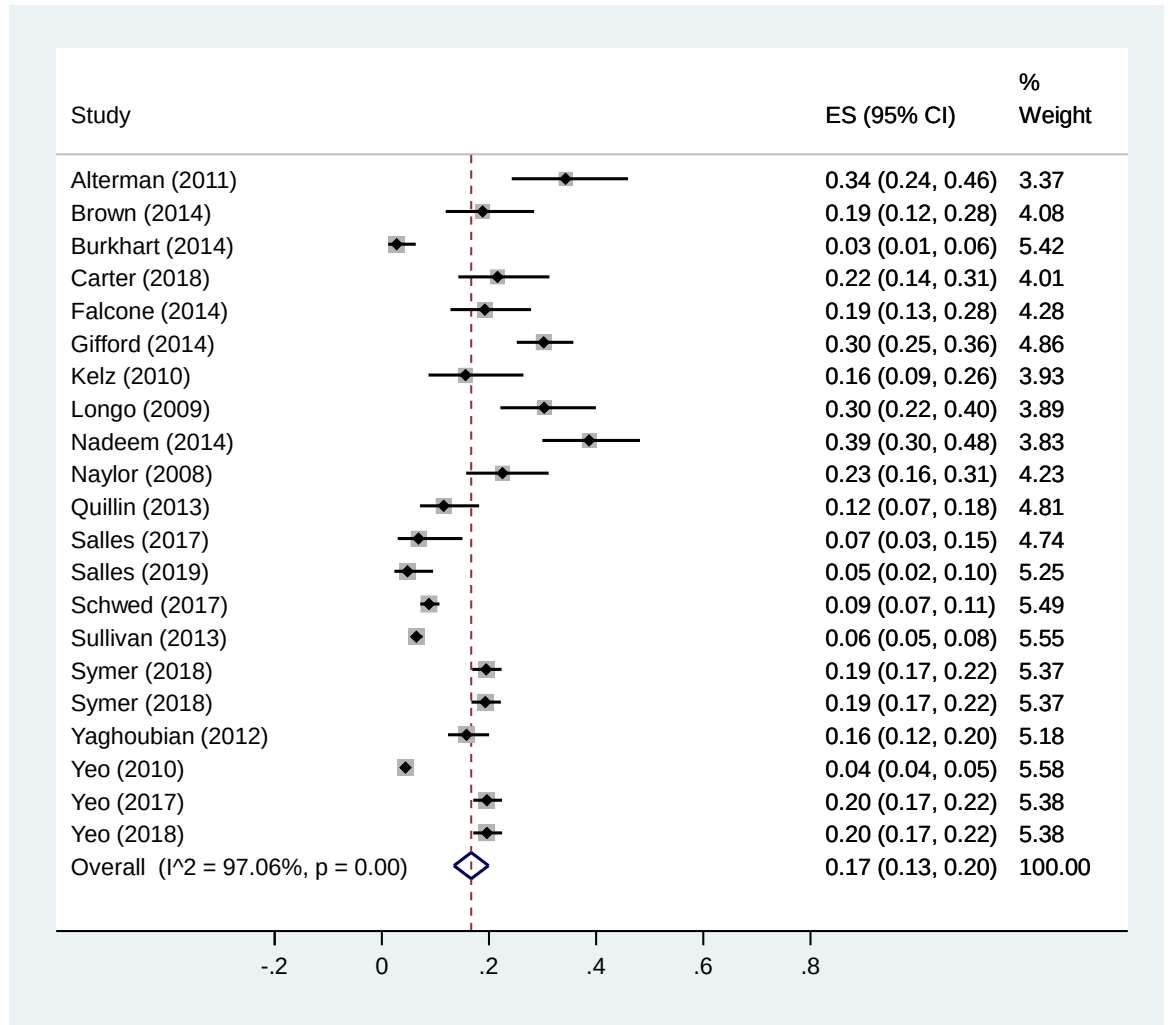
| Study    | Representativeness of the trainee population | Ascertainment of exposure | Comparability of cohorts on the basis of the design or analysis | Assessment of outcome | Adequacy of response rate | Total score |
|----------|----------------------------------------------|---------------------------|-----------------------------------------------------------------|-----------------------|---------------------------|-------------|
| Dodson   | C                                            | A                         | C                                                               | B                     | A                         | 3           |
| Everett  | A                                            | A                         | C                                                               | B                     | C                         | 3           |
| Farley   | C                                            | A                         | C                                                               | B                     | C                         | 2           |
| Gifford  | C                                            | A                         | A                                                               | B                     | C                         | 3           |
| Leibrant | A                                            | A                         | C                                                               | B                     | B                         | 4           |
| Nadeem   | C                                            | A                         | C                                                               | B                     | B                         | 3           |

Figure 2.3. Sensitivity analysis including only multi-institutional studies



This sensitivity analysis included only studies that included data from multiple institutes, in order to check for bias from single institute studies. The pooled attrition changed to 14% (95% CI 10-17%), with greater heterogeneity. ES= estimate of attrition. Weight %= influence of the study on the overall meta-analysis.  $I^2$ = level of heterogeneity.

Figure 2.4. Sensitivity analysis including only studies published after 2008



This sensitivity analysis included only studies that were published after 2008, to account for changes in trainee demographics and training standards. The pooled attrition remained 17% (95% CI 13-20%). ES= estimate of attrition. Weight %= influence of the study on the overall meta-analysis.  $I^2$ = level of heterogeneity.

## 2.3.2 Attrition

### 2.3.2.1 Age

Two out of four studies found no association with age and attrition [87 98] (Table 2.5). In the studies that found increasing age to be a risk factor for attrition, age was dichotomised to under and over 29 [99] and under and over 35 years [100] in the analysis. The positive finding in the study by Naylor [99] may be due to the outcome measure which combines attrition with failure to pass the board examination.

Table 2.5. Studies investigating the effect of protected characteristics on attrition (age, sex, race/ethnicity, marital and parental status)

| Age         |      |            |                                                                          |
|-------------|------|------------|--------------------------------------------------------------------------|
| Author      | Year | Study Size | Conclusions                                                              |
| Brown       | 2014 | 85         | Age not associated with attrition (OR 1.0 95% CI 0.8-1.4)                |
| Yeo         | 2010 | 3959       | Age not associated with attrition ( $\beta$ 0.05 95% CI -0.03-0.13)      |
| Naylor      | 2008 | 111        | Age >29 years associated with attrition (OR 0.11 95% CI 0.02-0.47)       |
| Sullivan    | 2013 | 2033       | Age $\geq$ 35 years associated with attrition (OR 0.28 95% CI 0.19-0.39) |
| Sex         |      |            |                                                                          |
| Author      | Year | Study Size | Conclusions                                                              |
| Alterman    | 2011 | 101        | No association with gender (not reported)                                |
| Aufses      | 1998 | 88         | No association with gender (32% vs 17%, $p=0.12$ )                       |
| Bergen      | 1998 | 132        | No association with gender (RR 2.26 95% CI 0.96-5.31)                    |
| Brown       | 2014 | 85         | No association with gender (OR 1.0 95% CI 0.2-3.6)                       |
| Carter      | 2018 | 108        | No association with gender (female 22% vs male 19%, $p=0.77$ )           |
| Dodson      | 2004 | 120        | No association with gender (female 27% vs male 13%)                      |
| Falcone     | 2014 | 103        | No association with gender (female 23.1% vs male 17.9%, $p=0.57$ )       |
| Longo       | 2009 | 99         | No association with gender (female 39% vs 26% male)                      |
| Nadeem      | 2014 | 106        | No association with gender (female 54.5% vs male 34.5%, $p=0.07$ )       |
| Sullivan    | 2013 | 2033       | No association with gender (female 7% vs male 6.2%)                      |
| Yaghoubi an | 2012 | 348        | No association with gender (female 47.3% vs male 52.7%, $p=0.08$ )       |
| Yeo         | 2010 | 3959       | No association with gender ( $\beta$ -0.23 95% CI -0.72-0.30)            |

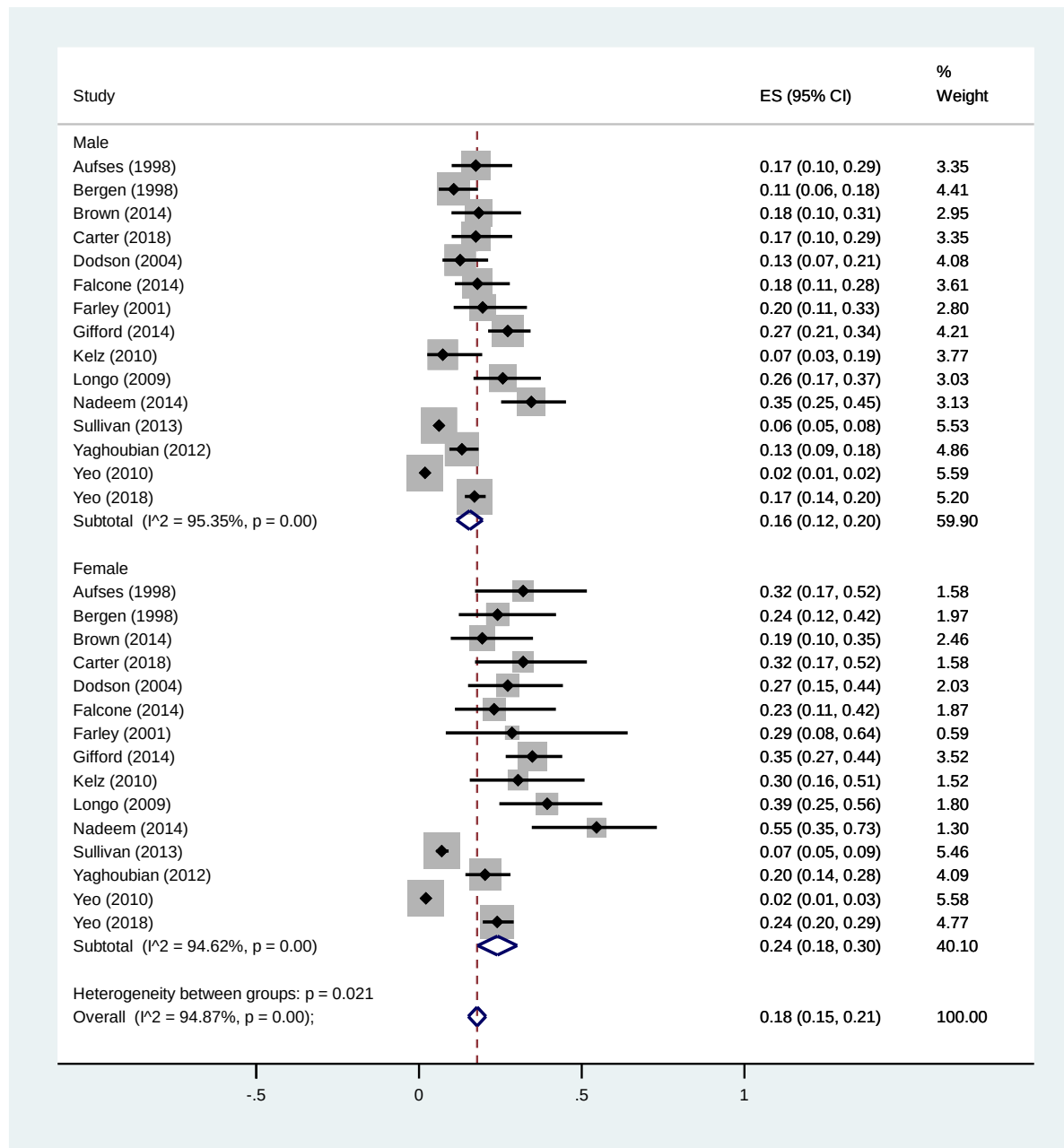
|                                    |             |                   |                                                                                                                                                                                           |
|------------------------------------|-------------|-------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Gifford                            | 2014        | 371               | Significant difference between sexes (Female OR 1.9 CI 1.2-3.0)                                                                                                                           |
| Symer, Wong                        | 2018        | 792               | Significant difference between sexes (24% of women vs 16% of men left, p 0.01)                                                                                                            |
| Yeo                                | 2017        | 836               | Significant difference between sexes (24% of women vs 17% of men left, p= 0.02)                                                                                                           |
| Yeo                                | 2018        | 836               | Significant difference between sexes (Female OR 1.40 95% CI 1.02-1.94)                                                                                                                    |
| <b>Race/ Ethnicity</b>             |             |                   |                                                                                                                                                                                           |
| <b>Author</b>                      | <b>Year</b> | <b>Study Size</b> | <b>Conclusions</b>                                                                                                                                                                        |
| Yeo                                | 2010        | 3959              | No association between race/ethnicity ( $\beta$ -0.09 95% CI -0.59-0.41)                                                                                                                  |
| Sullivan                           | 2013        | 2033              | Hispanic residents higher risk of attrition (OR 0.50 95% CI 0.38-0.65)<br>Black residents higher risk of attrition (OR 0.28 95% CI 0.20-0.40)                                             |
| Symer, Wong                        | 2018        | 792               | Hispanic residents less likely to complete residency (13.1% non-Hispanic vs 7.8% Hispanic completed residency, p=0.04)                                                                    |
| Yeo                                | 2017        | 836               | Hispanic residents less likely to complete residency (29% non-Hispanic vs 19% Hispanic completed residency, p=0.03)                                                                       |
| Yeo                                | 2018        | 836               | Hispanic residents less likely to complete residency (OR 1.71 95% CI 1.06-2.76)                                                                                                           |
| <b>Marital and Parental Status</b> |             |                   |                                                                                                                                                                                           |
| <b>Author</b>                      | <b>Year</b> | <b>Study Size</b> | <b>Conclusions</b>                                                                                                                                                                        |
| Brown                              | 2014        | 85                | No association with child rearing (OR 1.0 95% CI 0.1-9.6)<br>Association with marital status (Married OR 0.2 95% CI 0.01-0.9)                                                             |
| Sullivan                           | 2013        | 2033              | No association with child rearing (18% with children left vs 15% completed residency, p 0.31)<br>No association with marital status (46% married left vs 42% completed residency, p 0.34) |
| Yeo                                | 2010        | 3959              | No association with child rearing ( $\beta$ 0.45 95% CI -0.32-0.98)<br>No association with marital status (OR 0.23 95% CI -0.32-0.78)                                                     |

### 2.3.2.2 Sex

The pooled attrition prevalence for male residents on random effect meta-analysis was 16% (95% CI 12-20%), with significant between study heterogeneity ( $I^2 = 95.35\%$ ,  $p < 0.01$ ) (Figure 2.5). The pooled attrition prevalence for women was significantly higher at 24% (95% CI 18-30%,  $z = -4.6832$   $p < 0.001$ ), again with significant heterogeneity ( $I^2 = 94.62\%$ ,  $p < 0.01$ ). On sensitivity analysis, including only multi-institutional studies or those published after 2008 did not significantly affect the pooled attrition of male or female residents (Supplemental Figure 2.6 & 9).

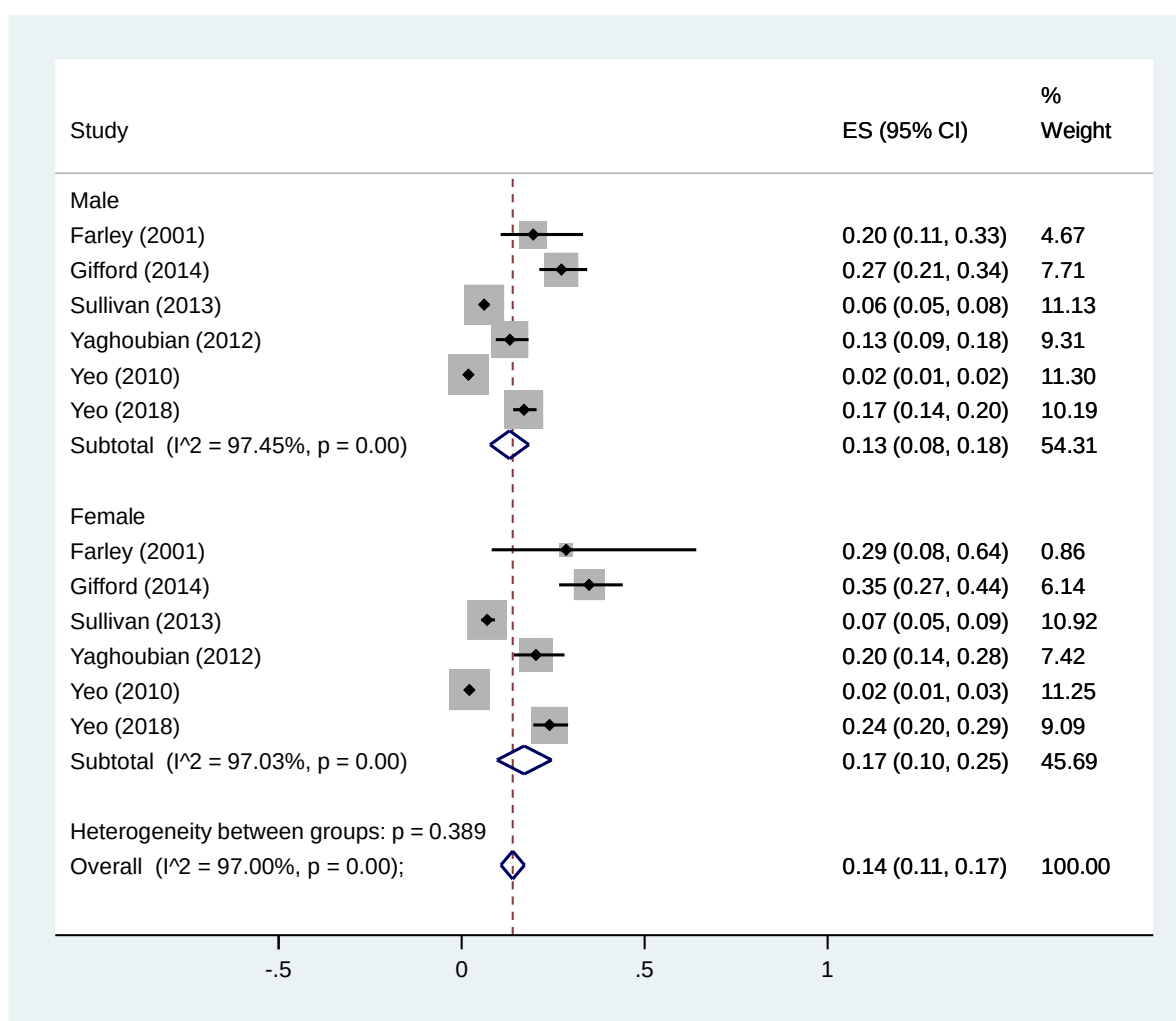
Four out of 16 studies found a significantly higher attrition amongst female residents [38 101-103] (Table 2.5). One reported that women were almost twice as likely to leave training as men (OR 1.9 95% CI 1.2-3.0) [101]. A nine year follow up study found there were differences in attrition rate for men and women over time, with similar rates in the first year but at four years into residency women had significantly higher rates of attrition (21.9% vs 16.3%,  $p = 0.05$ ) [38]. Women also had a higher cumulative attrition (OR 1.40 95% CI 1.02-1.94) [38].

Figure 2.5. Forest plot of pooled attrition by sex



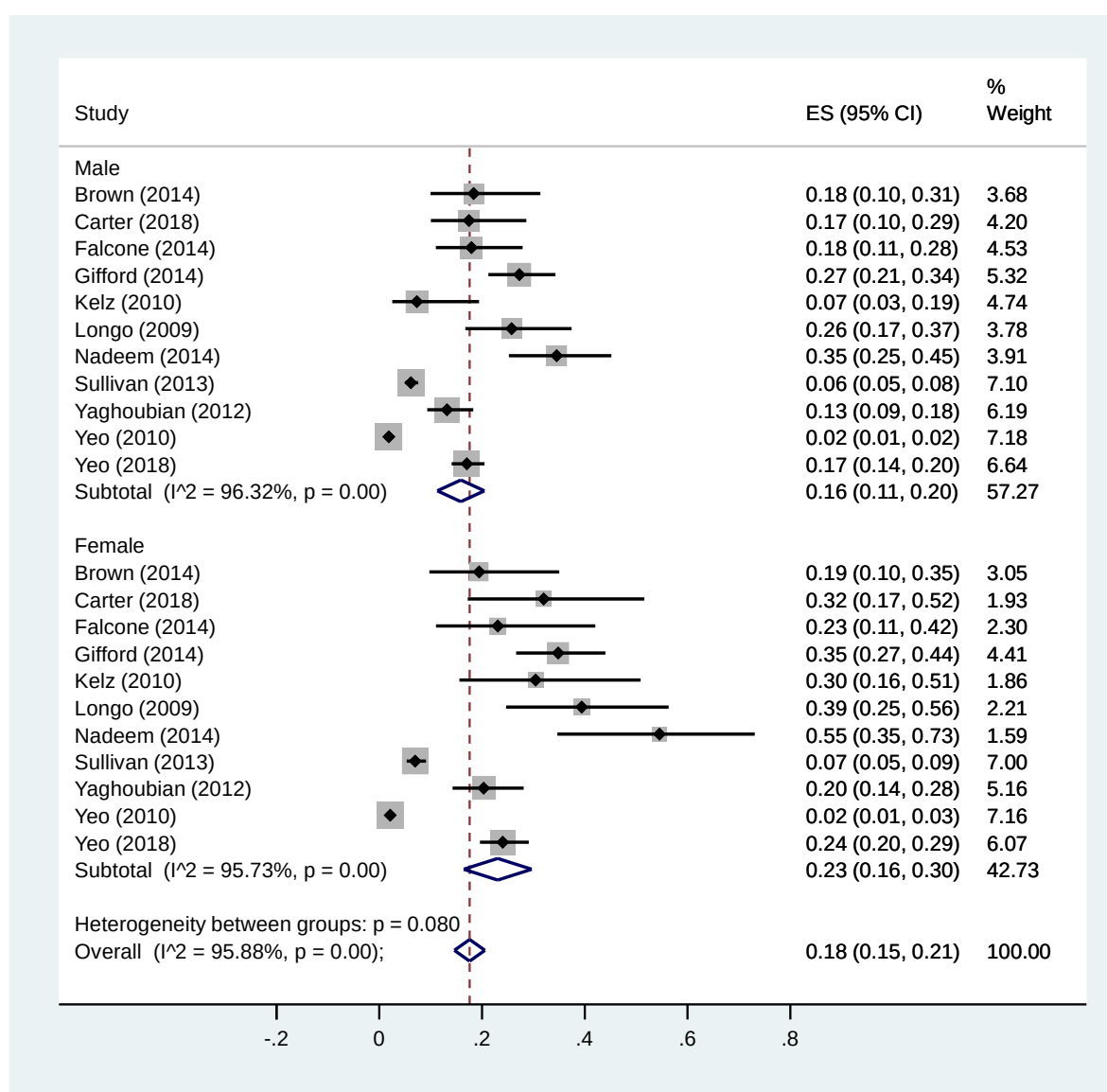
The pooled attrition for men was 16% (95% CI 12-20%), compared to 24% for women (95% CI 18-30%). ES= estimate of attrition. Weight %= influence of the study on the overall meta-analysis.  $I^2$ = level of heterogeneity.

Figure 2.6. Forest plot of sensitivity analysis of attrition by sex including only multi-institutional studies



This sensitivity analysis looking at the impact of sex on attrition included only multi-institutional studies. The pooled attrition remained higher for women than men (17% vs 13%). ES= estimate of attrition. Weight %= influence of the study on the overall meta-analysis.  $I^2$ = level of heterogeneity.

Figure 2.7. Forest plot of sensitivity analysis of attrition by sex including only studies published after 2008.



This sensitivity analysis looking at the impact of sex on attrition included only studies published after 2008. The pooled attrition remained higher for women than men (23% vs 16%). ES= estimate of attrition. Weight %= influence of the study on the overall meta-analysis.  $I^2$ = level of heterogeneity.

#### 2.3.2.3 Ethnicity/ race

Five studies investigated the association between race or ethnicity and attrition [38 87 100 102 103] (Table 2.5). Four studies reported that Hispanic residents were less likely to complete residency, however 3 of these studies were based on the same population of residents [38 100 102 103]. One study found that while White ethnicity was not associated with higher completion rates across both sexes (69.7% completion vs 65.8% non-completion,  $p=0.34$ ) [103], on subgroup analysis of women, White women had lower non-completion rates than non-White women (20% vs 30%  $p=0.08$ ).

#### 2.3.2.4 Marital and parental status

None of the studies found an association between parental status and attrition [87 98 100]; this included two large multi-institutional studies (Table 2.5). Only one study found those that were married were less likely to leave training, this was a small single-institutional study of 85 residents from 1999 to 2009 [98].

#### 2.3.2.5 Personal factors

There was no association between attrition and “grit” [104 105] social belonging [106] or motivational personality traits [107] (Table 2.6). Grit was defined as perseverance and passion for long term goals. The number of residents that did not complete training in these studies was small and therefore limits the power of statistical analysis. Quillin et al reported that residents who learn by observation are more likely to leave the programme and opt for a non-surgical specialty [108].

Table 2.6. Studies investigating the effect of other factors on attrition (personal, workplace and programme and medical school factors)

| Personal Factors                |      |            |                                                                                                                                                                                                                                 |
|---------------------------------|------|------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Author                          | Year | Study Size | Conclusions                                                                                                                                                                                                                     |
| Burkhart                        | 2014 | 180        | No significant association with grit ( $p=0.246$ )                                                                                                                                                                              |
| Salles                          | 2017 | 73         | No significant association with grit ( $\beta$ 85.83, $p=0.999$ )                                                                                                                                                               |
| Salles                          | 2015 | 146        | No significant association with lack of belonging ( $r=0.15$ , $p=0.1846$ )                                                                                                                                                     |
| Symer                           | 2018 | 801        | No significant association with motivational personality traits ( $p=0.51$ )                                                                                                                                                    |
| Quillin                         | 2013 | 130        | Association with learning style ( $p=0.0467$ )                                                                                                                                                                                  |
| Workplace and Programme Factors |      |            |                                                                                                                                                                                                                                 |
| Author                          | Year | Study Size | Conclusions                                                                                                                                                                                                                     |
| Everett                         | 2007 | 2555       | Association with 80 hour workweek (0.6 lost/programme/year pre vs 0.8 lost/programme/year post, $p=0.0414$ )                                                                                                                    |
| Leibrant                        | 2006 | 215        | No association with 80 hour work week (0.7 lost/programme/year pre vs 0.8 lost/programme/year post)                                                                                                                             |
| Sullivan                        | 2013 | 2033       | Association with early postgraduate year (9.4% PGY-1 left vs 4.5% PGY-2, $p<0.001$ )<br>Association with regional location (Northeast HR 2.39 vs South, $p=0.006$ )                                                             |
| Yeo                             | 2010 | 3959       | Association with early postgraduate year ( $\beta$ -0.82 95% CI -1.06- -0.58)                                                                                                                                                   |
| Symer, Wong                     | 2018 | 792        | Association with larger programme size (25.4% from large programme completed vs 34% small programme, $p=0.03$ )                                                                                                                 |
| Yeo                             | 2017 | 836        | Association with larger programme size (24% from large programme left vs 18% small programmes, $p=0.03$ )<br>Association with military programmes vs academic programmes vs community programmes (35% vs 20% vs 17%, $p=0.03$ ) |
| Yeo                             | 2018 | 836        | Association with military programmes vs academic programmes (OR 2.68 95% CI 1.36-5.29)                                                                                                                                          |

| Yaghoubian                          | 2012 | 348        | No association with remediation (20% vs 15%, p=40)                                                                                                                                                                                                                           |
|-------------------------------------|------|------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Medical School and Academic Factors |      |            |                                                                                                                                                                                                                                                                              |
| Author                              | Year | Study Size | Conclusions                                                                                                                                                                                                                                                                  |
| Farley                              | 2001 | 53         | No association with applicant ranking (p=0.18)                                                                                                                                                                                                                               |
| Falcone                             | 2014 | 103        | No association with place of medical degree (p=0.89)                                                                                                                                                                                                                         |
| Yaghoubian                          | 2012 | 348        | No association with place of medical degree (0% vs 5.3% foreign medical graduate, p=0.09)<br>Association with PGY-3 ABSITE score (p=0.04)                                                                                                                                    |
| Alterman                            | 2011 | 101        | Association with special skill on medical school application (OR 3.59 95% CI 1.035-11.95) and medical school grade point average (p=0.023)<br>Association with residency interview score (OR 188.27 95% CI 3.757-9435.405), STEP1 score (p=0.001) and ABSITE score (p<0.001) |
| Naylor                              | 2008 | 111        | Association with residency application- comments in the dean's letter (OR 4.57 95% CI 2.00-10.43), participation in team sports (OR 4.96 95% CI 1.36-18.05).<br>Association with merit scholarship (OR 0.25 95% CI 0.08-0.78)                                                |
| Symer, Wong                         | 2018 | 792        | Association with experience in surgical clerkship- perception that medical school faculty were happy with their careers (OR 0.57 95% CI 0.34-0.96), those that got along well with attending surgeons during medical school (OR 2.93 95% CI 1.34-6.39)                       |

#### 2.3.2.6 Workplace and programme factors

Eight studies reported the impact of workplace factors on failure to complete General Surgery residency [38 87 100 102 103 109-111] (Table 2.6). Early postgraduate year [87 100], larger programme size [102 103] and military programmes [38 103] were found to be associated with higher attrition.

#### 2.3.2.7 Medical school and academic factors

Six studies investigated medical school factors affecting completion of residency [99 102 109 112-114] (Table 2.6). Two studies reported an association between ABSITE score and attrition [109 114]. Residents who felt medical school faculty were happy with their surgical careers were less likely to experience attrition [102], while those who got along well with attending surgeons during medical school had higher odds of attrition. Protective factors on the residency application were comments in the dean's letter, participation in team sports [99] and residency interview score [114].

#### 2.3.3 Performance

Six studies focused on factors that predicted performance throughout surgical residency [67 115-119] (Table 2.7). Performance included exam scores, operative case volume and in-training evaluations. Childrearing was not associated with operative case volume or exam performance [98]. Factors reported to affect US post-graduate surgical exam performance were learning preference [115] and faculty

evaluation of clinical performance [120]. However, these studies are based on small sample sizes. The only UK based study investigated whether postgraduate examination scores are a predictor of performance throughout UK surgical training [67]. Non-White ethnicity and exam performance were found to be independent predictors of unsatisfactory performance.

Table 2.7. Studies looking at factors that predict performance

| Author     | Year | Study Size | Conclusions                                                                                                                                                                                      |
|------------|------|------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Brown      | 2014 | 85         | No association with childrearing and operative case volume (men $p=0.40$ , women $p=-.93$ ) or board pass rates (men $p=0.76$ , women $p=0.50$ )                                                 |
| Burkhart   | 2014 | 180        | No association between grit score and ABSITE performance ( $p=0.891$ )                                                                                                                           |
| Hayward    | 1987 | 144        | No association with gender or place of medical degree (not reported)                                                                                                                             |
| Quillin    | 2013 | 130        | No association with learning style and first time pass rate on the ABSQE ( $p=0.615$ ) or the ABSCE ( $p=0.510$ )<br>Association with learning style and operative cases volume ( $p=0.0467$ )   |
| Kim        | 2015 | 53         | Association with learning preferences and ABSITE performance ( $p=0.03$ )                                                                                                                        |
| Scrimgeour | 2018 | 2750       | Association with non-White ethnicity (OR 1.36 95% CI 1.08-1.71), MRCS pass score (OR 0.98 95% CI 0.98-1.00) and MRCS attempt number (OR 1.50 95% CI 1.16-1.94) with unsatisfactory ARCP outcome  |
| Wade       | 1993 | 48         | Association with clinical performances and first time pass rate of ABS ( $p<0.005$ )<br>Association with ABSITE performance and first time pass rate of the certifying examination ( $p<0.001$ ) |

## Section 2.4 Summary

This systematic review and meta-analysis provided a review of what is already known about the relationship between protected characteristics and attrition and performance in surgical training around the world. The overall pooled attrition rate was 17% across all studies with women having a significantly higher rate than men. Some studies reported a higher attrition for Hispanic residents compared to non-Hispanic residents. There was no increased risk of attrition with age, marital or parental status. The full discussion of the findings is provided in Chapter 7.

The majority of the studies included in the review are from the US and there is a lack of data from the UK. On conducting this review, it became apparent that there was a gap in the literature for contemporary quantitative studies looking at the impact of protected characteristics in Higher Surgical Training in the UK. Using this information Chapters 4, 5 and 6 aim to address this lack of knowledge using quantitative methods.

## **Chapter 3 The Impact of COVID-19 on Surgical Training: A Systematic Review**

### **Section 3.1 Introduction**

In Chapter 1, Section 1.7, the emergence of coronavirus (COVID-19) is described, it continues to have a worldwide impact. As of writing, there have been approximately 180 million cases and over three million deaths reported [121], with some countries still reporting increasing numbers of cases. Countries around the world have seen different peaks and waves of the pandemic, at time of writing the UK is currently easing restrictions following the second wave of COVID-19. However, even as things start to improve and the number of hospitalised cases fall in the UK, the pandemic will have persistent and long-term effects for surgical trainees. This global health crisis has placed huge demand on healthcare systems and the prioritisation of surgical services has shifted. Non-urgent elective surgical cases have been cancelled [79 122], outpatient clinics have dramatically reduced [123] and there has been a reduction in the number of patients presenting as an emergency [124]. Examinations, courses and conferences have been postponed on an international basis across specialities [125 126]. The reprioritisation of health services, redeployment of staff to COVID-19 wards and decrease in operative volumes may have a significant impact on surgical training and the mental wellbeing of surgical trainees.

Whilst all specialty training has been affected it is perhaps craft specialties which have been most affected, with the lack of procedural training opportunities. Only the most urgent elective cases have been performed and conservative management is increasingly being recommended for some emergency presentations such as appendicitis [127]. Furthermore, in order to minimise operative time and the risk of COVID-19 transmission intraoperatively, senior surgeons are now performing more of the emergency cases and training opportunities are further reduced [128]. This has resulted in decreased operative activity for trainees across all surgical specialities in the UK [129].

Moving forward, there is a need to quantify the scale of disruption to surgical training in order to mitigate the adverse effects of lost training opportunities and deficiencies in experience.

### 3.1.1 Aim

The aim of this systematic review is to describe the impact of COVID-19 on surgical training globally.

## Section 3.2 Method

### 3.2.1 Protocol Registration

This systematic review was performed in line with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) [96]. The protocol is available on the Open Science Framework (OFS) at

[https://osf.io/xz5h8/?view\\_only=d2f52ec92c464029ad0cdea5028f547c](https://osf.io/xz5h8/?view_only=d2f52ec92c464029ad0cdea5028f547c)

(Appendix 4).

### 3.2.2 Eligibility Criteria

The review sought to identify papers evaluating the impact of COVID-19 on surgical training worldwide. All surgical specialities were included. All types of published research articles were included with no restrictions on the language of or date of publication.

### 3.2.3 Exclusion Criteria

3. Letters, correspondence and editorial reviews were not included.
4. Obstetrics and Gynaecology was not considered a surgical specialty for the purpose of this review.

### 3.2.4 Information sources, search and study selection

MEDLINE Ovid, Embase Ovid, PubMed and the Cochrane Central Register of Controlled Trials (CENTRAL) were searched electronically up to 26<sup>th</sup> June 2020 using a mixture of keywords and MeSH terms (Figure 3.1). The reference lists of included studies were searched for further eligible studies.

The title and abstract screening was performed by two review authors independently and in duplicate. Potentially eligible studies were evaluated in full text to identify studies meeting the inclusion criteria. A third reviewer opinion was sought in the event of disagreement.

Figure 3.1. Medline search strategy

1. SARS-Cov2.mp. [mp=ti, ab, hw, tn, ot, dm, mf, dv, kw, fx, dq, nm, kf, ox, px, rx, an, ui, sy]
2. coronavirus.mp. or Coronavirinae/
3. pandemic/ or covid-19.mp.
4. covid.mp.
5. 'surgical training'.mp. or surgical training/
6. 'surgeons in training'.mp. or residency education/ or surgical training/
7. 'surgical trainee'.mp. or surgical training/
8. 'surgical training programme'.mp.
9. surgical resident.mp. or resident/
10. 'resident in training'.mp.
11. postgraduate.mp. [mp=ti, ab, hw, tn, ot, dm, mf, dv, kw, fx, dq, nm, kf, ox, px, rx, ui, sy]
12. training progression.mp. [mp=ti, ab, hw, tn, ot, dm, mf, dv, kw, fx, dq, nm, kf, ox, px, rx, ui, sy]
13. assessment.mp. [mp=ti, ab, hw, tn, ot, dm, mf, dv, kw, fx, dq, nm, kf, ox, px, rx, ui, sy]
14. 1 or 2 or 3 or 4
15. 5 or 6 or 7 or 8 or 9 or 10
16. training.mp. [mp=ti, ab, hw, tn, ot, dm, mf, dv, kw, fx, dq, nm, kf, ox, px, rx, ui, sy]
17. 11 or 12 or 13 or 16

18. 14 and 15 and 17

### 3.2.5 Data collection process

The data was extracted from the studies using a pre-designed proforma, independently and in duplicate. Study authors were contacted if further information was required for the included studies. The primary outcome measure was the impact on surgical training. Impact could be measured in terms of operative cases, changes to patient contact, redeployment, extension to training or trainee views on changes to training quality. Country of origin, study size, surgical specialty, methodology and outcomes were recorded.

### 3.2.6 Risk of bias in individual studies

Methodology checklists for both cohort and case control studies were reviewed, and used to critically appraise and grade the evidence of included studies. Quality was assessed using the Newcastle-Ottawa scale [97].

### 3.2.7 Synthesis of results

The results section was divided into themes arising from the studies: operative impact, non-operative impact, redeployment, educational/academic impact and personal impact. A meta-analysis was not performed due to heterogeneity in study design and differences in training specialty and training system.

## Section 3.3 Results

### 3.3.1 Study selection

The searches identified 292 articles (Figure 3.2). The main reason for exclusion on title and abstract screening was wrong outcome or wrong population. Twenty nine studies met the inclusion criteria after full text review (Table 3.1). These studies included data from 5260 trainees and 339 programme directors. Thirteen of the studies were from the US, six were from European countries, one from South America, one from Pakistan, one from India, and seven included data from multiple countries. Twenty six of the studies were surveys including 5 national surveys across 8 surgical specialties. The survey responses by trainees across different specialties and countries reflect a negative impact of COVID-19 on surgical training. High proportions of trainees felt that the pandemic had adversely affected training [130-132]. The findings are presented by themes emerging from the included studies.

Figure 3.2. PRISMA flow diagram

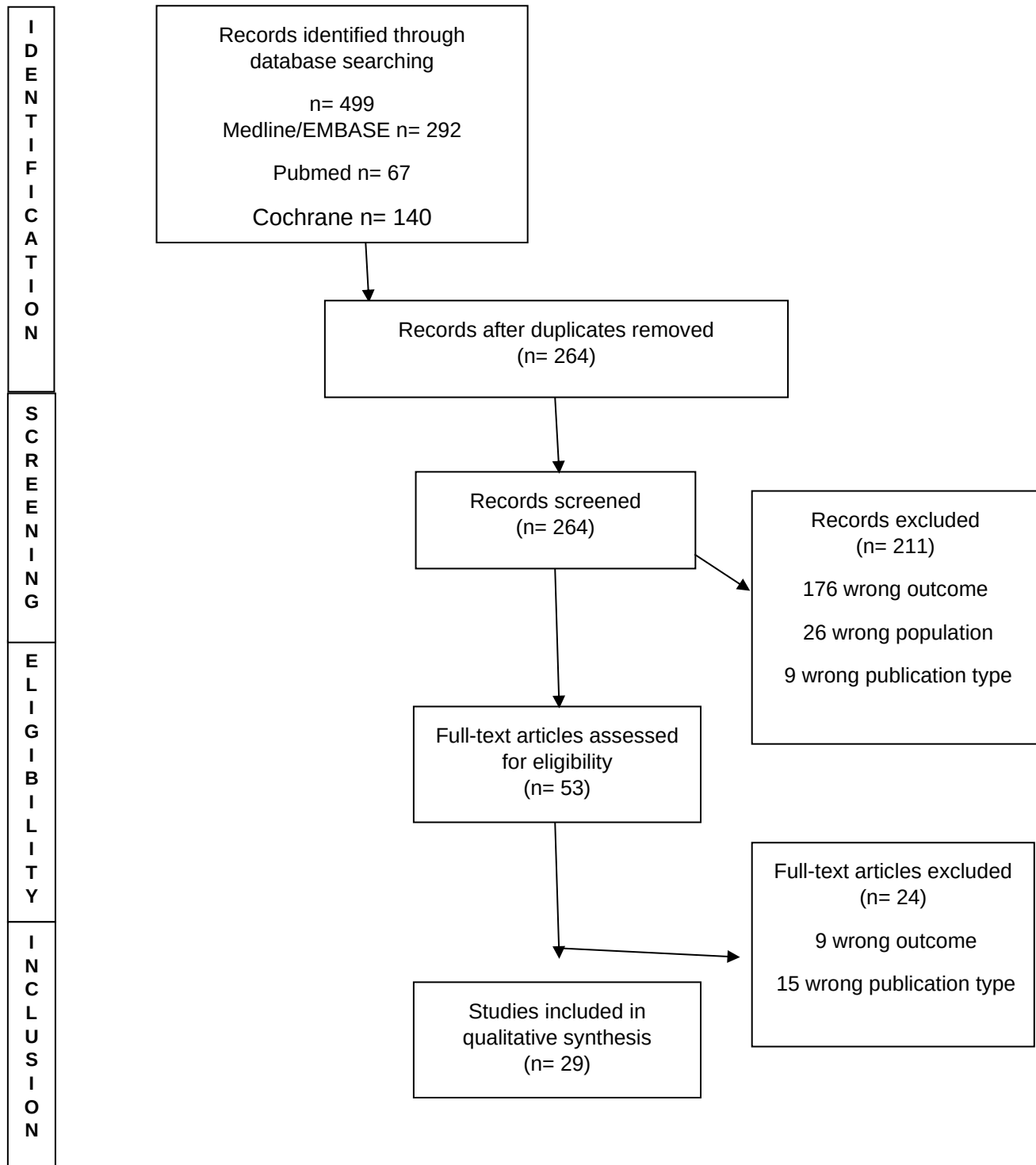


Table 3.1. Summary of all included studies

| Author     | Country                                          | Size | Speciality      | Method                 | Response rate | Clinical activity impact                                                                                                                                                                                                                                                                                                                                                                                                        |
|------------|--------------------------------------------------|------|-----------------|------------------------|---------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Abdessater | France                                           | 275  | Urology         | National survey        | 55.5%         | 85.5% felt the quality of their work had been affected.<br>91.6% reported feeling stressed.<br>Risk factors for stress were past medical history (OR 2.57, 95% CI 1.31-5.98) and COVID-19 patients management (OR 1.85, 95% CI 0.98-3.59)                                                                                                                                                                                       |
| Alhaj      | Canada, USA, Kuwait, Saudi Arabia, Serbia, Italy | 52   | Neurosurgery    | Cross sectional survey | 98.1%         | 98% felt training was affected.<br>90% felt mental health was affected.<br>100% reported their social life was affected.                                                                                                                                                                                                                                                                                                        |
| Amparore   | Italy                                            | 351  | Urology         | National survey        | 60.8%         | 7.7% involved on COVID-19 wards.<br>41.4% reduction in on call duties, 74.1% reduction in diagnostic procedures, 62.1% reduction in endoscopic surgery, 57.8% in open surgery and 44.2% for minimally invasive surgery.<br>For final year trainees, reduction from 84-44% of minimally invasive ops (p<0.001) and 82 to 44% (p=0.002) of major surgery.<br>85.2% reported at least 2 hours per day for smart learning purposes. |
| An         | USA                                              | 121  | Orthopaedics    | Survey                 | 82%           | 1 out of 5 centres had redeployed trainees to support patients with COVID-19.<br>3 out of 5 residency programmes withdrew trainees from all outpatient activity.<br>20% using mental health resources to support wellbeing.<br>Educational activity has continued via video-conferencing.                                                                                                                                       |
| Aziz       | USA                                              | 1102 | General surgery | Survey                 | Not reported  | 77% reported daily rounds and floor duties were delegated to other members of staff.<br>40.6% reported that they were not allowed in the operating room for cases considered high risk of COVID-19 transmission.<br>Significant decrease in the number of operative cases per week.<br>80.67% attended no outpatient clinic activity during the pandemic.                                                                       |

|           |              |                                    |                                |                           |              |                                                                                                                                                                                                                                                                                                                             |
|-----------|--------------|------------------------------------|--------------------------------|---------------------------|--------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|           |              |                                    |                                |                           |              | 80.6% reported all teaching was provided by online platforms.<br>33.1% reported more burnout than pre-COVID pandemic.                                                                                                                                                                                                       |
| Bernardi  | Italy        | 3                                  | General surgery                | Operative log book review | N/a          | Number of interventions performed significantly decreased (36.2 vs 14.0, p=0.033).<br>Mean number of surgeries as first operator decreased from 11.8 ± 7.9 to 4.5 ± 5.8 (p=0.099)<br>Non-significant trend towards decreased participation in all surgeries.<br>Education provided via webinars and other online platforms. |
| Brar      | USA          | 33 programme directors             | Oral and maxillofacial surgery | Survey                    | 35%          | All programmes had suspended elective and non-urgent operations.<br>40% reported using telemedicine.<br>73% reported resources for resident wellness and stress reduction.<br>Education continued on digital platforms.                                                                                                     |
| Burks     | USA          | 1 programme                        | Neurosurgery                   | Operative case review     | n/a          | Operative case totals were lower at all levels of training.<br>Significant decrease in cases compared to year before (p<0.01).                                                                                                                                                                                              |
| Collins   | USA          | 73                                 | General and plastic surgery    | Survey                    | 73.7%        | 90% expressed concern about decline in operative exposure.<br>Estimated reduction in operative volume of 63.3%.<br>Residents were more concerned about the health of loved ones as opposed to their own risk of contracting COVID-19 (p<0.01).                                                                              |
| English   | UK           | 3                                  | General surgery                | Operative log book review | N/a          | Operative training continued in emergency cases.<br>Change to more open compared to laparoscopic procedures.                                                                                                                                                                                                                |
| Fero      | USA          | 64 programme leaders, 106 trainees | Urology                        | Cross sectional survey    | 20%          | 20% redeployed.<br>Decreased surgical volume 83-100%.<br>79% perceive negative impact on training.<br>Increase use of telehealth (99%), decrease size of inpatient trainee teams (90%).<br>Transition to virtual learning.                                                                                                  |
| Ferrara   | 32 countries | 504                                | Ophthalmology                  | Survey                    | Not reported | 55.2% of trainees felt the pandemic had had a severe impact on training.<br>76.4% reported more than a 50% reduction in clinical activity.<br>67.7% attended web-based teaching.                                                                                                                                            |
| Figuerola | Chile        | 100                                | Orthopaedics                   | Survey                    | 90.9%        | 86% using online educational tools.<br>13% reported lack of practical education was a problem with online learning.                                                                                                                                                                                                         |

|         |              |                                       |                      |                                |              |                                                                                                                                                                                                                                                                                                                                                                                                            |
|---------|--------------|---------------------------------------|----------------------|--------------------------------|--------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|         |              |                                       |                      |                                |              | 30% felt all non-practical education should be performed using online tools.                                                                                                                                                                                                                                                                                                                               |
| Givi    | USA          | 31 trainees<br>37 programme directors | Otolaryngology       | Survey<br>Operative log review | Not reported | 70% of program directors reported a 50-90% reduction in elective cases, but 81% stated fellows continued to participate in oncology cases.<br>86% of fellow-led clinics cancelled<br>Operative log comparison was similar to pre-COVID-19 times.<br>82% of fellows have met the requisite number of operative cases for certification.<br>97% reported weekly participation in virtual tumour board series |
| Guo     | USA          | 175                                   | Otolaryngology       | Survey                         | 83%          | 98.3% reported a decrease in clinical activities.<br>68% expressed concern in the ability to receive adequate surgical training.<br>54.7% of senior trainees felt the pandemic had had a negative impact on future job prospects.                                                                                                                                                                          |
| Huntley | USA          | 161 trainees, 13 programme directors  | Oral & maxillofacial | Survey                         | 83%          | 14% redeployed.<br>96.5% reported modifications to training programme.<br>66% not concerned with meeting graduate requirements. Greatest concern was for trainees scheduled to graduate in 2022 (60%).<br>88.8% felt operative experience been affected, with mean decrease in operative experience of 67%.<br>97.7% stated elective cases stopped altogether.<br>94.2% stated move to virtual didactics.  |
| Kapila  | 10 countries | 86                                    | Plastic surgery      | Survey                         | Not reported | 85% of all trainees felt their training had suffered.<br>Decreased surgical activity was reported by 86% of Belgian trainees and 73% of international trainees.<br>46% of Belgian trainees redeployed compared to 27% of international trainees.<br>Anxiety regarding own health and that of loved ones was reported by 54% of Belgian and 69% of international trainees.                                  |
| Khusid  | USA          | 332                                   | Urology              | National survey                | 20%          | 22% redeployed.<br>Factors significantly associated with concerns over future operative autonomy were ability to reach case requirements, cancellation of elective cases and PGY4 trainees.<br>Risk factors for depression were local COVID-19 severity, personal history of COVID-19 infection and concerns over operative autonomy.                                                                      |

|                |                       |                          |                                              |        |              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|----------------|-----------------------|--------------------------|----------------------------------------------|--------|--------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Mishra         | India                 | 716                      | Ophthalmology                                | Survey | Not reported | 24.6% redeployed.<br>80.7% felt training negatively impacted.<br>75.7% thought online teaching was useful.<br>54.8% reported higher levels of stress, 46.5% felt 'unhappy'.                                                                                                                                                                                                                                                                                                                                                                                             |
| Munjal         | 22 countries          | 66 residents, 30 faculty | Otolaryngology and paediatric otolaryngology | Survey | Not reported | 91.7% reported all elective cases had been cancelled.<br>86.4% felt all levels of residents were affected equally.<br>87.5% reported that no supplementary operative education is being provided.<br>41.7% reported that all teaching seminars are virtual.                                                                                                                                                                                                                                                                                                             |
| Osama          | Pakistan              | 112                      | All surgical specialties                     | Survey | Not reported | 86.6% felt hands-on experience has been adversely affected.<br>82.1% reported clinical exposure has been affected.<br>61% were concerned about transmitting the virus to loved ones.<br>Significant reduction in working hours per week ( $p<0.001$ ).<br>Burnout was significantly reduced compared to pre pandemic ( $p<0.001$ ).                                                                                                                                                                                                                                     |
| Paesano        | Latin America Spain   | 148                      | Urology                                      | Survey | 100%         | 15% said urology activity completely ceased and staff redeployed 82% said activity of urology department significantly reduced.<br>75% said surgical training has been completely affected.<br>65% felt academic raining has been partially or completed affected.                                                                                                                                                                                                                                                                                                      |
| Megaloikonomos | 23 European countries | 327                      | Orthopaedics                                 | Survey |              | 58.6% felt surgical training was significantly impaired.<br>58.2% were concerned about meeting annual training goals.<br>In 57.1% of institutions only essential activities were performed.<br>20.9% redeployed.                                                                                                                                                                                                                                                                                                                                                        |
| Pelargos       | USA Canada            | 197                      | Neurosurgery                                 | Survey | Not reported | 35.1% providing non-specialty care to COVID-19 patients.<br>82% inpatient and outpatient volumes reduced<br>91% reported work responsibility had decreased, with significant decrease in work hours ( $p<0.001$ ).<br>33.7% concerned would negatively affect residency education, with senior trainees more likely to be concerned $p=0.028$ .<br>8.2% concerned would affect overall case numbers.<br>26.5% concerned limit ability to get desired employment or fellowship.<br>Significant increase in number of trainees spending >4hours on didactics $p<0.0001$ . |

|            |       |                              |                 |                 |       |                                                                                                                                                                                                                                                                                                                |
|------------|-------|------------------------------|-----------------|-----------------|-------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Rosen      | USA   | 65<br>programme<br>directors | Urology         | Survey          | 45%   | 26% redeployment.<br>60% programmes report concern trainees will not meet case minimums.<br>Reduction of trainee presence reported by 92% of programs.<br>Significant decrease in patient-contact time (4.7 to 2.1days/week, $p<0.001$ )<br>48% of programmes reported education had been negatively impacted. |
| White      | USA   | 84<br>programme<br>directors | General surgery | Survey          | 33.6% | 44% reported attendings were operating without resident presence.<br>All programmes reduced the number of residents on rounds.<br>90.5% reported the use of telehealth clinics.<br>86.9% reported resident teaching moved online.<br>8.3% reported redeployment.                                               |
| Zheng      | USA   | 24                           | General surgery | Survey          | 61.5% | The biggest concern amongst chief residents was the potential delay in board examinations.<br>93.3% of attending surgeons suggested a personalised approach for additional training.                                                                                                                           |
| Zingaretti | Italy | 115                          | Plastic surgery | National survey | 72%   | Majority feel lack of training is detrimental to professional growth.<br>The majority were using webinars to keep knowledge updated.                                                                                                                                                                           |
| Zoia       | Italy | 192                          | Neurosurgery    | Survey          | 58%   | 72.4% reported reduced time in neurosurgical department.<br>78.6% performed less operations, 16.1% performed no operations.<br>Production of scientific papers or research projects increased in 55.7% of cases.                                                                                               |

### 3.3.2 Operative impact

All of the included studies reported a decrease in the number of operative cases or operative experience available to trainees. The operative logs of three General Surgery trainees before and during the COVID-19 pandemic in Italy were compared [133]. There was a significant decrease in the total number of operative cases performed by trainees ( $p=0.033$ ). It was noted that this particularly affected 'medium-complexity' operations which would generally be performed by the trainees as first operator. This decrease was explained by the cessation of benign surgical activity and decreases in the number of emergency admissions. A national survey of 351 Italian Urology trainees found substantial reductions in trainee exposure to surgical training opportunities [134]. A reduction in diagnostic procedures was reported by 74.1% of respondents: 62.1% in endoscopic surgery, 57.8% in open surgery and 44.2% in minimally invasive surgery. In the United States, 106 Urology trainees included in a cross-sectional survey also reported a decrease in surgical volume dependent upon the local prevalence of COVID-19 [131], with 76% of those working in a high COVID-19 area reporting decreased surgical volume compared to 22% in low COVID-19 area ( $p=0.01$ ).

According to 70% (26/37) of head and neck program directors across the United States, there was a 50-90% reduction in elective cases performed by fellows, however 81% reported that fellows continued to participate in oncological cases [135]. Impact was minimised as 82% (25/31) of fellows had already met the operative requirements for

certification by the onset of the pandemic. In a cross sectional survey of 161 Oral and Maxillofacial Surgery (OMFS) trainees in the United States, 97.7% reported that all elective cases had ceased and 83.6% reported that the scheduling of urgent and emergency cases had been affected [136]. Eighty eight percent stated that their operative experience had been affected with an average perceived decrease in experience of 67% [136]. Two studies investigating the impact of COVID-19 on Neurosurgical training found a decrease in the volume of operative cases [137 138]. An Italian study of 192 Neurosurgery trainees reported that 78.6% had performed fewer operations than before the pandemic and 16.1% had not performed any operations at all [137]. Similarly, 99.5% of 197 Neurosurgical trainees across the United States and Canada reported that the number of operations performed at their institution had decreased.

The reduction in surgical cases has caused concerns amongst trainees and program directors; a common theme was the inability to meet case number targets. Sixty percent of Urology program directors in the United States were concerned that trainees will not meet minimum case requirements due to the pandemic [139]. Echoing this, the main concern expressed by 148 Urology trainees throughout Latin America and Spain was the impact of the health crisis on their surgical learning curve, with all stating that their operative activity had been at least partially affected [140]. Amongst Neurosurgery trainees across the United States and Canada, 8.2% (16/197) were concerned that their overall requisite case numbers would be impacted by the pandemic

[138]. Khusid et al. investigated factors associated with concerns over operative autonomy [141]. This was defined as concerns over the ability to operate independently as an attending urologist due to interruptions in training caused by COVID-19. Worries around the ability to reach case number requirements, cancellation of elective cases and higher level of training were risk factors for increased operative autonomy concern after the pandemic [141].

Some studies suggested different experiences for trainees at different stages in training. In a national survey of Urology trainees in Italy, final year trainees were significantly more likely to report complete suppression of activities ( $p=0.003$ ) and reduction in minimally invasive surgery ( $p=0.002$ ) [134]. Amongst OMFS trainees 66% were not concerned with meeting graduation requirements, however 60% of senior trainees due to graduate in the next few years expressed concern regarding this [136].

### 3.3.3 Redeployment, non-operative impact and change to working patterns

Redeployment rates were variable across studies, ranging from 35.1% [138] to 6% [140]. Redeployment was defined as providing non-surgical care to patients or being transferred to a non-surgical specialty. The highest rate was reported by Pelargos et al with 35.1% (69/197) of Neurosurgery trainees across the United States and Canada providing non-specialty support to patients with COVID-19 [138]. The lowest rate

was 6%, reported amongst 148 Urology trainees across 18 countries [140]. No studies reported that no trainees had been redeployed.

Some studies reported restructuring of the trainee rotas to incorporate altered working patterns. All five of the Orthopaedic training programmes in the United States surveyed by An et al. had restructured rotas to include periods of clinical duty followed by remote work and self-isolation [142]. Three studies reported a reduction in trainee presence within the hospital [137-139]. Ninety two percent (60/65) of United States Urology programs reported a formal reduction of trainee presence, with a significant decrease in patient-contact time from an average of 4.7 days per week to 2.1 ( $p<0.001$ ) [139]. Pelargos et al. reported similar findings with a significant reduction in working hours with 97.9% (193/197) of Neurosurgery trainees working over 60 hours per week prior to the pandemic and only 34% doing the same after the pandemic began [138]. The majority of Neurosurgery trainees (139/192) across Italy reported a decrease in the time they spent within the neurosurgical department, part of the strategy to reduce trainee exposure to COVID-19 [137].

Trainee involvement in outpatient activity has reduced according to many studies. In the United States, three out of five Orthopaedic programmes removed trainees from all outpatient activity [142] and 86% of fellow-led head and neck clinics were cancelled during the pandemic [135]. However, remote clinical work continued to be performed by trainees in some studies [131 139 140]. Fifty one percent of Urology trainees (54/106) based in the United States reported that

they had continued to participate in in-person clinical encounters and 65% were still participating in telehealth consultations [131]. Remote clinical work was being performed by trainees in 77% (50/65) of Urology programs according to surveyed program directors in the United States [139].

### 3.3.4 Educational/academic

Due to the decrease in clinical activity, the time for educational and academic pursuits increased. Across countries and specialities, the majority of studies reported there was a move towards online educational tools. Journal clubs, conferences and webinars were provided via virtual platforms. The proportion of those reporting a change to online education ranged from 86% [143] to 98.5% [138]. Amongst Italian General Surgery trainees, the educational programme was shifted to an online system, with weekly journal club and twice weekly webinars [133].

The perception of online teaching varied. In a survey of Orthopaedic trainees in Chile, 82% (82/100) viewed the new resources positively and stated that they would continue attending webinars after the pandemic [143]. Almost all (194/197) of surveyed Neurosurgery trainees in the United States and Canada reported that their teaching programme had been converted to an online platform with a significantly greater proportion spending more than four hours weekly on online learning resources than before the pandemic [138]. However, these were only received favourably by 64.6%. Paesano et al. reported

that 65% (96/148) of Urology trainees across Latin America and Spain felt that theoretical training has been negatively affected, this is despite 93% accessing online learning tools [140]. Similarly, Rosen et al. found that 48% (31/65) of Urology programme directors in the United States reported that teaching had been negatively impacted by COVID-19 despite all surveyed programs using video-conferencing [139].

Seven studies reported that trainees now had more time to devote to educational or academic activities [131-134 137 138 144]. Three studies found that the time dedicated to research had improved [131 133 139] and 55.7% (107/192) of Neurosurgical trainees across Italy reported increased productivity of scientific papers [137].

### 3.3.5 Wellbeing

Aside from the changes to clinical activity and working pattern, COVID-19 has had an impact on the wellbeing of surgical trainees. Over 90% of French Urology trainees reported feeling more stressed than before the pandemic [145]. Factors significantly associated with stress were the presence of COVID-19 positive patients in the department (OR 2.39, 95% CI 1.30-4.39), working in a high epidemic location (OR 1.71, 95% CI 1.06-2.78) and being a more senior trainee (OR 1.76, 95% CI 1.05-2.97). More than half of surveyed Ophthalmology trainees (393/716) across India also reported an increase in stress levels and 46.5% described feeling 'unhappy' during the lockdown period [130]. Negative impacts on mental health were reported amongst Neurosurgery trainees worldwide [144] and 20% of orthopaedic

trainees across five training programmes in the United States were using mental health resources to support their well-being during the pandemic [142]. Khusid et al reported that performing a greater number of operations per week before the pandemic was associated with higher depression severity amongst Urology trainees in the United States [146].

Three studies reported that working throughout the pandemic had had an impact on life outside the hospital [131 138 144]. A third (62/197) of Neurosurgery trainees across the United States and Canada reported that working during the pandemic had a negative impact on their interpersonal relationships [138], 54% of Urology trainees felt that the pandemic had caused home-life disruption and 39% had increased worries regarding finances [131]. All of the 52 Neurosurgery trainees participating in an international survey reported that their social life had been affected by the pandemic [144].

Two studies reported trainee views on obtaining employment after the end of their current rotation. Neurosurgical trainees in the United States and Canada were concerned about the change to educational experience and career prospects due to the pandemic, with 26.5% (52/197) expressing concerns over the ability to obtain employment or fellowship of their choice due to COVID-19 restrictions [138]. Amongst 51 ENT fellows in the United States, 57% had secured a post fellowship appointment while 10% stated that this was now in question or on hold due to COVID-19 [135].

### Section 3.4 Summary

The COVID-19 pandemic resulted in a disruption to this thesis. Due to redeployment and staff restructuring, research fellows including myself re-entered full time clinical practice. The idea for this study came about due to personal experiences of reduced operative exposure, clinical opportunities and academic activity experienced during the pandemic. This was the first systematic review looking at the impact of COVID-19 on surgical training worldwide. The main findings from the review were negative impacts on the operative and non-operative clinical opportunities for trainees, with a knock-on effect on mental health and wellbeing. These findings were echoed across all surgical specialities and across all countries included in the review. The full discussion can be found in Chapter 7.

## **Chapter 4 Personal Characteristics Associated with Progression in General Surgical Specialty Training: A Cohort Study**

### **Section 4.1 Introduction**

The surgical workforce is increasingly diverse. It benefits from, and relies upon, graduates from many different countries and backgrounds. In recent years, the demographic of surgical trainees has changed, with more women and non-UK trained graduates entering the specialty (Chapter 1, Section 1.5).

The proportion of female consultant surgeons in the UK remains low (Table 1.2). This is echoed worldwide, where surgery is dominated by men [147 148] and those from more affluent socioeconomic backgrounds [63]. Globally, women in surgery are underrepresented and this has been highlighted in the world media with campaigns such as #ILookLikeASurgeon [149] and the “New Yorker Cover Challenge” [150]. In the UK and Australia males make up 88% of consultant surgeons [62 151], and 80% of US surgeons are male [152]; this is despite the fact that women now outnumber men at medical school in the UK and the United States [153 154]. However, the number of females training in surgery is increasing; over a third of UK and US surgeons in training are women [14 95], which, with time, will substantially increase the proportion of female consultant surgeons [155]. In 2017, 10.7% of UK doctors in training across all specialities were working less than full time [57]. The majority of less than full time

trainees are female [60], therefore it is reasonable to assume that with an increasingly female workforce, the proportion of surgical trainees that intend to work less than full time may increase.

The UK Equality Act (2010) and protected characteristics (age, sex, disability, gender reassignment, marriage, pregnancy, race, religion or sexual orientation) have been previously discussed [34] (Chapter 1, Section 1.4). The impact of differential attainment on postgraduate medical outcomes has been of interest for many years, however, this has not been studied in General Surgical training. In order to retain a highly skilled workforce within surgery, it is essential to ensure fair and equal assessment of progression for all, regardless of protected characteristics or working pattern. This is the first study to assess the impact of demographic and training specific factors on trainee progression through Annual Review of Competence Progression (ARCP) panels in General Surgical Specialty training in the United Kingdom.

#### 4.1.1 Aims

To identify demographic factors, including protected characteristics, and training specific factors which predict a non-standard Annual Review of Competency Progression (ARCP) outcome during General Surgical specialty training in the UK.

## Section 4.2                      Method

### 4.2.1 Data source

This is a cohort study using anonymised data provided by the UK Medical Education Database (UKMED), described in Chapter 1, Section 1.8. Approval for the study was granted by the UKMED board (Appendix 5). Ethical approval is not required for these studies (Appendix 2). The data in UKMED links with information held by the GMC, with ARCP outcomes and demographic information available for each graduate. The ARCP process was introduced in 2007, however within UKMED ARCP outcomes are only collected from 2010 onwards hence any outcomes prior to this were not available. The UKMED data can be modelled to assess the relationship between predictors of success and progression throughout surgical training.

### 4.2.2 Outcome measure

The outcome measure in this study was ARCP outcome. The Annual Review of Competency Progression (ARCP) is the way in which doctors are reviewed to ensure they meet standards of safe patient care and are progressing adequately in their training [20]. Successful progression onto the next stage of training is dependent on the trainee meeting a number of speciality specific targets such as requisite number of workplace based assessments, attendance at relevant courses and operative logbook experience. Possible ARCP outcomes are summarised in Table 1.3 (Page 27). ARCP outcomes were coded into an ordinal scale following the method developed by Tiffin et al [70]:

- Group 1: “Satisfactory progress/training completed”: ARCP outcomes 1, 6, and 7.1
- Group 2: “Insufficient evidence presented”: ARCP outcome 5
- Group 3: “Targeted training required (no extended time)”: ARCP outcome 2 and 7.2
- Group 4: “Extended training time required/left programme”: ARCP outcome 3 or 4

Any ARCP outcomes coded as ‘Out of Programme’ (outcome 8) were removed. Outcomes 7.1 and 7.2 only applied to fixed term posts (not training posts), therefore were not included in the analysis.

#### 4.2.3 Cohort derivation

The cohort of interest is General Surgery trainees in specialty training (ST3-ST8), with an ARCP outcome recorded between 2010 and 2017. All of the ARCP outcomes associated with General Surgery were selected. In the event of more than one ARCP outcome within 12 months, the first chronological outcome was used. This allows us to consider ARCP outcomes as independent of each other and therefore accounts for the fact people enter and leave the cohort at different time points.

#### 4.2.4 Predictor variable selection

Variables were selected to include a mixture of demographic, socioeconomic and training specific factors. Age at ARCP was the only continuous variable. Region of primary medical qualification was categorised into UK, European Economic Area (EEA) and International Medical Graduates (IMG). Geographical location of training was characterised into home nation and thence divided into Health Education England (HEE) region within England [156]. In the case of pre-medicine socioeconomic status, multiple variables existed within the dataset. However, there were no measures of pre-medicine socioeconomic status for non-UK graduates and there was a high proportion of missing data. Of the available measures the Index of Multiple Deprivation (IMD) was selected. IMD is a standardised system that characterises areas by social deprivation, which is calculated by taking into account multiple factors such as income and employment

domains. The score is calculated differently for each of the UK countries [157]. The score ranks each small area within England, Northern Ireland, Scotland or Wales, from least deprived (1) to most deprived (5). Full details can be found in the UKMED data dictionary [74]. The postcode on application to medical school is used to calculate the score, hence only values for UK graduates are available. Therefore, a non-UK category was added to account for EEA and IMG and a missing category- which accounted for missing data from UK graduates only.

#### 4.2.5 Missing data

Missing data was coded as a separate category within each variable, to avoid reducing the sample size in the regression model. Missing data per each category is listed in Table 4.2. Some of the missing data was due to the measurement of certain variables being UK specific and therefore not present for non-UK graduates. It was not possible to look at other protected characteristics available within UKMED (religion and sexual orientation), as data on these were only collected from 2016 and so were missing from over 85% of the whole cohort of interest.

#### 4.2.6 Statistical analysis

Descriptive statistics were performed to describe the satisfactory and non-standard cohorts. Variables of interest were tabulated to ensure sufficient numbers of trainees per category. Data was rounded to ensure anonymity as per guidance from the Higher Education Statistics Agency [158]. A multilevel mixed-effects ordinal regression was

performed with individual trainees as the first level and training region as the second level to obtain unadjusted odds ratios. Geographical location of training was characterised into home nation and thence divided into Health Education England (HEE) region within England [156]. Odds ratios and 95% confidence intervals were reported, controlled for clustering by region of training. To obtain p values Wald's test was used for binary variables and likelihood ratio tests for categorical variables.

Age at ARCP and sex were considered *a priori* confounders. A multiple multilevel mixed-effects ordinal regression was performed including age at ARCP, sex and the significant variables from the univariate analysis (place of medical qualification, less than full time training, academic training, military training and index of multiple deprivation). The regression was performed in a backward stepwise manner. All interaction terms were checked at each stage of the model. P values <0.05 were taken as significant. All analyses were performed using STATA version 15 (StataCorp LLC, College Station, TX, USA) [159].

## Section 4.3                      Results

### 4.3.1 Cohort demographics

The analysis included 2730 trainees in higher General Surgical training, comprising 10,135 ARCP outcomes. Sixty eight percent were male. The median age at ARCP was 36 years (IQR 28-56). The majority of trainees (77%) had attended a UK medical school. Twenty eight percent of trainees were awarded a non-standard outcome at any point in training. Table 4.1 summarises the number of ARCP outcomes by demography and characteristics. Between 2010 and 2017 0.70% of trainees were released from programme (ARCP Outcome 4), representing 2.5% of all non-standard outcomes.

Table 4.1. Demography and protected characteristics by ARCP Outcome.

|                                                  | <b>Group 1</b><br><b>Satisfactory</b><br><b>outcome</b><br><b>N=7859 (77%)</b> | <b>Group 2</b><br><b>Insufficient</b><br><b>evidence</b><br><b>N=1005 (10%)</b> | <b>Group 3</b><br><b>Targeted time</b><br><b>training</b><br><b>N=710 (7%)</b> | <b>Group 4</b><br><b>Extended</b><br><b>training time/left</b><br><b>programme</b><br><b>N=562 (6%)</b> |
|--------------------------------------------------|--------------------------------------------------------------------------------|---------------------------------------------------------------------------------|--------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------|
| <b>Male: Female</b>                              | 5325: 2540 (68%)                                                               | 726: 280 (72%)                                                                  | 500: 210 (70%)                                                                 | 380: 180 (68%)                                                                                          |
| <b>Age at ARCP*</b>                              | 36 (28-51)                                                                     | 36 (28-47)                                                                      | 36 (29-48)                                                                     | 38 (30-56)                                                                                              |
| <b>Place of Primary</b><br><b>Medical Degree</b> |                                                                                |                                                                                 |                                                                                |                                                                                                         |
| UK                                               | 6350 (81%)                                                                     | 800 (80%)                                                                       | 580 (81%)                                                                      | 415 (74%)                                                                                               |
| EEA                                              | 205 (3%)                                                                       | 35 (3%)                                                                         | 20 (3%)                                                                        | 20 (3%)                                                                                                 |
| IMG                                              | 1305 (16%)                                                                     | 170 (17%)                                                                       | 110 (16%)                                                                      | 130 (23%)                                                                                               |
| <b>Ethnicity</b>                                 |                                                                                |                                                                                 |                                                                                |                                                                                                         |
| White                                            | 2715 (35%)                                                                     | 435 (43%)                                                                       | 220 (31%)                                                                      | 135 (24%)                                                                                               |
| BME                                              | 1095 (14%)                                                                     | 210 (21%)                                                                       | 155 (22%)                                                                      | 65 (11%)                                                                                                |
| Missing                                          | 4050 (51%)                                                                     | 360 (36%)                                                                       | 335 (47%)                                                                      | 365 (65%)                                                                                               |
| <b>Less than full</b><br><b>time</b>             | 1065 (14%)                                                                     | 105 (10%)                                                                       | 95 (13%)                                                                       | 75 (13%)                                                                                                |
| Yes                                              | 6480 (82%)                                                                     | 900 (89%)                                                                       | 595 (84%)                                                                      | 460 (82%)                                                                                               |
| No                                               | 315 (4%)                                                                       | 5 (1%)                                                                          | 20 (3%)                                                                        | 30 (5%)                                                                                                 |
| Missing                                          |                                                                                |                                                                                 |                                                                                |                                                                                                         |
| <b>Graduate on</b><br><b>entry</b>               | 365 (5%)                                                                       | 50 (5%)                                                                         | 45 (6%)                                                                        | 25 (4%)                                                                                                 |
| Yes                                              | 7495 (95%)                                                                     | 955 (95%)                                                                       | 665 (94%)                                                                      | 535 (96%)                                                                                               |
| No                                               |                                                                                |                                                                                 |                                                                                |                                                                                                         |
| <b>Academic</b><br><b>Trainee</b>                | 345 (4%)                                                                       | 50 (5%)                                                                         | 30 (4%)                                                                        | 20 (3%)                                                                                                 |
| Yes                                              | 7510 (96%)                                                                     | 955 (95%)                                                                       | 685 (96%)                                                                      | 545 (96%)                                                                                               |

|                                      |            |           |           |           |
|--------------------------------------|------------|-----------|-----------|-----------|
| No                                   |            |           |           |           |
| <b>Military Trainee</b>              |            |           |           |           |
| Yes                                  | 110 (2%)   | 25 (3%)   | 5 (1%)    | 10 (2%)   |
| No                                   | 7750 (98%) | 980 (97%) | 705 (99%) | 550 (98%) |
| <b>Index of Multiple Deprivation</b> |            |           |           |           |
| 1 (Least deprived)                   | 1255 (16%) | 215 (21%) | 95 (14%)  | 50 (9%)   |
| 2                                    | 755 (10%)  | 125 (12%) | 80 (11%)  | 35 (6%)   |
| 3                                    | 480 (6%)   | 90 (9%)   | 60 (9%)   | 30 (5%)   |
| 4                                    | 285 (4%)   | 35 (4%)   | 40 (5%)   | 25 (4%)   |
| 5 (Most deprived)                    | 135 (1%)   | †         | 25 (4%)   | †         |
| Non-UK                               | 1510 (19%) | 205 (20%) | 130 (18%) | 145 (26%) |
| Missing                              | 3440 (44%) | 320 (32%) | 275 (39%) | 270 (48%) |

\*Median and interquartile range.

#### 4.3.2 Univariate analysis

Older age at ARCP, non-UK graduates, non-academic and non-military training and IMD had significantly increased risk of a non-standard ARCP outcome in the univariate logistic regression analysis (Table 4.2) after adjustment for clustering by training region. For each year increase in age at ARCP, there was an 8% increased risk of non-standard outcome (OR 1.08 95% CI 1.07-1.10). Non-UK graduates were more likely to receive a non-standard outcome than those who trained in the UK (EEA OR 1.31 95% CI 0.99-1.73, IMG OR 1.13 95% CI 1.00-1.28). Trainees from the most deprived social category had more than 50% increased risk of receiving a non-standard outcome compared to the least deprived (OR 1.54 95% CI 1.11-2.16). Female sex and less than full time training were protective factors in the univariate analysis. Female trainees were 17% less likely to receive a non-standard outcome than males (OR 0.83 95% CI 0.75-0.93). Those who were in less than full time training at the time of ARCP were 4% less likely to receive a non-standard outcome than full time trainees during General Surgical Speciality training (OR 0.96 95% CI 0.77-1.19). Military trainees were 16% less likely to receive a non-standard outcome than non-military trainees (OR 0.84 95% CI 0.49-1.44).

#### 4.3.3 Multivariable analysis

Older age at ARCP and index of multiple deprivation remained significant predictors of a non-standard ARCP outcome in the multivariable logistic regression (Table 4.2). Female sex, military

trainees and less than full time training remained protective factors. Place of medical degree and academic training were no longer significant as a predictor of outcome. For each year increase in age at ARCP, trainees were 13% more likely to receive a non-standard outcome (OR 1.13 95% CI 1.11-1.15). Trainees from the most deprived areas were 49% more likely to receive a non-standard outcome compared to the least deprived (OR 1.49 95% CI 1.06-2.08). Females were 11% less likely to receive a non-standard outcome than males (OR 0.89 95% CI 0.80-0.99). Trainees who worked less than full time were associated with a 15% decreased risk of a non-standard ARCP outcome (OR 0.85 95% CI 0.73-0.99). Military trainees were 10% less likely to receive a non-standard outcome than civilian trainees (OR 0.90 95% CI 0.52-1.54).

Table 4.2. Univariate and multiple multilevel mixed-effects ordinal logistic regression. Level 1-trainee, Level 2 training region. UK- United Kingdom, EEA- European Economic Area (excluding UK), IMG- International Medical Graduate (Rest of world, excludes UK and EEA)

|                                        | Unadjusted OR for non-standard outcome (95% CI) | P value | Adjusted OR* for non-standard outcome (95%CI) | P value |
|----------------------------------------|-------------------------------------------------|---------|-----------------------------------------------|---------|
| <b>Female sex</b>                      | 0.83 (0.75-0.93)                                | 0.001   | 0.89 (0.80-0.99)                              | 0.045   |
| <b>Age at ARCP</b>                     | 1.08 (1.07-1.10)                                | <0.001  | 1.13 (1.11-1.15)                              | <0.001  |
| <b>Place of Primary Medical Degree</b> |                                                 |         |                                               |         |
| UK                                     | 1                                               |         | 1                                             |         |
| EEA                                    | 1.31 (0.99-1.73)                                | 0.039   | 1.38 (0.98-1.95)                              | 0.148   |
| IMG                                    | 1.13 (1.00-1.28)                                |         | 1.10 (0.87-1.40)                              |         |
| <b>Less than full time</b>             |                                                 |         |                                               |         |
| No                                     | 1                                               |         | 1                                             |         |
| Yes                                    | 0.88 (0.76-1.01)                                | <0.001  | 0.85 (0.73-0.99)                              | <0.001  |
| Missing                                | 0.61 (0.45-0.83)                                |         | 0.58 (0.43-0.79)                              |         |
| <b>Graduate at Entry</b>               | 1.09 (0.88-1.36)                                | 0.411   |                                               |         |
| <b>Academic Trainee</b>                |                                                 |         |                                               |         |
| No                                     | 1                                               |         | 1                                             |         |
| Yes                                    | 0.96 (0.77-1.19)                                | 0.045   | 0.90 (0.73-1.13)                              | 0.366   |
| Missing                                | 0.88 (0.80-0.97)                                |         | 0.54 (0.45-0.64)                              |         |

|                                      |                  |        |                  |        |
|--------------------------------------|------------------|--------|------------------|--------|
| <b>Military Trainee</b>              |                  |        |                  |        |
| <b>No</b>                            | 1                |        | 1                |        |
| <b>Yes</b>                           | 0.84 (0.49-1.44) | 0.039  | 0.90 (0.52-1.54) | <0.001 |
| <b>Missing</b>                       | 0.88 (0.80-0.97) |        | 0.55 (0.46-0.65) |        |
| <b>Index of Multiple Deprivation</b> |                  |        |                  |        |
| 1 (Least deprived)                   | 1                |        | 1                |        |
| 2                                    | 1.51 (0.95-1.40) |        | 1.09 (0.90-1.33) |        |
| 3                                    | 1.41 (1.14-1.74) |        | 1.34 (1.08-1.66) |        |
| 4                                    | 1.47 (1.13-1.90) | <0.001 | 1.29 (0.99-1.67) | 0.041  |
| 5 (Most deprived)                    | 1.54 (1.11-2.16) |        | 1.49 (1.06-2.08) |        |
| Non-UK                               | 1.23 (1.05-1.45) |        | 1.14 (0.90-1.44) |        |
| Missing                              | 0.97 (0.84-1.12) |        | 1.11 (0.92-1.33) |        |

\*Adjusted for sex, age at ARCP, place of medical degree, less than full time training, academic training, military training and index of multiple deprivation.

## Section 4.4 Summary

This study is the first to examine the relationship between protected characteristics and ARCP outcomes in General Surgery in the UK. Interestingly and in contrast to the findings in Chapter 2, female sex was found to be a protective factor for ARCP outcome. Less than full time training was also protective. Risk factors for non-standard outcome were older age and index of multiple deprivation. The fact that the majority of studies included in Chapter 2 were from US residency programmes might explain some of the differences in our findings of UK surgical training. The full discussion can be found in Chapter 7.

As previously discussed, surgical training in the UK includes a broad range of specialties with differences in demographics and training structure. The question whether the findings in General Surgery would be mirrored in other surgical specialties remained and this led to Chapter 5. Chapter 5 uses the same methodology to investigate the impact of protected characteristics on ARCP outcomes in Trauma and Orthopaedics.

## **Chapter 5            Personal Characteristics Associated with Progression in Trauma and Orthopaedic Specialty Training: A Cohort Study**

### **Section 5.1    Introduction**

Trauma and Orthopaedic Surgery (T&O) has been described as lacking diversity, with fewer women and ethnic minorities than other surgical specialities [147 160]. The current demographics of T&O consultants and trainees in the UK is outlined in Table 1.2. Despite women now outnumbering men at medical school, this is not reflected in Orthopaedic training with women making up only 6% of consultants, compared to 27% in Paediatric Surgery [27]. A recent survey of female surgical trainees reported that T&O was the most sexist surgical specialty, something that may discourage females from embarking on training in T&O [161]. In 2020, 58% of T&O consultants identified as White, compared to 1.5% Black ethnicity [27]. In order to attract and retain a gender and ethnic-diverse workforce within T&O, the focus needs to be on inclusivity and fair and equal progression for all trainees.

Differential attainment and evidence of this throughout postgraduate medicine is discussed in Chapter 1, Section 1.4. In surgical training in the UK, differential attainment can be measured using The Annual Review of Competency Progression (ARCP). The relationship between protected characteristics and ARCP outcomes is discussed in Chapter 1, Section 1.6.

Studies have reported an attainment gap amongst some groups of trainees, for example Black and Minority ethnicity in ARCP and postgraduate exam outcomes [162 163]. The General Medical Council has identified differential attainment as an important area requiring research [164]. Despite this, the impact of protected characteristics on progression through Trauma and Orthopaedic Speciality training has not been studied in the UK. To recruit and retain a diverse and skilled T&O workforce, for fairness and for patients to gain from the benefit that would bring, it is essential to ensure that there is equity in progression, regardless of protected characteristics.

### 5.1.1 Aim

The aim of this study is to identify demographic factors, including protected characteristics, and training specific factors which predict a non-standard Annual Review of Competency Progression (ARCP) outcome during Trauma and Orthopaedic Specialty training in the UK.

## Section 5.2 Method

We performed a cohort study using anonymised data from the UK Medical Education Database (UKMED). The data contained within this resource is described in Chapter 1, Section 1.8. Approval for the study was granted by the UKMED board (Appendix 5). Ethical approval is not required for these studies (Appendix 2). The methodology follows that from Chapter 4. The UKMED database holds ARCP outcomes and demographic information for each graduate. This data can be modelled to assess the relationship between predictors of success and progression throughout surgical training.

### 5.2.1 Outcome Measure

The outcome measure in this study was ARCP outcome, as described in Chapter 4 (Page 119). The possible ARCP outcomes are summarised in Table 1.3 (Page 27). ARCP outcome was converted into an ordinal category following the method developed by Tiffin *et al* [70] (Page 120).

### 5.2.2 Cohort Derivation

All Trauma and Orthopaedic trainees in specialty training (ST3-ST8) with an ARCP outcome recorded between 2010 and 2017 were included. In the event of more than one ARCP outcome within 12 months, the first chronological outcome was used.

### 5.2.3 Predictor Variable Selection

A mixture of demographic, socioeconomic and training specific factors were selected. Region of primary medical qualification was categorised into UK, European Economic Area (EEA) and International Medical Graduates (IMG). EEA includes member states of the European Union and the European Free Trade Association. IMG includes any countries outside of the EEA. The Index of Multiple Deprivation (IMD) was selected as a measure of pre-medicine socioeconomic status. IMD characterises areas by social deprivation and ranks each small area within England, Northern Ireland, Scotland or Wales, from least deprived (1) to most deprived (5). The score is calculated differently for each of the UK countries [157]. The postcode on application to medical school is used to calculate the score, hence only values for UK graduates are available. Therefore, a non-UK category was added to account for EEA and IMG and a missing category- which accounted for missing data from UK graduates only.

#### 5.2.4 Statistical Analysis

Descriptive statistics were performed to describe the satisfactory and non-standard cohorts. Variables of interest were tabulated to ensure sufficient numbers of trainees per category. Headcount data was rounded to ensure anonymity as per guidance from the Higher Education Statistics Agency [158]. Age at ARCP was the only continuous variable. Missing data was coded as a separate category within each variable. A univariate multi-level ordinal regression was performed, with individual trainees as the first level and training region as the second. This takes into account the fact that trainees had

multiple ARCPs over time and were nested by training region. Training region was characterised into home nation and thence divided into Health Education England (HEE) region within England [156]. The factors in the univariate analysis were sex, age at ARCP, place of primary medical degree, less than full time training, graduate at entry and IMD. Wald's test and likelihood ratio tests were used to obtain p values.

The a priori confounders were age at ARCP and sex. A multi-level multiple ordinal regression was performed including age at ARCP, sex and the significant variables from the univariate analysis (place of medical qualification, graduate on entry, less than full time, academic training and IMD). Odds ratios and 95% confidence intervals were reported, taking into account clustering by region. The regression was performed in a step wise manner, with variables that became non-significant being systematically removed from the model. P values <0.05 were taken as significant. Analyses were performed using STATA version 15 (StataCorp LLC, College Station, TX, USA) [159].

### Section 5.3 Results

The analysis included 2,510 trainees in Trauma and Orthopaedic Specialty training, comprising 11,011 ARCP outcomes (Table 5.1). Eighty five percent (2130/2510) of trainees were male. The median age at ARCP was 33 years (IQR 24-50). The majority of trainees (85%) had attended a UK medical school. Seventeen percent (1913/11011) of the outcomes were non-standard. Between 2010 and 2017 of the non-standard outcomes, 1.9% were Outcome 4 (released from training programme). Of the trainees requiring extended training time or that were asked to leave the programme, 17% (60/358) had a prior or subsequent non-standard ARCP.

Table 5.1. Demography and protected characteristics by ARCP Outcome.

|                                        | <b>Group 1</b><br><br><b>Satisfactory outcome</b><br><br><b>N= 9098 (82.6%)</b> | <b>Group 2</b><br><br><b>Insufficient evidence</b><br><br><b>N= 917 (8.3%)</b> | <b>Group 3</b><br><br><b>Targeted time training</b><br><br><b>N= 638 (5.8%)</b> | <b>Group 4</b><br><br><b>Extended training time/left programme</b><br><br><b>N= 358 (3.3%)</b> |
|----------------------------------------|---------------------------------------------------------------------------------|--------------------------------------------------------------------------------|---------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------|
| <b>Male: Female</b>                    | 7715:1385 (85%)                                                                 | 755:160 (82%)                                                                  | 530:110 (83%)                                                                   | 280:80 (78%)                                                                                   |
| <b>Age at ARCP*</b>                    | 33 (24-50)                                                                      | 32 (25-46)                                                                     | 34 (26-46)                                                                      | 35 (27-48)                                                                                     |
| <b>Place of Primary Medical Degree</b> |                                                                                 |                                                                                |                                                                                 |                                                                                                |
| UK                                     | 7740 (85%)                                                                      | 800 (87%)                                                                      | 545 (85%)                                                                       | 295 (82%)                                                                                      |
| EEA                                    | 210 (2%)                                                                        | 25 (3%)                                                                        | 20 (3%)                                                                         | 15 (4%)                                                                                        |
| IMG                                    | 1145 (13%)                                                                      | 95 (10%)                                                                       | 75 (12%)                                                                        | 45 (13%)                                                                                       |
| <b>Less than full time</b>             |                                                                                 |                                                                                |                                                                                 |                                                                                                |
| Yes                                    | 685 (8%)                                                                        | 65 (7%)                                                                        | 50 (8%)                                                                         | 37 (10%)                                                                                       |
| No                                     | 8060 (89%)                                                                      | 849 (93%)                                                                      | 585 (92%)                                                                       | 305 (85%)                                                                                      |
| Missing                                | 355 (4%)                                                                        | -                                                                              | -                                                                               | 16 (5%)                                                                                        |
| <b>Index of Multiple Deprivation</b>   |                                                                                 |                                                                                |                                                                                 |                                                                                                |
| 1 (Least deprived)                     | 1795 (20%)                                                                      | 235 (26%)                                                                      | 145 (23%)                                                                       | 55 (15%)                                                                                       |
| 2                                      | 1335 (15%)                                                                      | 150 (16%)                                                                      | 85 (13%)                                                                        | 45 (13%)                                                                                       |
| 3                                      | 825 (9%)                                                                        | 105 (11%)                                                                      | 55 (9%)                                                                         | 25 (7%)                                                                                        |
| 4                                      | 510 (6%)                                                                        | 65 (7%)                                                                        | 50 (8%)                                                                         | 25 (7%)                                                                                        |
| 5 (Most deprived)                      | 255 (3%)                                                                        | 40 (4%)                                                                        | 20 (3%)                                                                         | 15 (4%)                                                                                        |

|         |            |           |           |           |
|---------|------------|-----------|-----------|-----------|
| Non-UK  | 1355 (15%) | 115 (13%) | 95 (15%)  | 60 (17%)  |
| Missing | 3025 (33%) | 205 (22%) | 190 (30%) | 136 (38%) |

\*Median and interquartile range. Totals may not equal 100% due to rounding to protect anonymity as per HESA.

In univariate analysis female sex, age at ARCP and graduates at entry had significantly increased risk of a non-standard ARCP outcome (Table 5.2). Female trainees were 27% more likely to receive a non-standard outcome than males (OR 1.27 95% CI 1.11-1.45) in univariate analysis. For each year increase in age at ARCP, there was a 2% increase in risk of non-standard outcome (OR 1.02 95% CI 1.01-1.03). Those who were graduates at entry to medical school were 33% more likely to receive a non-standard outcome than standard pathway entry (OR 1.33 95% CI 1.10-1.62). Those who gained their medical degree within the EEA had a non-significant higher risk of non-standard outcome (OR 1.35 95% CI 1.00-1.82). International medical graduation had a non-significant decreased risk of ARCP outcome (OR 0.89 95% CI 0.76-1.04). Less than full time training had no effect on ARCP outcome (OR 1.00 95% CI 0.83-1.20). There was a non-significant trend of increasing risk of non-standard ARCP outcome with increasing index of multiple deprivation, however the most deprived category was not associated with a significant increased risk compared to the least deprived (OR 1.19 95% CI 0.90-1.58).

Female sex and age at ARCP remained significant predictors of a non-standard ARCP outcome in the multivariable logistic regression (Table 5.2). International medical graduation was protective. After adjustment for other factors, female sex was associated with a 26% increased risk of non-standard outcome (OR 1.26 95% CI 1.10-1.44). Increasing age at ARCP was also significantly associated with non-standard outcome, with a 4% increase risk in non-standard outcome for each year older at

time of ARCP (OR 1.04 95% CI 1.03-1.06). International medical graduates had a 34% decreased risk of non-standard outcome compared to UK graduates (OR 0.66 95% CI 0.54-0.81). Those who gained their medical degree within the EEA were not at higher risk of non-standard outcome (OR 1.04 95% CI 0.76-1.43). Less than full time training was not associated with risk of a non-standard ARCP outcome (OR 0.92 95% CI 0.76-1.12), nor was graduate on entry (OR 1.11 95% CI 0.90-1.35). Index of social deprivation was not associated with risk of non-standard ARCP outcome overall.

Table 5.2. Univariate (unadjusted) and multiple (adjusted) ordinal regression for non-standard ARCP Outcome.

|                                        | Unadjusted OR<br>(95% CI) | P value | Adjusted OR <sup>+</sup><br>(95%CI) | P value |
|----------------------------------------|---------------------------|---------|-------------------------------------|---------|
| <b>Female sex</b>                      | 1.27 (1.11-1.45)          | <0.001  | 1.26 (1.10-1.44)                    | 0.001   |
| <b>Age at ARCP (years)</b>             | 1.02 (1.01-1.03)          | 0.005   | 1.04 (1.03-1.06)                    | <0.001  |
| <b>Place of Primary Medical Degree</b> |                           |         |                                     |         |
| UK                                     | 1                         | *       | 1                                   |         |
| EEA                                    | 1.35 (1.00-1.82)          | 0.05    | 1.04 (0.76-1.43)                    | 0.785   |
| IMG                                    | 0.89 (0.76-1.04)          | 0.143   | 0.66 (0.54-0.81)                    | <0.001  |
| <b>Less than full time</b>             |                           |         |                                     |         |
| No                                     | 1                         | *       | 1                                   |         |
| Yes                                    | 1.00 (0.83-1.20)          | 0.979   | 0.92 (0.76-1.12)                    | 0.424   |
| Missing                                | 0.28 (0.18-0.45)          | <0.001  | 0.28 (0.18-0.44)                    | <0.001  |
| <b>Graduate at Entry</b>               | 1.33 (1.10-1.62)          | 0.003   | 1.11 (0.90-1.35)                    | 0.323   |
| <b>Index of Multiple Deprivation</b>   |                           |         |                                     |         |
| 1 (Least deprived)                     | 1                         | *       | 1                                   |         |
| 2                                      | 0.86 (0.72-1.01)          | 0.070   | 0.83 (0.70-0.98)                    | 0.033   |
| 3                                      | 0.89 (0.73-1.08)          | 0.238   | 0.88 (0.72-1.07)                    | 0.210   |
| 4                                      | 1.10 (0.89-1.38)          | 0.374   | 1.04 (0.84-1.30)                    | 0.699   |
| 5 (Most deprived)                      | 1.19 (0.90-1.58)          | 0.216   | 1.12 (0.85-1.49)                    | 0.422   |
| Non-UK                                 | 0.85 (0.72-1.01)          | 0.060   | -                                   | -       |
| Missing                                | 0.75 (0.65-0.87)          | <0.01   | 0.71 (0.61-0.83)                    | <0.001  |

+Adjusted for sex, age at ARCP, place of primary medical degree, graduate on entry, less than full time training and index of multiple deprivation. UK- United Kingdom; EEA- European Economic Area (excluding UK); IMG- International Medical Graduate (Rest of world, excludes UK and EEA). \* Likelihood ratio test for category significant at p<0.05 level.

## Section 5.4 Summary

As for Chapter 4, this study also represents the first study looking specifically at factors affecting ARCP outcomes in Trauma and Orthopaedics in the UK. Women were 26% more likely to receive a non-standard outcome than men, compared to General Surgery where female sex was protective. Inline with the findings in Chapter 4 , older age remained a significant risk factor for non-standard outcome. International medical graduates were found to have a lower risk of non-standard compared to UK graduates which is a unique finding that we have not seen duplicated elsewhere in post-graduate medicine. The full discussion can be found in Chapter 7. Chapters 4 and 5 show there are clear differences between specialities in terms of the impact of protected characteristics. Chapter 6 aimed to combine all surgical specialities and examine differences in ARCP outcomes.

## **Chapter 6                      Differences in ARCP outcome by surgical specialty: A Cohort Study**

### **Section 6.1    Introduction**

Surgical training in the UK is comprised of ten specialties:

Cardiothoracic Surgery, Otolaryngology (ENT), General Surgery, Neurosurgery, Oral and Maxillofacial Surgery (OMFS), Paediatric Surgery, Plastic Surgery, Trauma and Orthopaedics, Urology and Vascular Surgery (Chapter 1, Section 1.2). The Joint Committee on Surgical Training (JCST) is the advisory body to the surgical Royal Colleges in the UK and Republic of Ireland, and along with its Specialty Advisory Committees (SACs) develops a specific curriculum for each of the surgical specialties with clear criteria defined for each specialty to meet prior to completion around academic, procedural and clinical competence [165].

Throughout surgical training, progression to the next stage of training is dependent on meeting curriculum targets and is assessed by the Annual Review of Competency Progression (ARCP) [16]. ARCP is the formal and structured evaluation of a portfolio of evidence to ensure a doctor has achieved the required competencies to enable satisfactory progression through each stage of medical training [16]. The end point of successful completion of surgical training is the award of Certificate of Completion of Training (CCT) which allows entry onto the General Medical Council specialist register [166].

The aim of surgical training is the same across all specialties: to enable surgeons to acquire the curriculum standards and the professional responsibilities to practice as a day one consultant surgeon in the UK [19]. If the training programme is meeting the needs of trainees, we would expect similar proportions of ARCP outcomes across all surgical specialties. The GMC is committed to promoting excellence in the delivery of postgraduate medical education and therefore it is important to ensure consistency of training standards and assessment across surgical training [167]. The work within this thesis has demonstrated differences in surgical ARCP outcomes by gender, age and place of medical qualification [168], however to date there have been no studies comparing ARCP outcomes across surgical specialties.

#### 6.1.1 Aim

To examine ARCP outcomes within UK surgical specialty training and identify any differences between specialties.

## Section 6.2 Method

We performed a cohort study using anonymised data from the UK Medical Education Database (UKMED) [82], described in Chapter 1, Section 1.8) Approval for the study was granted by the UKMED board (Appendix 5). Ethical approval is not required for these studies (Appendix 2). For each graduate, ARCP outcomes are linked to demographic information. These data can be modelled to assess the differences in ARCP outcomes between surgical specialities. These data have been used to study outcomes and progression in medical specialties and foundation programme extensively and have been shown to be reliable [169-171].

### 6.2.1 Outcome Measure

The outcome measure in this study was ARCP outcome. ARCP outcome was converted into an ordinal category following the method developed by Tiffin *et al* [70], as described earlier in the thesis (Page 120)

### 6.2.2 Cohort Derivation

All trainees (ST3-ST8) from Cardiothoracic, ENT, General Surgery, Neurosurgery, OMFS, Paediatric Surgery, Plastic Surgery, Trauma and Orthopaedics and Urology with an ARCP outcome recorded between 2010 and 2017 were included. Trauma and Orthopaedic Surgery was taken as the reference category in the regression analyses as this had the largest number of outcomes and had been modelled as an individual specialty in Chapter 5. In the event of more than one ARCP

outcome within 12 months, the first chronological outcome was used. It was not possible to include Vascular Surgery as this only became a separate specialty in 2013 and the number of outcomes was too small (N=189).

### 6.2.3 Predictor Variable Selection

Age, sex, region of primary medical qualification, less than full time training and year of ARCP were selected as confounding factors due to the variation in these demographics across specialties. Region of primary medical qualification was categorised into UK, European Economic Area and International Medical Graduates (IMG) [172]. Less than full time training requires the same standard of competencies to be met at ARCP, however the training time may be longer.

### 6.2.4 Statistical Analysis

Descriptive statistics were derived to describe the satisfactory and non-standard cohorts. Demographic data was rounded to ensure anonymity as per guidance from the Higher Education Statistics Agency [158]. Missing data was coded as a separate category within each variable. Chi squared test was used to compare the difference in the proportion of satisfactory outcomes compared to General Surgery, as General Surgery had the highest proportion of non-standard outcomes. Predicted probabilities of obtaining each ARCP outcome were calculated for each specialty to allow comparison across all specialties and displayed in a caterpillar plot using STATA post-estimation commands. A multi-level ordinal regression was performed, with a

random intercept at the trainee level. This takes into account the fact that trainees had multiple ARCPs over time. Wald's test and likelihood ratio tests were used to obtain p values.

A multi-level multiple ordinal regression was performed to investigate the odds of non-standard ARCP outcome by specialty. Odds ratios with 95% confidence intervals adjusted for sex, age, region of primary medical qualification, less than full time training and year of ARCP were reported. P values <0.05 were taken as significant. Analyses were performed using STATA version 15 (StataCorp LLC, College Station, TX, USA) [159].

### Section 6.3 Results

The analysis included 8,220 trainees across all specialties, comprising 31,788 ARCP outcomes. Trauma and Orthopaedics had the largest proportion of ARCP outcomes, followed by General Surgery (Table 6.1). Seventy six percent of all trainees were male. The proportion of female trainees varied from 15% in Trauma and Orthopaedics to 49% in Paediatric Surgery (Table 6.2). The median age at ARCP was 35 years (IQR 32-37). The majority of trainees (81%) had attended a UK medical school. Eighty two percent (25,991/31,788) of the outcomes were satisfactory, 8% insufficient evidence, 6% targeted training and 4% either extended training time or released from training programme (Table 6.3). Between 2010 and 2017, of the non-standard outcomes, 1.3% (75/5797) were Outcome 4 (released from training programme). Between 2010 and 2017 standard outcomes reduced from 85% to 78%. There was wide variation in the proportion of non-standard outcomes between specialties (Table 6.1). General Surgery had the lowest proportion of standard outcomes (77.5%), compared to 87.6% in Urology. OMFS had the greatest proportion (6.9%) of extended training/left programme outcomes while ENT had the lowest at 2.2%. All specialties except Paediatric Surgery had a significantly greater number of satisfactory outcomes than General Surgery on Chi square test (Table 6.1). Figure 6.1 illustrates the variation in ARCP outcome by speciality. General Surgery had the lowest predicted probability of a satisfactory outcome comparing across all specialties and Urology had

the greatest. General Surgery and Paediatric Surgery had the greatest predicted probability of all other non-standard outcomes.

Table 6.1. Number of ARCPs by speciality

| <b>Speciality</b>              | <b>Satisfactory<br/>N (%)</b> | <b>Insufficient<br/>evidence<br/>N (%)</b> | <b>Targeted<br/>training<br/>N (%)</b> | <b>Extended training/<br/>left programme<br/>N (%)</b> | <b>Total no. of ARCPs<br/>N (%)</b> |
|--------------------------------|-------------------------------|--------------------------------------------|----------------------------------------|--------------------------------------------------------|-------------------------------------|
| <b>General Surgery</b>         | 7859 (77.5%)                  | 1005 (9.9%)                                | 710 (7.0%)                             | 562 (5.5%)                                             | 10136 (32%)                         |
| <b>Trauma and Orthopaedics</b> | 9098 (82.6%)*                 | 917 (8.3%)                                 | 638 (5.8%)                             | 358 (3.3%)                                             | 11011 (35%)                         |
| <b>Plastic Surgery</b>         | 2091 (85.5%)*                 | 181 (7.4%)                                 | 89 (3.6%)                              | 84 (3.4%)                                              | 2445 (8%)                           |
| <b>Urology</b>                 | 2091 (87.6%)*                 | 149 (6.2%)                                 | 86 (3.6%)                              | 62 (2.6%)                                              | 2388 (7%)                           |
| <b>Neurosurgery</b>            | 1555 (84.5%)*                 | 121 (6.6%)                                 | 81 (4.4%)                              | 83 (4.5%)                                              | 1840 (6%)                           |
| <b>ENT</b>                     | 1127 (86.5%)*                 | 81 (6.2%)                                  | 66 (5.1%)                              | 29 (2.2%)                                              | 1303 (4%)                           |
| <b>Maxillofacial</b>           | 812 (81.0%)*                  | 74 (7.4%)                                  | 47 (4.7%)                              | 69 (6.9%)                                              | 1002 (3%)                           |
| <b>Cardiothoracic Surgery</b>  | 782 (83.1%)*                  | 73 (7.8%)                                  | 37 (3.9%)                              | 49 (5.2%)                                              | 941 (3%)                            |
| <b>Paediatric Surgery</b>      | 576 (79.8%)                   | 60 (8.3%)                                  | 45 (6.2%)                              | 41 (5.7%)                                              | 722 (2%)                            |
| <b>Total</b>                   | 25991 (81.8%)                 | 2661 (8.4%)                                | 1799 (5.6%)                            | 1337 (4.2%)                                            | 31788 (100%)                        |

\* Significant difference in the number of satisfactory outcomes compared to General Surgery using  $\chi^2$ .

Table 6.2. Demographics by specialty

|                                 | General Surgery   | Trauma and Orthopaedics | Plastic Surgery  | Urology          | Neurosurgery     | ENT              | OMFS            | Cardiothoracic Surgery | Paediatric Surgery |
|---------------------------------|-------------------|-------------------------|------------------|------------------|------------------|------------------|-----------------|------------------------|--------------------|
| <b>Age at ARCP (years, IQR)</b> | 35 (33-38)        | 33 (30-36)              | 36 (33-38)       | 35 (32-37)       | 34 (31-37)       | 36 (33-38)       | 38 (36-41)      | 37 (33-40)             | 35 (33-38)         |
| <b>Sex (M:F)</b>                | 1780:850<br>(68%) | 2130:380<br>(85%)       | 435:215<br>(67%) | 535:185<br>(74%) | 415:100<br>(81%) | 295:110<br>(73%) | 240:55<br>(81%) | 225:55<br>(80%)        | 115:110<br>(51%)   |
| <b>PMQ region</b>               |                   |                         |                  |                  |                  |                  |                 |                        |                    |
| UK                              | 2035 (78%)        | 2060 (82%)              | 540 (83%)        | 545 (75%)        | 380 (74%)        | 305 (75%)        | 250 (86%)       | 175 (62%)              | 175 (79%)          |
| EEA                             | 90 (3%)           | 70 (3%)                 | 40 (6%)          | 30 (4%)          | 50 (10%)         | 25 (6%)          | 30 (10%)        | 35 (12%)               | 15 (6%)            |
| IMG                             | 495 (19%)         | 380 (15%)               | 70 (11%)         | 145 (21%)        | 85 (16%)         | 80 (19%)         | 85 (4%)         | 70 (26%)               | 35 (15%)           |

Numbers rounded as per HESA so may not equal 100%. PMQ= place of medical qualification; UK= United Kingdom; EEA= European economic area; IMG=

International medical graduate; OMFS= Oral and Maxillofacial Surgery.

Table 6.3. Demography and protected characteristics by ARCP Outcome.

|                            | <b>Group 1</b><br><br><b>Satisfactory outcome</b><br><br><b>N=25,991 (82%)</b> | <b>Group 2</b><br><br><b>Insufficient evidence</b><br><br><b>N=2,661 (8%)</b> | <b>Group 3</b><br><br><b>Targeted time training</b><br><br><b>N=1,799 (6%)</b> | <b>Group 4</b><br><br><b>Extended training time/left programme</b><br><br><b>N=1,337 (4%)</b> | <b>Total</b><br><br><b>N=31788</b> |
|----------------------------|--------------------------------------------------------------------------------|-------------------------------------------------------------------------------|--------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------|------------------------------------|
| <b>Male: Female</b>        | 19,845: 6,150                                                                  | 1,980: 680                                                                    | 1,325: 475                                                                     | 940: 400                                                                                      | 24,090:7705                        |
| <b>Age at ARCP*</b>        | 35 (24-57)                                                                     | 34 (25-48)                                                                    | 35 (26-49)                                                                     | 37 (27-54)                                                                                    | 35 (32-37)                         |
| <b>PMQ region</b>          |                                                                                |                                                                               |                                                                                |                                                                                               |                                    |
| UK                         | 20,950 (81%)                                                                   | 2,295 (86%)                                                                   | 1,485 (83%)                                                                    | 1,070 (80%)                                                                                   | 25,800 (81%)                       |
| EEA                        | 1,050 (4%)                                                                     | 80 (3%)                                                                       | 80 (4%)                                                                        | 65 (5%)                                                                                       | 1275 (4%)                          |
| IMG                        | 3,990 (15%)                                                                    | 285 (11%)                                                                     | 230 (13%)                                                                      | 200 (15%)                                                                                     | 4705 (15%)                         |
| <b>Less than full time</b> |                                                                                |                                                                               |                                                                                |                                                                                               |                                    |
| Yes                        | 2,665 (10%)                                                                    | 295 (10%)                                                                     | 215 (12%)                                                                      | 185 (14%)                                                                                     | 3,365 (11%)                        |
| No                         | 22,105 (85%)                                                                   | 2325 (87%)                                                                    | 1,540 (86%)                                                                    | 1,100 (82%)                                                                                   | 27,070 (85%)                       |
| Missing                    | 1,220 (5%)                                                                     | 40 (2%)                                                                       | 40 (2%)                                                                        | 55 (4%)                                                                                       | 1355 (4%)                          |
| <b>Year of ARCP</b>        |                                                                                |                                                                               |                                                                                |                                                                                               |                                    |
| 2010                       | 3460 (85%)                                                                     | 235 (6%)                                                                      | 190 (5%)                                                                       | 200 (5%)                                                                                      | 4090 (13%)                         |
| 2011                       | 3490 (86%)                                                                     | 225 (8%)                                                                      | 180 (5%)                                                                       | 165 (4%)                                                                                      | 4060 (13%)                         |
| 2012                       | 3410 (83%)                                                                     | 308 (7%)                                                                      | 230 (6%)                                                                       | 170 (4%)                                                                                      | 4120 (13%)                         |
| 2013                       | 3510 (83%)                                                                     | 315 (7%)                                                                      | 265 (6%)                                                                       | 155 (4%)                                                                                      | 4240 (13%)                         |
| 2014                       | 3280 (80%)                                                                     | 355 (9%)                                                                      | 270 (7%)                                                                       | 200 (5%)                                                                                      | 4105 (13%)                         |
| 2015                       | 3040 (79%)                                                                     | 400 (10%)                                                                     | 245 (6%)                                                                       | 180 (5%)                                                                                      | 3865 (12%)                         |
| 2016                       | 3005 (80%)                                                                     | 395 (11%)                                                                     | 210 (6%)                                                                       | 130 (4%)                                                                                      | 3740 (12%)                         |

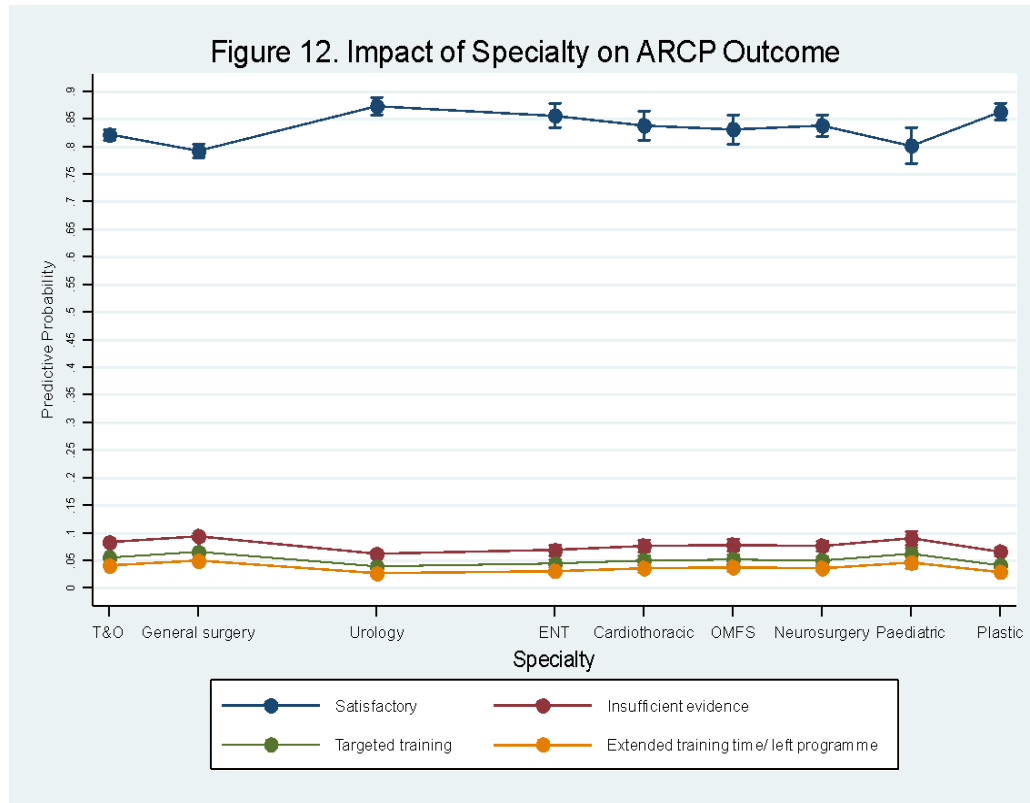
|      |            |           |          |          |            |
|------|------------|-----------|----------|----------|------------|
| 2017 | 2795 (78%) | 435 (12%) | 205 (6%) | 135 (4%) | 3575 (11%) |
|------|------------|-----------|----------|----------|------------|

\*Median and interquartile range. Numbers rounded as per HESA so may not equal

100%. PMQ= place of medical qualification; UK= United Kingdom; EEA= European

economic area; IMG= international medical graduate.

Figure 6.1. Impact of speciality on ARCP Outcome



This caterpillar plot demonstrates the predicted probability of each ARCP Outcome by surgical specialty with 95% confidence intervals. It is adjusted for sex and median age of each specialty.

On univariate analysis of all specialties combined, factors associated with a non-standard outcome were female sex (OR 1.22 95% CI 1.12-1.33), increasing age at ARCP (1.03 95% CI 1.02-1.04), less than full time training (OR 1.21 95% CI 1.07-1.36) and more recent ARCP date (OR 1.07 95% CI 1.05-1.08) (Table 6.4). On comparing the specialties, Plastic Surgery (OR 0.81 95% CI 0.70-0.95), Urology (OR 0.66 95% CI 0.56-0.78) and ENT (OR 0.75 95% CI 0.61-0.92) trainees were significantly less likely to receive a non-standard ARCP outcome compared to Trauma and Orthopaedic trainees (Table 6.4). General Surgery trainees were 45% more likely to receive a non-standard ARCP outcome than Trauma and Orthopaedics (OR 1.45 95% CI 1.32-1.58), and Paediatric Surgery trainees 28% more likely (OR 1.28 95% CI 1.00-1.63). Neurosurgery, OMFS and Cardiothoracic Surgery did not have a significantly higher risk of non-standard outcome compared to Trauma and Orthopaedics (OR 0.90 95% CI 0.75-1.07, OR 1.18 95% CI 0.95-1.47, OR 0.96 95% CI 0.77-1.21) (Table 6.4).

After adjustment, women across all surgical specialties were 11% more likely to receive a non-standard ARCP outcome than men (OR 1.11 95% CI 1.02-1.22) (Table 6.4). For each year increase in age at ARCP, trainees were 4% more likely to receive a non-standard outcome (OR 1.04 95% CI 1.03-1.05). Between 2010 and 2017, there was a 4% increase in the likelihood of non-standard outcome for trainees having an ARCP more recently (OR 1.04 95% CI 1.03-1.06). Compared to UK graduates, international medical graduates were 31% less likely to receive a non-standard outcome (OR 0.69 95% CI 0.61-0.78). There was no significant difference between UK and EEA

graduates. Less than full time training did not increase the risk of non-standard outcome across all specialities after adjustment.

After adjusting the data for sex, age, region of primary medical qualification, less than full time training and ARCP year, General Surgery trainees were 33% more likely to receive a non-standard ARCP outcome than Trauma and Orthopaedic trainees (OR 1.33 95% CI 1.21-1.45) (Table 6.4). Plastic Surgery trainees were 30% less likely to receive a non-standard outcome than Trauma and Orthopaedic trainees after adjustment (OR 0.70 95% CI 0.60-0.82), Urology 36% less likely (OR 0.64 95% CI 0.54-0.75) and ENT 24% less likely (OR 0.76 95% CI 0.61-0.93). There was no significant difference for Neurosurgery, OMFS, Cardiothoracic or Paediatric Surgery trainees after adjustment.

Table 6.4. Multi-level ordinal regression showing factors associated with non-standard ARCP outcome.

|                                         | <b>Unadjusted OR<br/>(95% CI)</b> | <b>P value</b> | <b>Adjusted OR<br/>(95% CI)</b> | <b>P value</b> |
|-----------------------------------------|-----------------------------------|----------------|---------------------------------|----------------|
| <b>Speciality</b>                       |                                   |                |                                 |                |
| Trauma and Orthopaedics                 | 1                                 | -              | 1                               | -              |
| General Surgery                         | 1.45 (1.32-1.58)                  | <0.001         | 1.33 (1.21-1.45)                | 0.001          |
| Plastic Surgery                         | 0.81 (0.70-0.95)                  | 0.010          | 0.70 (0.60-0.82)                | <0.001         |
| Urology                                 | 0.66 (0.56-0.78)                  | <0.001         | 0.64 (0.54-0.75)                | <0.001         |
| Neurosurgery                            | 0.90 (0.75-1.07)                  | 0.223          | 0.88 (0.74-1.04)                | 0.142          |
| ENT                                     | 0.75 (0.61-0.9 2)                 | 0.005          | 0.76 (0.61-0.93)                | 0.009          |
| Oral & Maxillofacial Surgery            | 1.18 (0.95-1.47)                  | 0.125          | 0.93 (0.75-1.16)                | 0.506          |
| Cardiothoracic Surgery                  | 0.96 (0.77-1.21)                  | 0.753          | 0.88 (0.70-1.10)                | 0.268          |
| Paediatric Surgery                      | 1.28 (1.00-1.63)                  | 0.048          | 1.16 (0.91-1.48)                | 0.228          |
| <b>Female</b>                           | 1.22 (1.12-1.33)                  | <0.001         | 1.11 (1.02-1.22)                | 0.020          |
| <b>Age at ARCP</b>                      | 1.03 (1.02-1.04)                  | <0.001         | 1.04 (1.03-1.05)                | <0.001         |
| <b>PMQ region</b>                       |                                   |                |                                 |                |
| UK                                      | 1                                 | -              | 1                               | -              |
| EEA                                     | 0.93 (0.77-1.13)                  | 0.482          | 0.89 (0.73-1.08)                | 0.253          |
| IMG                                     | 0.77 (0.69-0.87)                  | <0.001         | 0.69 (0.61-0.78)                | <0.001         |
| <b>Less than full time<br/>training</b> | 1.21 (1.07-1.36)                  | 0.002          | 1.11 (0.98-1.26)                | 0.093          |
| Yes                                     | 0.50 (0.41-0.62)                  | <0.001         | 0.51 (0.41-0.63)                | <0.001         |
| Missing                                 |                                   |                |                                 |                |
| <b>Year of ARCP</b>                     | 1.07 (1.05-1.08)                  | <0.001         | 1.04 (1.03-1.06)                | <0.001         |

ENT= ear, nose & throat; PMQ= primary medical qualification. UK= United Kingdom; EEA= European economic area; IMG= international medical graduate.

## Section 6.4 Summary

Chapter 6 represents the largest most contemporary study of UK surgical training and is the first to examine variation in ARCP outcomes across specialities. Across all specialties, General Surgery was found to have higher rates of non-standard ARCP outcome. Echoing the findings of Chapter 5, women were significantly more likely to receive a non-standard outcome than men and older age remained a risk factor. The full discussion can be found in Chapter 7. It is clear from this study that there are wide variations in training outcomes across specialities and further work is required to investigate the causes behind differential attainment within surgery as a whole.

## **Chapter 7            Discussion**

This chapter discusses the results from the five original research articles. Chapters 2-6 provide original insights into factors affecting progression in surgical training. Chapter 2 is a meta-analysis focusing on factors associated with attrition and is largely based on US residency programmes. Chapter 3 is a systematic review providing a narrative of the effect of COVID-19 across all areas of surgical training, including clinical and operative impact and trainee wellbeing. Chapter 4 is the first of the cohort studies identifying risk factors for non-standard ARCP in General Surgery. Chapter 5 focuses on factors associated with non-standard ARCP in Trauma and Orthopaedics. Chapter 6 is the largest of the cohort studies investigating differences in ARCP outcomes across all surgical specialities. The findings address the aims of the thesis to identify factors associated with attrition, performance, ARCP outcomes and to define the impact of COVID-19 on surgical training.

### **7.1     Factors associated with attrition**

Chapter 2 is the first study to report the association between protected characteristics and attrition and performance during surgical training [173]. Overall, of the studies included in our systematic review 25 reported factors associated with progression or completion of surgical training and seven focused on factors affecting performance. The pooled attrition rate was high at 17% which causes a burden to residency programmes and existing residents. Efforts should be made to retain residents and to reduce the

financial and training implications of attrition. Worryingly given the changing demographic of surgical trainees rates of attrition were higher in women.

Attrition rates in General Surgery residency remain higher than other surgical specialities [174-176]. In a study of Canadian surgical residents, 26.8% were considering leaving their training programme with poor work-life balance cited as the main reason [177]. This study provides clarity regarding the impact of resident sex on attrition after two previous meta-analyses reported differing findings [91 178]. We found a significantly higher attrition rate for female residents on pooled meta-analysis. This is consistent with a meta-analysis that found female residents had a 25% pooled attrition rate compared to 15% of men [91]. This finding is not unique to General Surgery, higher attrition rates for female residents have also been reported in Neurosurgery [179 180] and Orthopaedics [175].

Higher attrition for Hispanic residents has been reported across other specialities. A 2019 study of US emergency medicine residents found that a significantly greater proportion of Hispanic residents left the programme compared to White residents [181]. They also reported a higher rate of dismissal for Hispanic residents compared to Asian and White residents. The fact that Hispanic residents are an underrepresented group in postgraduate medicine may result in less access to role models they can identify with which may impede residency satisfaction [182]. Residents of non-White ethnicity were less likely to feel they fit in their residency programme which may partly explain the higher attrition [183].

Half of the studies found that age is associated with increased attrition, in both of these studies age was dichotomised to an arbitrary number which may influence the findings (92, 93). All three of the studies that analysed the effect of parental status find no increased rates (79, 91, 93). These findings are reassuring given the increasing number of female surgical trainees and increasing acceptance of childrearing during residency. One study found that while the perception of negative attitudes towards pregnancy during training has decreased over time, some stigma persists [184]. It additionally reported that those who had graduated from medical school more recently were more likely to have a pregnancy during training than their older counterparts. The finding that childrearing does not affect attrition or performance should encourage residency programmes to develop clear guidance regarding parental leave, as in a recent study only 3.8% of residents were able to correctly identify the American Board of Surgery policy and felt unsupported [185].

## 7.2 The impact of COVID-19 on surgical training

COVID-19 has a negative impact across all surgical specialities and this has been felt worldwide. All studies reported a decrease in operative volume and experience for trainees with some reporting concerns over trainees' ability to meet training requirements. There was a trend towards decreased time spent in the hospital across studies and the use of telemedicine for remote consultations. Of the studies that investigated the impact on mental health and wellbeing, all reported an adverse effect whilst working throughout the

pandemic. Some positives highlighted from the studies were the move to online educational resources and additional time for self-directed study or research.

Across the eight included surgical specialities, experience for trainees has decreased along with rising stress levels and negative mental health repercussions. With the pandemic still ongoing and the threat of further waves, the way we deliver surgical training needs to change. Some suggestions in order to mitigate the loss of experience during the pandemic include a personalised approach for additional training [186], intake assessments of trainees to identify deficiencies and enable targeted interventions and updating curricula to reflect the loss in opportunities [187]. Surgical simulation may also play a role in allowing trainees to gain some practical experience outside of the operating theatre [188], thereby minimising risk of transmission of infection. It is also vital that trainees are supported from a mental health perspective during the pandemic and whilst attempting to recoup training experience.

While on a lesser scale than the current COVID-19 pandemic, the 2003 Severe Acute Respiratory Distress Syndrome (SARS) epidemic resulted in over 8000 cases across 26 countries [189]. This had an effect on medical education and health provision. Sherbino and Atzema [190] describe the impact of SARS on medical education by the loss of formal teaching sessions, delays to new clinical rotations and faculty taking on nonclinical roles so previous teaching commitments were cancelled. Toronto suffered a dramatic outbreak of SARS causing the cancellation of elective procedures and reduction in outpatient activity [191].

Surgical trainees in the UK already struggle to meet operative case requirements, with 85% coming in on days off in order to maximise training opportunities [192]. It is likely that the decrease in operative experiences during the COVID-19 period will compound this [129]. The lack of exposure to operative practice and resultant concerns surrounding trainees' ability to meet minimum case requirements needs to be addressed. The Joint Committee on Surgical Training reported that nearly 900,000 elective training cases were lost due to COVID-19 and in order to recover training levels to pre-pandemic levels within 12 months, 75,500 additional training cases would be required every month [193]. There is the suggestion that senior trainees may be disproportionately affected by the reduction in operative case volume and some studies report concern over future job opportunities. These findings are supported by Zheng et al. who found amongst chief residents common concerns were the inability to meet case requirements and feeling unprepared for fellowship or future job [186].

All of the studies that investigated the effect of COVID-19 on stress, mental health and home-life disruption found a negative impact. Due to the additional stress and disruption caused by COVID-19, clinicians are at greater risk of developing burnout long-term [194]. Findings from China reported 50.4% of health care workers reported symptoms of depression and 71.5% reported distress whilst working through the pandemic [195]. One study investigating the impact of COVID-19 on anxiety amongst medical staff in China found that female clinicians had an increased incidence of anxiety [196]. Only one of our studies compared degree of stress by sex, amongst French Urology trainees sex was not associated with increased stress during

the pandemic [145]. Surgical trainees across all specialities are already known to have high rates of burnout [197 198], therefore it is important that trainees are given adequate support not only during but also after the pandemic.

Despite the overwhelming negative impact of COVID-19 on surgical training, some positives can be found. The rapid adaptation of educational resources to delivery through online platforms has allowed trainees to continue to develop their theoretical knowledge. Similarly, the conversion of conferences to webinar format enables a greater number of surgeons to access educational material remotely and reduces the need for study leave, costs associated with travel and accommodation [188]. Some studies reported changes to working life had allowed additional time to be devoted to research. While redeployment forces trainees to step out of their comfort zone and may cause some anxiety [199], redeployment to an appropriately supervised area can allow the acquisition of new skills and the refreshing of old [200 201].

### 7.3 Factors associated with ARCP outcome

Chapter 4, 5 & 6 are the first studies investigating the effect of personal characteristics on progression through Higher Surgical Training. Differential attainment has been shown to exist across specialties. Within the surgical environment, possible contributory factors include unconscious bias [202], microaggressions [203] and lack of role modelling for minority groups. In reality, there will be a complex interplay of factors that result in the findings of

the thesis. The factors are likely to be present at a systemic, institutional and individual level which makes the understanding and tackling of differential attainment difficult. The findings specific to the work in this thesis are discussed in turn.

We have shown that after adjustment for other factors age at ARCP and index of multiple deprivation may predict non-standard outcome at ARCP in General Surgery, while female sex and less than full time training are protective. We found different factors predictive of non-standard ARCP in our Trauma and Orthopaedic cohort, with female sex a risk factor for non-standard outcome at ARCP. Across all three studies, older age at ARCP was associated with higher risk of non-standard outcome, although to varying degrees. When combining all surgical specialities, women are less likely to receive a standard ARCP outcome and the likelihood of a non-standard outcome for all trainees has increased throughout time.

Women have a different experience in training to male trainees across the world. A meta-analysis found that there was a higher prevalence of harassment and gender discrimination amongst female trainees than male trainees across all specialities worldwide [204]. A survey based study investigating women's perceptions of gender based discrimination in US surgical training, reported that 88% of women had experienced gender based discrimination during surgical residency [95]. Aligned with our findings in General Surgery, previous studies examining all medical specialties have reported a 40% increased likelihood of a non-standard outcome for male trainees [66 70]. Similarly, a study looking at medical speciality trainees found that males were significantly more likely to receive ARCP outcomes 3

and 4 (extended training time and left programme) than females (7.1% vs 3.8%,  $p < 0.001$ ) [205]. Our finding that women in T&O and across all surgical specialties combined are more likely to receive a non-standard outcome is worrying. Surgery remains dominated by men and attitudes towards women in surgery have been challenged in recent years. One study reported that 59% of women in surgery had experienced workplace discrimination, there was also a perception that the surgical environment is better equipped to support male trainees [161]. Other studies have found that female trainees have adverse outcomes in surgical training. In a meta-analysis comprising 17,407 surgical trainees across the world, women were found to have a higher pooled attrition than men [173]. Orthopaedic residency programme directors were surveyed in a US study of attrition amongst orthopaedic residents [175]. The response rate was 54%, which accounted for 51% of all orthopaedic residents. Female residents were significantly more likely to leave the programme than their male counterparts. The training environment across most surgical specialities is predominately composed of male trainers and male trainees. It is recognised that men and women have different learning styles [206] and react to feedback differently [207]. As the majority of surgical consultants are men, trainees receive most training and feedback from male teachers. The differences in female learning style and response to feedback may partly contribute to the findings in this thesis.

It is reassuring that our adjusted results show no adverse association between female sex and ARCP outcome in General Surgery, especially as there are suggestions that surgery is not female friendly and is perceived to

have a male bias [208-211]. The finding that women across all specialities and within Trauma and Orthopaedics have adverse outcomes requires investigation at the specialty level and sharing of good and bad practice between specialities.

Our finding that older age at ARCP is associated with adverse ARCP outcomes across all three of our cohort studies is in line with other published research [68 69]. A study of over 38,000 UK graduate doctors with details regarding ARCP outcome provided by the GMC, found that older doctors were more likely to receive non-standard ARCP outcomes than their younger counterparts [68]. Older trainees were also more likely to be released from the programme. Smith and Tiffin found that older trainees were less likely to receive a satisfactory outcome at ARCP than younger trainees [69]. A US study of 111 surgical residents from a single institution during 1991-2000 found that age was a risk factor for unsatisfactory outcome, with those under 29 years 89% less likely to receive an unsatisfactory outcome (OR 0.11 95% CI 0.02-0.47) on multivariate analysis [30]. Unsatisfactory outcome was defined as attrition or failure to pass the board examination on first attempt. Furthermore, older residents had higher rates of burnout than younger doctors according to an international meta-analysis [198], which may contribute to difficulties meeting ARCP requirements. The reasons behind our findings are likely to be multifactorial and may include factors outside work including family, other external pressures and perhaps illness.

In order to increase self-reliance on the supply of medical graduates in the UK the UK Medical Workforce Standing Advisory Committee suggested establishment of medical courses for graduates [50]. Previous studies have

shown that older doctors do better or comparably to school leaver entrants at medical school [53 212], however our results suggest this is not sustained in General Surgery specialty surgical training.

In our General Surgery cohort, country of primary medical qualification was not associated with non-standard ARCP outcomes. This agrees with an earlier study that found no difference in the odds of receiving a satisfactory ARCP outcome between UK graduates and overseas graduates in UK surgical training [66]. Conversely, international medical graduates had a lower risk of non-standard ARCP outcome in Trauma and Orthopaedics. The finding that international medical graduation was protective in postgraduate medical training has not been reported in other studies. In a study of more than 53,000 doctors across medical training as a whole, investigating the use of Professional and Linguistic Assessments Board (PLAB) examination, found that international graduates are less likely to receive a satisfactory outcome at ARCP than UK graduates across medicine as a whole [70]. International medical graduates not only have to ensure they are competitive to secure a T&O higher surgical training number but also that they meet entry requirements which can involve additional exams and overcoming language and cultural barriers. It is possible that international medical graduates in T&O are a self-selected highly motivated group.

Trainees and medical students from deprived socioeconomic backgrounds are in the minority in the UK and US [213]. We found the Index of Multiple Deprivation to be a significant predictor in General Surgery. A 2015 report of core medical trainees found that those from the most deprived

socioeconomic background received the highest proportion of unsatisfactory ARCP outcomes (66). This trend was echoed in our sample of General Surgery trainees, however the results should be interpreted with caution due to missing data and the lack of a measure for non-UK graduates. The possible explanations for our finding include trainees from lower socioeconomic groups having a sense of lack of belonging within the surgical team. This can include feeling excluded in conversations and work place 'banter'. There is also the financial cost of surgical training which for some can be a barrier to attendance at courses, conferences and social gatherings.

When combining all the surgical specialities in Chapter 6, between 2010 and 2017 the likelihood of non-standard ARCP outcome has increased. The possible explanations for this include higher standards and criteria of the ARCP panel, changes in training quality and difficulties meeting ARCP requirements. Other factors such as increased familiarity of the system and requirements since its introduction in 2007, more rigorous application of the criteria and the recognition that it is more beneficial to trainees to issue a non-standard outcome earlier than later may also play a role in this finding. The largest increase in non-standard outcomes was in the insufficient evidence group. This may be due to increased service provision demands leaving less time for portfolio administration and changing curriculum requirements. Previous studies have described a decrease in operative case load for surgical trainees over time [214-216]. A large proportion of UK trainees struggle to meet operative case requirements, with 85% reporting coming in on off days to gain extra experience [192]. The variation in ARCP

outcomes over time is likely multi-factorial and beyond the scope of this study.

#### 7.4 Differences in ARCP across specialities

In Chapter 6, we found between-specialty variation in ARCP outcomes with General surgery trainees significantly more likely to have a non-standard ARCP outcome compared to other specialities. Across the specialities, 1.3% of trainees are released from training (Outcome 4).

There are a number of factors which may contribute to the difference in ARCP outcomes between surgical specialities. There are currently differences between requirements for CCT to be awarded between specialities. These inconsistencies have been highlighted in a 2019 paper by Wood et al [217]. For example, the academic requirement for CCT in General Surgery requires three peer reviewed publications by the end of training, Urology trainees require two, whilst Paediatric Surgery require four, Cardiothoracic trainees are required to deliver six presentations while those in ENT have no specified number. These different thresholds of attainment may therefore contribute to variation seen in the outcomes awarded in our cohort. Regardless of surgical speciality, there are universal requirements of a day one consultant. In the 2021 JCST curriculum update, the academic requirements are now uniform across all surgical specialities, however variation in operative case load and work based assessments persists [218 219]. The academic and management and leadership responsibilities are likely to be the same across specialities and therefore we support this

standardisation. The aim of the surgical training programmes is to produce competent day one consultants, this study should prompt a review of these requirements across specialties.

The specialties with the lowest proportion of non-standard outcomes (Urology, Plastic Surgery and ENT) have a smaller number of trainees which may increase the number of training opportunities and the ease of completing work-based assessments. In smaller specialties it is likely that trainees and trainers will have greater training continuity, this has been shown to increase intra-operative entrustment [220 221]. It is also possible that the variation in outcomes between specialties may be due to differences in the selection processes for appointment. Competition ratios vary by speciality and therefore there may be differences in baseline cohort characteristics.

In the United States, General Surgery residents have a higher rate of attrition compared to other specialties [174-176]. However, the failure to complete residency in these studies is largely due to voluntary attrition as opposed to unsatisfactory progression. Similarly, in a Canadian study across surgical specialties, General Surgery residents were the most likely to consider leaving the programme [222]. The main reason for this was concerns regarding work-life balance. Reassuringly, we have found a low proportion of trainees are asked to leave the programme.

Surgical trainees have been found to have low rates of career satisfaction and higher rates of burnout than compared to trainees in other medical specialties [223]. In a 2019 meta-analysis, General Surgery trainees had the

highest rate of burnout amongst the surgical subspecialties with a 58% prevalence rate of burnout [198]. Burnout was defined as a long-term stress reaction marked by emotional exhaustion, depersonalization, and reduced personal accomplishment [30]. Orthopaedics and Neurosurgery had a slightly lower rate at 55% and 52% respectively [198].

## 7.5 Strengths and limitations

The strengths and limitations of the studies included in this thesis will be discussed individually.

### 7.5.1 Chapter 2

Chapter 2 provides an up to date review of the literature regarding attrition and performance across surgical training. One of the strengths was the ability to perform a meta-analysis and provide clarity on the impact of sex on attrition. Previous studies had reported conflicting findings [91 178]. The findings of Chapter 2 serve to highlight that studies regarding attrition within UK surgical training are lacking and the fact that attrition is not formally recorded on a national scale.

In Chapter 2 the limitations are related to the included studies, the majority of which are conducted in a single institution which increases bias and reduces generalisability. A significant finding that limits generalisability to current surgical trainees is that fourteen of the studies include cohorts that started training over 20 years ago. During this time, training requirements and assessment processes have changed, as has the population of surgical

trainees with an increase in female trainees. However, on sensitivity analysis including only studies published since 2008 did not affect the overall pooled attrition or that of attrition by sex. Nine of the included studies rely on survey data which is subject to response and recall bias. Also, as all but two of the included studies are from the US, attrition rates and factors affecting this in other countries have not been investigated. Furthermore, the studies that focused on performance vary greatly in design and outcome measure. The definition of performance is not uniform across studies and this limits interpretation. Four of these studies are based on populations commencing surgical residency more than 20 years ago, in one case from 1967. A 2017 study outlines the different assessment tools used during residency and highlights the lack of effective tools to measure competence [224].

### 7.5.2 Chapter 3

Chapter 3 is, to our knowledge, the first systematic review on the impact of COVID-19 across all surgical specialities, focusing on trainee challenges across all the facets of surgical training. The main limitation of Chapter 3 is the lack of objective data regarding the impact on operative case volume, this has prohibited a meta-analysis. The lack of quantitative data within the included studies is likely due to the rapidly evolving pandemic and the need to publish papers looking at the impact on surgical training in a timely fashion to help understand and mitigate the after effects.

### 7.5.3 Chapter 4

The major strength of Chapter 4 is the ability to capture a large contemporary cohort of General Surgery trainees. This study is also the first to examine

the impact of demographic and training specific variables on ARCP outcomes in General Surgery. Prior to this thesis work pertaining to differential attainment in surgery was lacking, especially at the Higher Surgical Training level. The UKMED has provided a large cohort in which the data is recorded by the GMC and other regulatory bodies and so is not reliant on voluntary completion of surveys. This reduces bias within these studies and allows the use of ARCP as an outcome measure which is a nationally standardised objective assessment.

Some of the limitations of this study include the inability to include a measure of prior educational achievement or post-graduate examination success in the model. This is due to large amounts of missing data for these variables. Furthermore, we did not have ethnicity data for non-UK graduates which prohibited including ethnicity as a variable in the models. Other protected characteristics such as marital status, religion and sexuality were not available either due to failure to capture this information within surgical training or missing data. Furthermore, it was not possible to include training grade (ST3-ST8) in the analysis. This was due to the unreliability of grade of training within the database, reasons for this lay with the inputting of data directly into ISCP by trainees or administrative staff. It would have been beneficial to include training grade in order to help identify specific points within training that are more likely to result in non-standard outcome. Finally, As for all cohort studies, due to the observational nature of the study, it is not possible to account for variables not contained within the dataset. Also, it is not possible to prove causality in a longitudinal study.

#### 7.5.4 Chapter 5

The strengths of Chapter 5 are similar to those of the preceding chapter. Prior to this work, there was a lack of objective data looking at differential attainment within Trauma and Orthopaedic Surgery, this is despite multiple publications suggesting a male bias. The UKMED has enabled an analysis of all T&O trainees between 2010 and 2017, providing a truly representative sample. This is the first study to analysis the impact of protected characteristics and training specific variables on ARCP outcomes in T&O.

The limitations of Chapter 5 are shared with those of Chapter 4 and largely relate to the data available within UKMED. It was not possible to include prior education attainment, postgraduate examination success, ethnicity, religion or marital status for reasons discussed above. The lack of accurate data pertaining to training grade (ST3-ST8) prohibited this being included in the model.

#### 7.5.5 Chapter 6

Chapter 6 is the largest study to date looking at surgical ARCP outcomes and offers a unique insight into attainment within the surgical specialities. It is the first study comparing outcomes between surgical specialities and highlighted significant variability. Outcomes across nine out of ten surgical specialities were analysed, it was not possible to include Vascular Surgery within the analysis, due to the small number of ARCP outcomes available. This is because Vascular Surgery only became a separate speciality recently, previous Vascular trainees were included within General Surgery.

#### 7.6 Recommendations

The research included in this thesis has given rise to recommendations that can be applied to surgical training in the UK.

#### 7.6.1 Recording attrition

Attrition is not currently documented in a standardised way, if at all, in UK surgical training. We recommend that all trainees leaving the programme should have an exit interview, which should be documented on ISCP. This could be easily implemented by adding a form to ISCP and held by School of Surgery. Trainees who voluntarily leave the programme will have a unique insight into issues faced during training and the possible resources that may have been helpful. Over time, this would enable future analysis on those trainees who leave on a national level and identify any specialities or training regions that have higher than average attrition.

#### 7.6.2 Devise support for at risk groups

Older trainees are consistently identified as being at higher risk of non-standard ARCP outcome. Targeted interventions and support needs to be available to this group of doctors. This could include educating trainers and supervisors about the additional challenges that older trainees may face. Similarly, we have shown that women are more likely to have a non-standard outcome across all specialties. In line with the recommendations from the Kennedy review [11], which advocated the development of a task force to address more supportive structures and career paths for parents within surgery, this should be applied to HST. While these strategies aim to offer support to at risk groups, they do not address the wider issue of potential

direct or indirect discrimination that may contribute to the adverse outcomes. This would require intensive work at the training environment level.

### 7.6.3 Review ARCP processes

At present, only 10% of ARCP outcomes are required to be reviewed by an external person, although this figure is likely to be higher in surgical specialties with high levels of SAC liaison member engagement and non-standard outcomes are only awarded with the support of the Post Graduate Dean or their representative. However, as non-standard ARCP outcomes, in particular those resulting in the release from programme, are rare, it is unlikely that this process will detect patterns in the protected characteristics of those receiving non-standard outcomes. Therefore, we recommend that patterns in the award of Outcome 3 and 4 are reviewed annually at a national and deanery level.

### 7.6.4 Standardise CCT requirements

Despite the changes in the new curriculum due to be introduced in August 2021, the operative case volume and work based assessment requirements for CCT varies considerably across surgical specialties [218 219].

Academic, management and leadership domains have been amended and are now the same across specialties. Work based assessments serve the same function regardless of speciality and therefore the number required could be standardised. While some variation in operative load should be expected between the specialties, the new curriculum has significant variation in CCT requirements. Reducing the variation in operative logbook requirements would enable more direct comparisons in the future, however

variations in the intricacy and anatomical complexity between procedures may mean this is not possible. There is a lack of evidence underpinning the indicative numbers required and further work could focus on defining the number required to achieve competency.

## **Chapter 8            Summary**

The aim of this thesis was 'to identify factors associated with progression in surgical training'. Prior to the work presented in this thesis, the existing research on differential attainment in surgical specialities in the UK was outdated and largely based on small samples. Surgery lagged behind other specialities in investigating the attainment gap. The introductory chapters describe the current training structure and the demographics of the different surgical specialities. Differential attainment is explained in relation to the changing demographics of medical students and surgical trainees and how this may impact the future of the surgical workforce.

In order to understand factors affecting progression we used a mixture of systematic reviews, meta-analysis and cohort studies. The markers of progression chosen in this thesis were attrition (failure to complete training) and ARCP outcome. We selected a range of variables that had the potential to impact progression in surgical training. These included protected characteristics, socioeconomic status, training post type and surgical specialty. We also adapted our research to the COVID-19 pandemic by including this as a risk factor to progression and describing the impact of this in Chapter 3.

Chapters 4-6 comprise the largest studies of surgical trainees in recent years. By using a quantitative approach to analysis, we avoided the pitfalls of subjective survey data and allowed a national analysis including all trainees with an ARCP outcome between 2010 and 2017. Our results not

only describe the demographics of the contemporary surgical workforce but also identify factors associated with non-standard ARCP outcomes.

We have identified female sex as a risk factor for attrition in General Surgery in our meta-analysis of largely US based studies [173]. Marital and parental status are not associated with increased risk of attrition in General Surgery residency. Longitudinal studies of contemporary surgical cohorts are needed to investigate the complex and multi-factorial reasons for failing to complete surgical residency internationally.

We have described the global impact of COVID-19 on surgical trainees across all specialities [225]. Negative effects are not limited to operative and clinical experience, but also the mental health and wellbeing of trainees. To quantify the true impact of COVID-19 and to make recommendations for the future provision of training, further studies using operative case volume and assessment data are required. Delivery of surgical training in the ongoing pandemic will need to move away from traditional models of learning to ensure trainees are competent and well supported.

We have identified factors associated with non-standard ARCP outcome across surgical specialities in the UK. We have found that risk factors for progression differ by specialty. While female sex was associated with greater risk of non-standard ARCP in Trauma and Orthopaedics and across all specialities combined, this was not true in General Surgery. Older age was significantly associated with non-standard ARCP outcomes across all three cohort studies. Older trainees may need additional support throughout training to ensure career progression. Index of multiple deprivation was

associated with an increased risk of non-standard outcome in General Surgery, however this will require further research to understand fully. Contrary to studies within other specialities, international medical graduation was protective for standard ARCP outcome in Trauma and Orthopaedics. There is a wide variation in the use of non-standard ARCP outcomes across UK surgical specialities. Furthermore, the use of non-standard outcomes is becoming more frequent over time, possible explanations include variation in CCT requirements, training quality or difficulty meeting ARCP standards. The finding that some specialities and groups of trainees have lower rates of standard ARCP outcomes requires further investigation to ensure consistent training quality and assessment regardless of specialty.

### 8.1 Areas for future research

Further work required to build upon the findings of this thesis includes exploring the issues identified with the statutory education bodies with a view to review ARCP processes at a speciality and regional level. Any areas of differential attainment should be identified and corrected as a matter of urgency. A more detailed analysis of ARCP outcomes for those groups of trainees found to be at higher risk of non-standard outcome should be performed using further data from ISCP such as an in-depth study including details of work based assessments, logbook data and supervisor reports per specialty could help to further understand the variation in outcomes. The causes behind our findings are likely to be multi-factorial and a qualitative research approach could be employed to try and identify perceptions of bias

within the ARCP process by trainers and trainees. It was not possible to include all protected characteristics in our analyses, this is due to some not routinely being collected and missing data. Future work could focus on the remaining characteristics (e.g., religion, marital status) when additional data is available. The impact of COVID-19 on surgical training is likely to persist into the future and it is possible that the pandemic will further widen the attainment gap; research investigating whether certain groups have been disproportionately affected by COVID-19 is warranted.

#### 8.1.2 Conclusion

Across this thesis we have identified factors associated with progression throughout surgical training. Female sex was associated with increased attrition, and higher risk of non-standard ARCP outcome in Trauma and Orthopaedics and across all surgical specialities combined. We also found older age at time of ARCP to be a risk factor to progression across all three of our cohort studies. Socioeconomic status, as measured by the Index of Multiple Deprivation, was found to be a risk factor for non-standard outcome in General Surgery. We have also described significant differences in ARCP outcomes between surgical specialities and a change to a higher proportion of non-standard ARCP outcomes over time.

It is likely that the impact of protected characteristics on progression through surgical training is not limited to the UK and it is important to ensure that discrimination is not a factor in surgical training in any country. The new knowledge generated by this thesis provides an insight into the challenges

faced within surgical training in the UK. These findings need to be further disseminated and escalated to surgical governing bodies so that changes can be implemented to ensure training is fair for all.

## 8.2 Impact of the thesis

The work contained in this thesis has resulted in six publications and eight presentations on an international and national level. The findings have highlighted differential attainment across surgical specialities and I was invited to present the work to the ISCP management committee and The Joint Committee on Surgical Training. The work surrounding Trauma and Orthopaedics generated a lot of social media attention and subsequently I was invited to present this work to a focus group including the Trauma and Orthopaedic Speciality Advisor Committee chair, The British Orthopaedic Association Vice President and council members of the British Orthopaedic Association. The group acted on the findings and created a plan for action going forward. I have been approached to expand on the research in this thesis and extend this work to other specialities and have had discussions regarding an international analysis of surgical competency.

## Appendices

### Appendix 1 Note on terms used to describe ethnicity

Throughout this thesis, 'Ethnic minorities' will be used to refer to all ethnic groups except the White British group. For comparisons with the White group as a whole we will use the terms 'all other ethnic groups combined' or 'Other than White'. This is in line with guidance at: [Writing about ethnicity - GOV.UK \(ethnicity-facts-figures.service.gov.uk\)](https://www.service.gov.uk/guidance/writing-about-ethnicity). When referencing previously published work regarding ethnicity, the original research terms included in the paper will be used to avoid confusion.

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16th January 2017

To Whom It May Concern:

**Re: UK Medical Education Database (UKMED) Research**

On the 11th November 2015, The Queen Mary Ethics of Research Committee viewed a generic proposal for research: this with regard to the analysis of data held by the UK Medical Education Database.

They noted confirmation received that this work both does not require NHS review; relates to the analysis of de-identified data that would be accessed under safe haven conditions, and that an annual report on agreed research could be provided for information.

Yours faithfully,

As such, members agreed that they were prepared to give documentary confirmation that there was no need for ethical review of these potential research studies, as presented.



Additional Confirmation

It was noted (via Chair and Reviewer's Action) on the 13<sup>th</sup> January 2017 that the inclusion of additional datasets — both confirmed and proposed - will not affect the assessment above. There continues to be no need for ethical review of these studies.

Ms Elizabeth Hall — QMREC Chair.

Appendix 3 Protocol for Factors Associated with Attrition and Performance  
throughout Surgical Training: a Meta-Analysis

**Review Protocol**

**Title**

Factors Associated with Progression and Bias throughout Surgical Training:  
a Systematic Review

**Registration**

In accordance with the guidelines, this systematic review protocol was made  
available on OSF registry.

**Authors**

Corresponding author: Carla Hope carlahope@nhs.net

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### **Author contributions**

CH and JR drafted the manuscript. All authors contributed to the development of the selection criteria, the risk of bias assessment strategy and data extraction criteria. CH and JR developed the search strategy. JL, GG and DH provided expertise on surgical training. All authors read, provided feedback and approved the final manuscript.

### **Financial support**

Not applicable.

### **Introduction**

There is some evidence that surgical training is biased towards White, affluent males. As the number of women and ethnic minorities in surgery is starting to increase, we want to know if there are any factors that predict success or are barriers to progression through postgraduate surgical training

worldwide. These factors should include protected characteristics and working pattern and socioeconomic factors.

## **Objectives**

The aim of this systematic review is to identify factors that influence progression through or completion of surgical training and will address the following:

1. Are there any factors that predict progression or completion through postgraduate surgical training?
2. Is there any evidence of bias towards certain groups during postgraduate surgical training?

## **Methods**

**Participants:** postgraduate surgical trainees. General surgery, trauma and orthopaedics, vascular, urology, ENT, cardiothoracics, plastics, neurosurgery, paediatric surgery and maxillofacial surgery will be included. Training in any country worldwide is eligible for inclusion.

**Intervention:** n/a

**Comparison:** n/a

**Outcome:** The primary outcome is the completion of (or failure to complete) surgical training, or other measure of progression through training such as performance in annual review, or in-training assessments. Attrition will be used a marker of lack of progression.

## **Inclusion Criteria**

The review aims to identify papers evaluating factors that affect progression through Surgical Training or identify bias within Surgical Training. We included all types of study. There were no restrictions on the language of or date of publication date when searching the electronic databases.

## **Exclusion Criteria**

1. Studies not investigating specialty surgical trainees e.g., consultants/faculty, non-medical staff, undergraduate training.
2. Studies focused on selection into training.

## **Information sources**

- MEDLINE Ovid
- EMBASE Ovid
- PUBMED
- Cochrane Central Register of Controlled Trials (CENTRAL).
- Reference lists of included articles

The subject strategies for databases will be modelled on the search strategy designed for MEDLINE Ovid. The reference lists of included studies will be searched for further eligible studies.

- Two review authors (CH and JJR) will independently and in duplicate perform the title and abstract screening. The full text of all eligible and potentially eligible studies will be further evaluated by DH and CH to identify studies meeting the inclusion criteria. Any disagreement will be resolved by discussion, or where necessary a third reviewer (GG) opinion. The studies that were evaluated in full text but do not meet the inclusion criteria will be included in table form with reasons for exclusion.

## **Data collection process**

Two review authors (CH and JJR) independently and in duplicate will extract the data. The review authors will not be blinded to the authors of the included studies. Any disagreement will be resolved by discussion, or where

necessary a third reviewer (GG) opinion. If clarification was needed for any aspect of the included studies, the authors will be contacted by email if possible.

The following details will be collected for each included study.

1. Publication year.
2. Country of origin.
3. Participant characteristics- type of surgical training programme such as subspecialty and grade.
4. Study size and design.
5. Summary of findings.

### **Risk of bias in individual studies**

Methodology checklists for both cohort and case control studies will be reviewed, and relevant aspects from each employed to critically appraise and grade the evidence of included studies. The quality of the included studies will be assessed using the Cochrane Risk of Bias Tool [10] for randomised studies and STROBE criteria [11] for other study types.

### **Synthesis of results**

We intend to perform a narrative summary due to the nature of the objectives. It is likely that a range of factors affecting progression or bias will be identified and some of these may be subjective. We also expect a wide range of study designs and populations. We will organise the narrative into

two sections: factors affecting progression and factors associated with bias.

We intend to structure the narrative by themes emerging from the literature (e.g., sex, age, ethnicity).

### **Dissemination of Results**

We intend to publish the results in a medical/surgical journal with an interest in education.

Appendix 4 Protocol for The Impact of Covid-19 on Surgical Training: a systematic review protocol

**Review Protocol**

**Title**

The impact of Covid-19 on Surgical Training: a Systematic Review Protocol

**Registration**

In accordance with the guidelines, this systematic review protocol was made available on OSF registry.

**Authors**

Corresponding author: Carla Hope carlahope@nhs.net

Carla Hope<sup>1</sup>, John-Joe Reilly<sup>2</sup>, Gareth Griffiths<sup>3</sup>, Jon Lund<sup>1</sup>, David Humes<sup>4,5</sup>

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5. National Institute for Health Research Nottingham Digestive Diseases Biomedical Research Unit, E Floor West Block, QMC Campus, Nottingham University Hospitals NHS Trust, Nottingham, UK, NG7 2UH

### **Author contributions**

CH and JR drafted the manuscript. All authors contributed to the development of the selection criteria, the risk of bias assessment strategy and data extraction criteria. CH and JR developed the search strategy. JL, GG and DH provided expertise on surgical training. All authors read, provided feedback and approved the final manuscript.

### **Financial support**

Not applicable.

### **Introduction**

The Covid-19 pandemic has affected all areas of life on a global scale. Health services have been re-structured and staff redeployed in order to accommodate the crisis. Many elective surgical operations and outpatient clinics have been postponed and surgical trainees have in some cases been redeployed to other areas. Training and assessment has understandably taken a backseat to the pandemic. As many countries move towards a rate

of stable infection, it is important to consider the impact of Covid-19 on surgical trainees and what interventions will be needed to minimise long term impact.

## **Objectives**

The aim of this systematic review is to identify the impact of Covid-19 on surgical training and will address the following:

1. How has covid-19 impacted surgical training?
2. What strategies can minimise the long term impact caused by Covid-19 to surgical training?

## **Methods**

**Participants:** postgraduate surgical trainees in any surgical specialty.

Training in any country worldwide is eligible for inclusion.

**Intervention:** Covid-19

**Comparison:** n/a

**Outcome:** The primary outcome is the impact on surgical training. This may be measured as loss of training opportunities, lack of assessments, loss of training time, delay in progression, redeployment, extended training time or trainee satisfaction.

## **Inclusion Criteria**

We included all types of study. There were no restrictions on the language of or date of publication date when searching the electronic databases.

## **Exclusion Criteria**

3. Studies not investigating specialty surgical trainees e.g., consultants/faculty, non-medical staff, undergraduate training.
4. Studies focused solely on the recovery of surgical services (without trainee perspective).

## **Information sources**

- MEDLINE Ovid
- EMBASE Ovid
- PUBMED
- Cochrane Central Register of Controlled Trials (CENTRAL).
- Reference lists of included articles

The subject strategies for databases will be modelled on the search strategy designed for MEDLINE Ovid. The reference lists of included studies will be searched for further eligible studies.

- Two review authors (CH and JJR) will independently and in duplicate perform the title and abstract screening. The full text of all eligible and potentially eligible studies will be further evaluated by DH and CH to identify studies meeting the inclusion criteria. Any disagreement will be resolved by discussion, or where necessary a third reviewer (GG) opinion. The studies that were evaluated in full text but do not meet the inclusion criteria will be included in table form with reasons for exclusion.

### **Data collection process**

Two review authors (CH and JJR) independently and in duplicate will extract the data. The review authors will not be blinded to the authors of the included studies. Any disagreement will be resolved by discussion, or where necessary a third reviewer (GG) opinion. If clarification was needed for any aspect of the included studies, the authors will be contacted by email if possible.

The following details will be collected for each included study.

6. Publication year.
7. Country of origin.
8. Participant characteristics- type of surgical training programme such as subspecialty and grade.
9. Study size and design.
10. Summary of findings.

### **Risk of bias in individual studies**

Methodology checklists for both cohort and case control studies will be reviewed, and relevant aspects from each employed to critically appraise and grade the evidence of included studies. The quality of the included studies will be assessed using the Cochrane Risk of Bias Tool [10] for randomised studies and STROBE criteria [11] for other study types.

### **Synthesis of results**

We intend to perform a narrative summary due to the nature of the objectives and the likely lack of data due to the recent nature of the Covid-19 pandemic. It is likely that most of the papers will be editorial or narrative in nature and hence a meta-analysis is unlikely to be possible. We also expect a wide range of populations with different surgical training structures. We intend to structure the narrative by themes emerging from the literature (e.g., loss of training time, loss of operative cases).

## **Dissemination of Results**

We intend to publish the results in a medical/surgical journal with an interest in surgical training.

## **Preliminary search strategies**

### **Medline/Ovid= 126**

1. coronavirus.mp. or Coronavirinae/
2. pandemic/ or covid-19.mp.
3. covid.mp.
4. 'surgical training'.mp. or surgical training/
5. 'surgeons in training'.mp. or residency education/ or surgical training/
6. 'surgical trainee'.mp. or surgical training/
7. 'surgical training programme'.mp.
8. surgical resident.mp. or resident/
9. 'resident in training'.mp.
10. postgraduate.mp. [mp=ti, ab, hw, tn, ot, dm, mf, dv, kw, fx, dq, nm, kf, ox, px, rx, an, ui, sy]
11. training progression.mp. [mp=ti, ab, hw, tn, ot, dm, mf, dv, kw, fx, dq, nm, kf, ox, px, rx, an, ui, sy]
12. assessment.mp. [mp=ti, ab, hw, tn, ot, dm, mf, dv, kw, fx, dq, nm, kf, ox, px, rx, an, ui, sy]
13. 1 or 2 or 3
14. 4 or 5 or 6 or 7 or 8 or 9
15. training.mp. [mp=ti, ab, hw, tn, ot, dm, mf, dv, kw, fx, dq, nm, kf, ox, px, rx, an, ui, sy]
16. 10 or 11 or 12 or 15
17. 13 and 14 and 16

**Pubmed= 28**

(((((coronavirus[Title/Abstract]) OR covid-19[Title/Abstract]) OR covid[Title/Abstract]) OR pandemic[Title/Abstract])) AND ((((((surgical training[Title/Abstract]) OR surgeons in training[Title/Abstract]) OR residency education[Title/Abstract]) OR surgical trainee[Title/Abstract]) OR surgical training programme[Title/Abstract]) OR surgical resident[Title/Abstract]) OR resident in training[Title/Abstract])) AND (((postgraduate) OR training progression) OR assessment) OR training)

**Cochrane= 129**

coronavirus OR covid-19 OR covid OR pandemic AND surgical train\* OR surgeons in training OR residency education OR surgical training programme OR surgical residen\* OR resident in training AND postgraduate OR training progression OR assessment OR training (Word variations have been searched)

## Appendix 5 UKMED Approval UKMEDP083

*Message sent on behalf of UKMED Advisory Board Chair and Research Subgroup Chair*

I am delighted to confirm that your resubmitted application UKMEDP83 has been reviewed by the Chair of UKMED Research Subgroup and the UKMED Advisory Board who took the decision to approve it.

In light of the fact the resubmission stipulates only analysing the surgical trainees, we would suggest first establishing the variation in overall primary and secondary ARCP outcomes by deanery in case there are some confounding local effects to consider.

Daniel Smith (copied into this message) will contact you regarding signing of a Data Sharing Agreement. Please note that we will publish the summary section of your application on the [UKMED Accepted Applications page](#).

With congratulations on successful application,

Prof Steve Thornton, Chair of the UKMED Advisory Board

Prof Jon Dowell, Chair of the UKMED Research Subgroup

## References

1. Silva J, Ribeiro-Alves M. Social inequalities and the pandemic of COVID-19: the case of Rio de Janeiro. *Journal of Epidemiology and Community Health* 2021;jech-2020-214724. doi: 10.1136/jech-2020-214724
2. COVID-19 and the unequal surge in mortality rates in Massachusetts, by city/town and ZIP Code measures of poverty, household crowding, race/ethnicity, and racialized economic segregation. Harvard Center for Population and Development Studies; 2020. Harvard Center for Population and Development Studies.
3. Caul S. Deaths Involving Covid-19 by Local Area and Socioeconomic Deprivation: Deaths Occurring Between 1 March and 31 July 2020. *Statistical Bulletin* 2020
4. General Medical Council. The state of medical education and practice in the UK 2018 [cited 21/06/2021 2021]. Available from: <https://www.gmc-uk.org/-/media/gmc-site-images/about/what-we-do-and-why/data-and-research/somep-2018/version-one---0412pm/somep-book-20187.pdf?la=en&hash=D45D35305C0F5EF15BD580C148493E7F49B07923> accessed 2021 02/01/2021.
5. NHS Confederation. NHS statistics, facts and figures 2017 [Available from: <http://www.nhsconfed.org/resources/key-statistics-on-the-nhs> accessed 09/09/2018 2018.
6. Esmail A, Everington S. Racial discrimination against doctors from ethnic minorities. *British Medical Journal* 1993;306(6879):691-92. doi: 10.1136/bmj.306.6879.691
7. The Queen on the application of Bapio Action Ltd [Cliamant] v Royal College of General Practitioners [First Defendant] and General Medical Council [Second Defendant], in the High Court of Justice, Queen's Bench Division, The Administrative Court, 2014.
8. Woolf K, Rich A, Viney R, et al. Fair Training Pathways for All: Understanding Experiences of Progression Final Report: General Medical Council, 2016.
9. Woolf K, Viney R, Rich A, et al. Fair Training Pathways for All: Understanding Experiences of Progression. Part 2. Final Report: General Medical Council; 2017 [Available from: [https://www.gmc-uk.org/-/media/documents/2017-05-08confidentialfairpathwayspart2finalreportforpublication\\_pdf-73892815.pdf](https://www.gmc-uk.org/-/media/documents/2017-05-08confidentialfairpathwayspart2finalreportforpublication_pdf-73892815.pdf) accessed 10/11/2018 2018.
10. General Medical Council. A quality workforce: ensuring standards, applying fairness, 2018.
11. Kennedy H. The Royal College- Our Professional Home. An independent review on diversity and inclusion for the Royal College of Surgeons of England, 2021.
12. Royal College of Surgeons of England. We will put diversity at the heart of our strategy 2021 [cited 2021 24/06/2021]. Available from: <https://www.rcseng.ac.uk/about-the-rcs/about-our-mission/diversity-review-2021/> accessed 24/06/2021 2021.
13. Work Psychology Group. Evaluating the impact of interventions aimed at addressing variation in progression associated with protected characteristics known as 'Differential Attainment' 2018 [cited 01/04/2021 2021]. Available from: [https://www.gmc-uk.org/-/media/documents/gmc-differential-attainment-final-report-13\\_08\\_18-76652679.pdf](https://www.gmc-uk.org/-/media/documents/gmc-differential-attainment-final-report-13_08_18-76652679.pdf) accessed 21/03/2021 2021.

14. Elsey EJ, West J, Griffiths G, et al. Time Out of General Surgery Specialty Training in the UK: A National Database Study. *Journal of Surgical Education* 2019;76(1):55-64. doi: <https://doi.org/10.1016/j.jsurg.2018.06.011>
15. Association of Surgeons in Training. The cost of surgical training 2007 [cited 2021 05/06/2021]. Available from: [https://www.asit.org/assets/documents/ASiT\\_Cost\\_of\\_Surgical\\_Training\\_final.pdf](https://www.asit.org/assets/documents/ASiT_Cost_of_Surgical_Training_final.pdf) accessed 05/02/2020 2020.
16. Health Education E. A Reference Guide for Postgraduate Specialty Training in the UK: The Gold Guide 2018 [cited 2021 27/06/2021]. GG7 31st January 2018:[Available from: [https://www.copmed.org.uk/images/docs/gold\\_guide\\_7th\\_edition/The\\_Gold\\_Guide\\_7th\\_Edition\\_January\\_2018.pdf](https://www.copmed.org.uk/images/docs/gold_guide_7th_edition/The_Gold_Guide_7th_Edition_January_2018.pdf) accessed 12/06/2021 2021.
17. Core Surgical Prep. Training Pathways 2020 [cited 2021 07/07/2021]. Available from: <https://coresurgicalprep.com/surgical-training/> accessed 07/07/2021 2021.
18. Joint Committee on Surgical Training. Core Surgical Training 2018 [cited 2020 23/12/2020]. Available from: <https://www.jcst.org/uk-trainees/core-surgical-training/> accessed 23/12/2020 2020.
19. General Medical Council. The Intercollegiate Surgical Curriculum: educating the surgeons of the future 2018 [cited 2020 27/12/2020]. Available from: [https://www.gmc-uk.org/-/media/documents/General\\_Surgery\\_inc.\\_Trauma\\_TIG\\_approved\\_Jul\\_17\\_.pdf?72509288.pdf](https://www.gmc-uk.org/-/media/documents/General_Surgery_inc._Trauma_TIG_approved_Jul_17_.pdf?72509288.pdf) accessed 27/12/2020 2020.
20. Conference of Postgraduate Medical Deans (UK). A Reference Guide for Postgraduate Foundation and Specialty Training in the UK: The Gold Guide 8th edition 2019 [updated 2020; cited 2020 23/12/2020]. Available from: [https://www.copmed.org.uk/images/docs/gold\\_guide\\_8th\\_edition/Gold\\_Guide\\_8th\\_Edition\\_March\\_2020.pdf](https://www.copmed.org.uk/images/docs/gold_guide_8th_edition/Gold_Guide_8th_Edition_March_2020.pdf) accessed 23/12/2020 2020.
21. Royal College of Surgeons. Improving Surgical Training: Trainee Prospectus 2020 2020 [cited 2020 01/12/2020]. Available from: <https://www.rcseng.ac.uk/careers-in-surgery/trainees/ist/> accessed 01/12/2020 2020.
22. Royal College of Surgeons of England. Surgery Entry Requirements 2020 [cited 2020 27/12/2020]. Available from: <https://www.rcseng.ac.uk/careers-in-surgery/careers-support/what-is-surgery-like-as-a-career/entry-requirements-and-training/> accessed 27/12/2020 2020.
23. Royal College of Surgeons of England. Time Out of Programme 2020 [cited 2020 27/12/2020]. Available from: <https://www.rcseng.ac.uk/careers-in-surgery/trainees/st3-and-beyond/time-out-of-programme/> accessed 27/12/2020 2020.
24. Healthcare for London. A framework for action. 2nd ed. London: Department of Health, 2007.
25. GOV.UK. Population of England and Wales 2020 [cited 2021 28/06/2021]. Available from: <https://www.ethnicity-facts-figures.service.gov.uk/uk-population-by-ethnicity/national-and-regional-populations/population-of-england-and-wales/latest#by-ethnicity> accessed 28/06/2021 2021.
26. Health Education England. Competition Ratios 2020 [cited 2021 06/01/2021]. Available from: <https://specialtytraining.hee.nhs.uk/Competition-Ratios> accessed 06/01/2021 2021.

27. NHS Digital. HCHS doctors in Surgical group by gender, ethnicity and grade, January 20 AH 3327 2020 [cited 2021 05/01/2021]. Available from: <https://digital.nhs.uk/data-and-information/supplementary-information/2020/hchs-doctors-in-surgical-group-by-gender-ethnicity-and-grade-jan20-ah3327> accessed 05/01/2021 2021.
28. General Medical Council. National training surveys reports 2020 [cited 2021 06/01/2021]. Available from: <https://www.gmc-uk.org/about/what-we-do-and-why/data-and-research/national-training-surveys-reports> accessed 06/01/2021 2021.
29. Robinson DBT, James OP, Hopkins L, et al. Stress and Burnout in Training; Requiem for the Surgical Dream. *Journal of Surgical Education* 2020;77(1):e1-e8. doi: <https://doi.org/10.1016/j.jsurg.2019.07.002>
30. Maslach C, Jackson SE, Leiter MP, et al. Maslach burnout inventory: Consulting psychologists press Palo Alto, CA 1986.
31. NHS Digital. Analysis of the representation of women across the hospital and community health services workforce 2018 [cited 2021 07/07/2021]. Available from: <https://digital.nhs.uk/data-and-information/find-data-and-publications/supplementary-information/2018-supplementary-information-files/analysis-of-the-representation-of-women-across-the-hospital-and-community-health-services-workforce> accessed 07/07/2021 2021.
32. Vascular Society. Vascular Surgery United Kingdom Workforce Survey 2018 [cited 2021 09/03/2021]. Available from: [https://vascularsociety.org.uk/userfiles/pages/files/Document%20Library/Vascular%20Surgery%20Workforce%20Survey%20%202018%20V4\\_0\(1\).pdf](https://vascularsociety.org.uk/userfiles/pages/files/Document%20Library/Vascular%20Surgery%20Workforce%20Survey%20%202018%20V4_0(1).pdf) accessed 09/03/2021 2021.
33. The Intercollegiate Specialty Curriculum Programme. About Us- ISCP 2020 [cited 2020 27/12/2020]. Available from: <https://www.iscp.ac.uk/iscp/about-us/about-iscp/> accessed 27/12/2020 2020.
34. Government Equalities Office. The UK Equality Act, 2010.
35. Regan de Bere S, Nunn S, Nasser M. Understanding differential attainment across medical training pathways: A rapid review of the literature, 2015.
36. House of L. Opinions of the Lords of Appeal for Judgment in the Cause R (on the application of Bapio Action Limited and another) v Secretary of State for the Home Department and another (Appellant), 2008.
37. Harkin E, Murphy M, Liskutin T, et al. Discriminatory questions asked during residency programme interviews: perspective from both interviewers and applicants. *Postgrad Med J* 2020 doi: 10.1136/postgradmedj-2019-136953 [published Online First: 2020/07/15]
38. Yeo HL, Abelson JS, Symer MM, et al. Association of time to attrition in surgical residency with individual resident and programmatic factors. *JAMA Surgery* 2018;153(6):511-17.
39. Jarman BT, Kallies KJ, Joshi ART, et al. Underrepresented Minorities are Underrepresented Among General Surgery Applicants Selected to Interview. *J Surg Educ* 2019;76(6):e15-e23. doi: 10.1016/j.jsurg.2019.05.018 [published Online First: 2019/06/09]
40. Durham SR, Donaldson K, Grady MS, et al. Analysis of the 1990-2007 neurosurgery residency match: does applicant gender affect neurosurgery match outcome? *J Neurosurg* 2018;129(2):282-89. doi: 10.3171/2017.11.Jns171831 [published Online First: 2018/06/09]

41. Hauser LJ, Gebhard GM, Blumhagen R, et al. Applicant characteristics associated with successful matching into otolaryngology. *The Laryngoscope* 2017;127(5):1052-57. doi: 10.1002/lary.26236 [published Online First: 2016/10/21]
42. Ruzycki SM, Earp M, Ma IWY. Applicant gender and matching to first-choice discipline: a cross-sectional analysis of data from the Canadian Resident Matching Service (2013-2019). *CMAJ Open* 2020;8(2):E346-E51. doi: 10.9778/cmajo.20190029
43. Meyerson SL, Sternbach JM, Zwischenberger JB, et al. The Effect of Gender on Resident Autonomy in the Operating room. *Journal of Surgical Education* 2017;74(6):e111-e18.
44. Meyerson SL, Odell DD, Zwischenberger JB, et al. The effect of gender on operative autonomy in general surgery residents. *Surgery* 2019;166(5):738-43. doi: 10.1016/j.surg.2019.06.006 [published Online First: 2019/07/17]
45. Steven K, Dowell J, Jackson C, et al. Fair access to medicine? Retrospective analysis of UK medical schools application data 2009-2012 using three measures of socioeconomic status. *BMC medical education* 2016;16:11. doi: 10.1186/s12909-016-0536-1 [published Online First: 2016/01/14]
46. Medical Schools Council. Selection Alliance 2018 report 2018 [cited 2021 05/01/2021]. Available from: <https://www.medschools.ac.uk/media/2536/selection-alliance-2018-report.pdf> accessed 20/12/2020 2020.
47. Medical Schools Council. Selection Alliance 2017 Report 2017 [cited 2021 09/03/2021]. Available from: <https://www.medschools.ac.uk/media/2388/msc-selection-alliance-2017-report.pdf#:~:text=medschools.ac.uk%20%201.%20Introduction%20This%20is%20the%20first,the%20Selecting%20for%20Excellence%20Final%20Report.%20While%20this> accessed 09/03/2021 2021.
48. General Medical Council. The state of medical education and practice in the UK 2020 2020 [cited 2021 24/06/2021]. Available from: <https://www.gmc-uk.org/about/what-we-do-and-why/data-and-research/the-state-of-medical-education-and-practice-in-the-uk/2020> accessed 27/12/2020 2020.
49. Universities UK. Patterns and trends in UK higher education 2018 [cited 2021 09/03/2021]. Available from: <https://universitiesuk.ac.uk/facts-and-stats/data-and-analysis/Pages/Patterns-and-trends-in-UK-higher-education-2018.aspx> accessed 09/03/2021 2021.
50. Medical Workforce Standing Advisory Committee. Planning the medical workforce: third report. *London: Department of Health* 1997
51. Peile E. Should all medical students be graduates first? Yes. *BMJ (Clinical research ed)* 2007;335(7629):1072. doi: 10.1136/bmj.39283.476725.BE [published Online First: 2007/11/24]
52. Garrud P. Who applies and who gets admitted to UK graduate entry medicine? - an analysis of UK admission statistics. *BMC medical education* 2011;11(1):71. doi: 10.1186/1472-6920-11-71
53. 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 medical education* 2018;18(1):250. doi: 10.1186/s12909-018-1355-3

54. Mathers J, Sitch A, Marsh JL, et al. Widening access to medical education for under-represented socioeconomic groups: population based cross sectional analysis of UK data, 2002-6. *BMJ (Clinical research ed)* 2011;342:d918. doi: 10.1136/bmj.d918
55. Milburn A. Fair Access to Professional Careers. A progress report by the Independent Reviewer on Social Mobility and Child Poverty 2013 [cited 2021 05/01/2021]. Available from: [https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment\\_data/file/61090/IR\\_FairAccess\\_acc2.pdf](https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/61090/IR_FairAccess_acc2.pdf) accessed 05/01/2021 2021.
56. General Medical Council. The state of medical education and practice in the UK, 2019.
57. General Medical Council. 2017 national training surveys summary report: initial results on doctors' training and progression 2017 [cited 2021 24/06/2021]. Available from: <https://www.gmc-uk.org/about/what-we-do-and-why/data-and-research/-/media/documents/2017-national-training-surveys-summary-report-initial-results-on-doctors-training-progressi-71003116.pdf> accessed 27/12/2020 2020.
58. General Medical Council. The state of medical education and practice in the UK 2017 [Available from: <https://www.gmc-uk.org/-/media/gmc-site-images/about/what-we-do-and-why/data-and-research/somep-2017/somep-2017-final-full.pdf?la=en&hash=1380D1946084C02C67CF59B0AD527BC8A52AF39E202026/06/2020>].
59. NHS Digital. NHS Hospital and Community Health Services (HCHS): HCHS doctors working in Anaesthetics and Surgical group, by specialty and grade, in NHS Trusts and CCGs in England, 2018.
60. Harries RL, Gokani VJ, Smitham P, et al. Less than full-time training in surgery: a cross-sectional study evaluating the accessibility and experiences of flexible training in the surgical trainee workforce. *BMJ Open* 2016;6(4):e010136. doi: 10.1136/bmjopen-2015-010136
61. Office for National Statistics. 2011 Census: workplace population analysis 2014 [cited 2021 27/06/2021]. Available from: <https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationestimates/articles/workplacepopulationanalysis/2014-05-23#workplace-population-characteristics> accessed 02/05/2020 2020.
62. General Medical Council. General Medical Council: the state of medical education and practice in the UK report 2017 [cited 2020 09/03/2020]. Available from: <https://www.gmc-uk.org/about/what-we-do-and-why/data-and-research/the-state-of-medical-education-and-practice-in-the-uk#the-state-of-medical-education> accessed 09/03/2020 2020.
63. Rodriguez Santana I, Chalkley M. Getting the right balance? A mixed logit analysis of the relationship between UK training doctors' characteristics and their specialties using the 2013 National Training Survey. *BMJ open* 2017;7(8):e015219-e19. doi: 10.1136/bmjopen-2016-015219
64. McManus IC, Dewberry C, Nicholson S, et al. The UKCAT-12 study: educational attainment, aptitude test performance, demographic and socio-economic contextual factors as predictors of first year outcome in a cross-sectional collaborative study of 12 UK medical schools. *BMC Medicine* 2013;11(1):244. doi: 10.1186/1741-7015-11-244

65. General Medical Council. How do doctors progress through key milestones during training?, 2016.
66. Tiffin PA, Orr J, Paton LW, et al. UK nationals who received their medical degrees abroad: selection into, and subsequent performance in postgraduate training: a national data linkage study. *BMJ Open* 2018;8(7):e023060. doi: 10.1136/bmjopen-2018-023060 [published Online First: 2018/07/10]
67. Scrimgeour DSG, Brennan PA, 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? *The Annals of The Royal College of Surgeons of England* 2018;100(8):669-75. doi: 10.1308/rcsann.2018.0153
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;5(2):e005658. doi: 10.1136/bmjopen-2014-005658 [published Online First: 2015/02/03]
69. Smith DT, Tiffin PA. Evaluating the validity of the selection measures used for the UK's foundation medical training programme: a national cohort study. *BMJ Open* 2018;8(7):e021918. doi: 10.1136/bmjopen-2018-021918 [published Online First: 2018/07/13]
70. Tiffin PA, Illing J, Kasim AS, et al. Annual Review of Competence Progression (ARCP) performance of doctors who passed Professional and Linguistic Assessments Board (PLAB) tests compared with UK medical graduates: national data linkage study. *BMJ (Clinical research ed)* 2014;348:g2622. [published Online First: 2014/04/17]
71. Robinson DBT, Hopkins L, James OP, et al. Egalitarianism in surgical training: let equity prevail. *Postgraduate Medical Journal* 2020;96(1141):650. doi: 10.1136/postgradmedj-2020-137563
72. Scrimgeour D, Brennan PA, 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;1-7. doi: 10.1308/rcsann.2018.0153 [published Online First: 2018/10/05]
73. Ministry of Housing CLG. The English Indices of Deprivation 2019 (IoD2019) 2019 [cited 2021 29/06/2021]. Available from: [https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment\\_data/file/835115/IoD2019\\_Statistical\\_Release.pdf](https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/835115/IoD2019_Statistical_Release.pdf) accessed 29/06/2021 2021.
74. Smith D, Twigg E, Gurusamy G, et al. UKMED- 2019 V1- March Data Dictionary, 2019.
75. Joint Committee on Intercollegiate Examinations. The Joint Committee on Intercollegiate Examinations 2021 [cited 2021 23/03/2021]. Available from: <https://www.jcie.org.uk/content/content.aspx?ID=1> accessed 23/03/2021 2021.
76. 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)? *The surgeon : journal of the Royal Colleges of Surgeons of Edinburgh and Ireland* 2018;16(4):220-26. doi: 10.1016/j.surge.2017.10.001 [published Online First: 2017/11/06]
77. Ellis R, Brennan P, Scrimgeour DSG, 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. *Postgraduate Medical Journal* 2021;postgradmedj-2021-139748. doi: 10.1136/postgradmedj-2021-139748

78. Scrimgeour DSG, Cleland J, Lee AJ, et al. Predictors of success in the Intercollegiate Membership of the Royal College of Surgeons (MRCS) examination. *The Annals of The Royal College of Surgeons of England* 2018;100(6):424-27. doi: 10.1308/rcsann.2018.0073
79. Stevens S, Pritchard A. Next steps on NHS response to COVID-19 2020 [cited 2021 05/01/2021]. Available from: <https://www.england.nhs.uk/coronavirus/wp-content/uploads/sites/52/2020/03/urgent-next-steps-on-nhs-response-to-covid-19-letter-simon-stevens.pdf> accessed 05/01/2021 2021.
80. Joint Committee on Surgical Training. Surgery specific management of ARCPs during COVID-19 2020 [cited 2020 27/12/2020]. Available from: <https://www.entuk.org/sites/default/files/Surgery%20specific%20management%20of%20ARCPs%20during%20COVID-19.pdf> accessed 27/12/2020 2020.
81. UK Medical Education Database. UK Medical Education Database 2020 [cited 2020 27/12/2020]. Available from: <https://www.ukmed.ac.uk/> accessed 27/12/2020 2020.
82. 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 medical education* 2018;18(1):6. doi: 10.1186/s12909-017-1115-9
83. United Kingdom Medical Education Database. Process for completing UKMED research 2020 [cited 2021 24/06/2021]. Available from: [https://www.ukmed.ac.uk/documents/UKMED\\_research\\_process.pdf](https://www.ukmed.ac.uk/documents/UKMED_research_process.pdf) accessed 24/06/2021 2021.
84. Beck C, Brown C. Could the UK Foundation Programme training post allocation process result in regional variations in the knowledge and skills of Foundation doctors? A cross-sectional study. *Health Science Reports* 2020;3(4):e201. doi: <https://doi.org/10.1002/hsr2.201>
85. McManus IC, Woolf K, Harrison D, et al. Calculated grades, predicted grades, forecasted grades and actual A-level grades: Reliability, correlations and predictive validity in medical school applicants, undergraduates, and postgraduates in a time of COVID-19. *medRxiv* 2020:2020.06.02.20116830. doi: 10.1101/2020.06.02.20116830
86. Curtis S, Smith D. A comparison of undergraduate outcomes for students from gateway courses and standard entry medicine courses. *BMC medical education* 2020;20(1):4. doi: 10.1186/s12909-019-1918-y
87. Yeo H, Bucholz E, Ann Sosa J, et al. A national study of attrition in general surgery training: Which residents leave and where do they go? *Annals of Surgery* 2010;252(3):529-34.
88. Kwakwa F, Jonasson O. Attrition in graduate surgical education: An analysis of the 1993 entering cohort of surgical residents. *Journal of the American College of Surgeons* 1999;189(6):602-10.
89. United States Congress. H.R.5-Equality Act 2019 [cited 2021 09/03/2021]. Available from: <https://www.congress.gov/bill/116th-congress/house-bill/5> accessed 2020 23/01/2020.
90. Shweikeh F, Schwed AC, Hsu CH, et al. Status of Resident Attrition From Surgical Residency in the Past, Present, and Future Outlook. *Journal of Surgical Education* 2018;75(2):254-62.
91. Khoushhal Z, Hussain MA, Greco E, et al. Prevalence and causes of attrition among surgical residents a systematic review and meta-analysis. *JAMA Surgery* 2017;152(3):265-72.
92. American College of Surgeons. Statement on Harassment, Bullying, and Discrimination 2019 [cited 2020 03/03/2020]. Available from:

- <https://www.facs.org/about-ac/s/statements/117-harassment>  
accessed 03/03/2020 2020.
93. General Medical Council. The GMC asks doctors for diversity data to help ensure fair regulation 2019 [cited 2020 03/03/2020]. Available from: <https://www.gmc-uk.org/news/news-archive/doctors-diversity-data> accessed 03/03/2020 2020.
  94. Liaison Committee on Medical Education. Liaison Committee on Medical Education (LCME) Standards on Diversity Washington DC2009 [Available from: <https://health.usf.edu/~media/Files/Medicine/MD%20Program/iversity/LCMEStandardsonDiversity1.ashx?la=en>. accessed 18/10/2019 2019.
  95. Bruce AN, Battista A, Plankey MW, et al. Perceptions of gender-based discrimination during surgical training and practice. *Medical Education Online* 2015;20(1):25923. doi: 10.3402/meo.v20.25923
  96. Moher D, Liberati A, Tetzlaff J, et al. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *BMJ (Clinical research ed)* 2009;339:b2535. doi: 10.1136/bmj.b2535 [published Online First: 2009/07/23]
  97. Wells G, Shea B, O'Connell D, et al. The Newcastle-Ottawa Scale (NOS) for assessing the quality of nonrandomised studies in meta-analyses [Available from: [http://www.ohri.ca/programs/clinical\\_epidemiology/oxford.asp](http://www.ohri.ca/programs/clinical_epidemiology/oxford.asp) accessed 04/01/2020 2020.
  98. Brown EG, Galante JM, Keller BA, et al. Pregnancy-related attrition in general surgery. *JAMA Surgery* 2014;149(9):893-97.
  99. Naylor RA, Reisch JS, Valentine RJ. Factors related to attrition in surgery residency based on application data. *Arch Surg* 2008;143(7):647-51; discussion 51-2. doi: 10.1001/archsurg.143.7.647 [published Online First: 2008/07/23]
  100. Sullivan MC, Yeo H, Roman SA, et al. Surgical residency and attrition: defining the individual and programmatic factors predictive of trainee losses. *Journal of the American College of Surgeons* 2013;216(3):461-71. doi: <https://dx.doi.org/10.1016/j.jamcollsurg.2012.11.005>
  101. Gifford E, Galante J, Kaji AH, et al. Factors associated with general surgery residents' desire to leave residency programs: A multi-institutional study. *JAMA Surgery* 2014;149(9):948-53.
  102. Symer MM, Abelson JS, Wong NZ, et al. Impact of medical school experience on attrition from general surgery residency. *Journal of Surgical Research* 2018;232:7-14.
  103. Yeo HL, Abelson JS, Mao J, et al. Who Makes It to the End?: A Novel Predictive Model for Identifying Surgical Residents at Risk for Attrition. *Annals of Surgery* 2017;266(3):499-507.
  104. Burkhart RA, Tholey RM, Guinto D, et al. Grit: a marker of residents at risk for attrition? *Surgery* 2014;155(6):1014-22. doi: <https://dx.doi.org/10.1016/j.surg.2014.01.015>
  105. Salles A, Lin D, Liebert C, et al. Grit as a predictor of risk of attrition in surgical residency. *American Journal of Surgery* 2017;213(2):288-91.
  106. Salles A, Wright RC, Milam L, et al. Social Belonging as a Predictor of Surgical Resident Well-being and Attrition. *Journal of Surgical Education* 2019;76(2):370-77.
  107. Symer MM, Abelson JS, Yeo HL, et al. The Surgical Personality: Does Surgery Resident Motivation Predict Attrition? *Journal of the American College of Surgeons* 2018;226(5):777-83.

108. Quillin IRC, Pritts TA, Hanseman DJ, et al. How residents learn predicts success in surgical residency. *Journal of Surgical Education* 2013;70(6):725-30.
109. Yaghoubian A, Galante J, Kaji A, et al. General surgery resident remediation and attrition: A multi-institutional study. *Archives of Surgery* 2012;147(9):829-33.
110. Everett CB, Helmer SD, Osland JS, et al. General surgery resident attrition and the 80-hour workweek. *American Journal of Surgery* 2007;194(6):751-57.
111. Leibrant TJ, Pezzi CM, Fassler SA, et al. Has the 80-hour work week had an impact on voluntary attrition in general surgery residency programs? *Journal of the American College of Surgeons* 2006;202(2):340-44.
112. Falcone JL. Home school dropout: a twenty-year experience of the matriculation of categorical general surgery residents. *Am Surg* 2014;80(2):216-8. [published Online First: 2014/02/01]
113. Farley DR, Cook JK. Whatever happened to the General Surgery graduating class of 2001? *Curr Surg* 2001;58(6):587-90. doi: 10.1016/s0149-7944(01)00493-7 [published Online First: 2005/08/12]
114. Alterman DM, Jones TM, Heidel RE, et al. The predictive value of general surgery application data for future resident performance. *J Surg Educ* 2011;68(6):513-8. doi: 10.1016/j.jsurg.2011.07.007 [published Online First: 2011/10/18]
115. Kim JJ, Gifford ED, Moazzez A, et al. Program Factors That Influence American Board of Surgery In-Training Examination Performance: A Multi-Institutional Study. *Journal of surgical education* 2015;72(6):e236-42. doi: <https://dx.doi.org/10.1016/j.jsurg.2015.06.014>
116. Hayward CZ, Sachdeva A, Clarke JR. Is there gender bias in the evaluation of surgical residents? *Surgery* 1987;102(2):297-99.
117. Wade TP, Andrus CH, Kaminski DL. Evaluations of surgery resident performance correlate with success in board examinations. *Surgery* 1993;113(6):644-48.
118. Quillin RC, 3rd, Pritts TA, Hanseman DJ, et al. How residents learn predicts success in surgical residency. *Journal of surgical education* 2013;70(6):725-30. doi: <https://dx.doi.org/10.1016/j.jsurg.2013.09.016>
119. Burkhart RA, Tholey RM, Guinto D, et al. Grit: A marker of residents at risk for attrition? *Surgery (United States)* 2014;155(6):1014-22.
120. Wade TP, Kaminski DL. Comparative evaluation of educational methods in surgical resident education. *Archives of surgery (Chicago, Ill : 1960)* 1995;130(1):83-7.
121. World Health Organisation. WHO Coronavirus (COVID-19) Dashboard 2021 [cited 2021 24/06/2021]. Available from: [https://covid19.who.int/?gclid=CjwKCAjwmMX4BRAAEiwA-zM4JpqYIZhA3EdyHAWZoc3-2iaZmvAxRKSxhEpg8QqHXyStKHNA1qIO1xoCXp8QAvD\\_BwE](https://covid19.who.int/?gclid=CjwKCAjwmMX4BRAAEiwA-zM4JpqYIZhA3EdyHAWZoc3-2iaZmvAxRKSxhEpg8QqHXyStKHNA1qIO1xoCXp8QAvD_BwE) accessed 24/06/2021 2021.
122. American College of Surgeons. COVID-19: Guidance for triage of non-emergent surgical procedures 2020 [cited 2020 16/07/2020]. Available from: <https://www.facs.org/covid-19/clinical-guidance/triage> accessed 16/07/2020 2020.
123. Rajan N, Joshi GP. COVID-19: Role of Ambulatory Surgery Facilities in This Global Pandemic. *Anesthesia and analgesia* 2020;131(1):31-36. doi: 10.1213/ANE.0000000000004847

124. NHS England. A&E attendances and emergency admissions June 2020 statistical commentary 2020 [cited 2020 16/07/2020]. Available from: <https://www.england.nhs.uk/statistics/wp-content/uploads/sites/2/2020/07/Statistical-commentary-June-2020-jf8hj.pdf> accessed 16/07/2020 2020.
125. Riding D. Statement on COVID-19 and its effect on surgical training 2020 [cited 2020 15/07/2020]. Available from: <https://www.rcsed.ac.uk/news-public-affairs/news/2020/march/statement-on-covid-19-and-its-effect-on-surgical-training> accessed 15/07/2020 2020.
126. Association of American Medical Colleges. Coronavirus (COVID-19) and the MCAT Exam 2020 [cited 2020 15/07/2020]. Available from: <https://students-residents.aamc.org/applying-medical-school/article/coronavirus-covid-19-and-mcat-exam/> accessed 15/07/2020 2020.
127. Javanmard-Emamghissi H, Boyd-Carson H, Hollyman M, et al. The management of adult appendicitis during the COVID-19 pandemic: an interim analysis of a UK cohort study. *Tech Coloproctol* 2020;1-11. doi: 10.1007/s10151-020-02297-4
128. Porpiglia F, Checcucci E, Amparore D, et al. Slowdown of urology residents' learning curve during the COVID-19 emergency. *BJU international* 2020;125(6):E15-E17.
129. Clements JM, Burke JR, Hope C, et al. The quantitative impact of COVID-19 on surgical training in the United Kingdom. *BJS Open* 2021;5(3) doi: 10.1093/bjsopen/zrab051
130. Mishra D, Nair AG, Gandhi RA, et al. The impact of COVID-19 related lockdown on ophthalmology training programs in India - Outcomes of a survey. *Indian journal of ophthalmology* 2020;68(6):999-1004.
131. Fero KE, Weinberger JM, Lerman S, et al. Perceived Impact of Urologic Surgery Training Program Modifications due to COVID-19 in the United States. *Urology* 2020;143:62-67.
132. Zingaretti N, Contessi Negrini F, Tel A, et al. The Impact of COVID-19 on Plastic Surgery Residency Training. *Aesthetic plastic surgery* 2020;26:1381-85.
133. Bernardi L, Germani P, Del Zotto G, et al. Impact of COVID-19 pandemic on general surgery training program: An Italian experience. *American Journal of Surgery* 2020 doi: 10.1016/j.amjsurg
134. Amparore D, Claps F, Cacciamani GE, et al. Impact of the COVID-19 pandemic on urology residency training in Italy. *Minerva urologica e nefrologica = The Italian journal of urology and nephrology* 2020;72(4):505-09.
135. Givi B, Moore MG, Bewley AF, et al. Advanced head and neck surgery training during the COVID-19 pandemic. *Head and Neck* 2020
136. Huntley RE, Ludwig DC, Dillon JK. Early Effects of COVID-19 on Oral and Maxillofacial Surgery Residency Training-Results From a National Survey. *Journal of Oral and Maxillofacial Surgery* 2020;78(8):1257-67.
137. Zoia C, Raffa G, Somma T, et al. COVID-19 and neurosurgical training and education: an Italian perspective. *Acta Neurochirurgica* 2020;162(8):1789-94.
138. Pelargos PE, Chakraborty A, Zhao YD, et al. An Evaluation of Neurosurgical Resident Education and Sentiment During the COVID-19 Pandemic: A North American Survey. *World neurosurgery* 2020;140:e381-e86.
139. Rosen GH, Murray KS, Greene KL, et al. Effect of COVID-19 on Urology Residency Training: A Nationwide Survey of Program

- Directors by the Society of Academic Urologists. *The Journal of urology* 2020;204(5):1039-45.
140. Paesano N, Santomil F, Tobia I. Impact of COVID-19 Pandemic on Ibero-American Urology Residents: Perspective of American Confederation of Urology (CAU). *International Braz J Urol* 2020;46:17.
  141. Khusid JA, Weinstein CS, Becerra AZ, et al. Well-Being and Education of Urology Residents During the COVID-19 Pandemic: Results of an American National Survey. *International journal of clinical practice* 2020;74:e13559.
  142. An TW, Henry JK, Igboechi O, et al. How Are Orthopaedic Surgery Residencies Responding to the COVID-19 Pandemic? An Assessment of Resident Experiences in Cities of Major Virus Outbreak. *The Journal of the American Academy of Orthopaedic Surgeons* 2020;28(15):e679-e85.
  143. Figueroa F, Figueroa D, Calvo-Mena R, et al. Orthopedic surgery residents' perception of online education in their programs during the COVID-19 pandemic: should it be maintained after the crisis? *Acta orthopaedica* 2020:1-4. doi: 10.1080/17453674.2020.1776461
  144. Alhaj AK, Al-Saadi T, Mohammad F, et al. Neurosurgery Residents' Perspective on COVID-19: Knowledge, Readiness, and Impact of this Pandemic. *World Neurosurgery* 2020;139:e848-e58.
  145. Abdessater M, Roupret M, Misrai V, et al. COVID19 pandemic impacts on anxiety of French urologist in training: Outcomes from a national survey. *Progres en urologie : journal de l'Association francaise d'urologie et de la Societe francaise d'urologie* 2020;30(8):448-55.
  146. Khusid JA, Weinstein CS, Becerra AZ, et al. Well-being and education of urology residents during the COVID-19 pandemic: Results of an American National Survey. *International Journal of Clinical Practice* 2020;74:e13559. doi: 10.1111/ijcp.13559
  147. Day CS, Lage DE, Ahn CS. Diversity Based on Race, Ethnicity, and Sex Between Academic Orthopaedic Surgery and Other Specialties: A Comparative Study. *JBJS* 2010;92(13)
  148. Daniels EW, French K, Murphy LA, et al. Has diversity increased in orthopaedic residency programs since 1995? *Clin Orthop Relat Res* 2012;470(8):2319-24. doi: 10.1007/s11999-012-2259-x [published Online First: 2012/01/31]
  149. Symplur LLC. #ILookLikeASurgeon social media hashtag [Available from: <https://www.symplur.com/healthcare-hashtags/ilooklikeasurgeon/> accessed 28/05/2019 2019.
  150. Favre M. Operating Theatre, Cover artwork. The New Yorker: Conde Nast, 2017.
  151. Mclain S, Cook V, Atkinson M, et al. Barriers to Women's Participation in Surgery: From Student to Specilaist. *ANZ journal of surgery* 2018;88(1):230.
  152. de Costa J, Chen-Xu J, Bentounsi Z, et al. Women in surgery: challenges and opportunities. *IJS Global Health* 2018;1(1)
  153. Wolfe L. Statistics on the number of women surgeons in the United States. The balance, 2017.
  154. Moberly T. Number of women entering medical school rises after decade of decline. *BMJ (Clinical research ed)* 2018;360:k254. doi: 10.1136/bmj.k254
  155. NHS Digital. NHS workforce statistics January 2018 2018 [cited 2021 28/06/2021]. Available from: <https://digital.nhs.uk/data-and-information/publications/statistical/nhs-workforce-statistics/nhs-workforce-statistics---january-2018> accessed 28/06/2021 2021.

156. Health Education England. UK Training Regions 2020 [cited 2021 28/06/2021]. Available from: <https://specialtytraining.hee.nhs.uk/portals/1/Content/Resource%20Bank/Inter-Deanery%20Transfer/UK%20Training%20Region%20Websites.pdf> accessed 28/06/2021 2021.
157. Abel GA, Barclay ME, Payne RA. Adjusted indices of multiple deprivation to enable comparisons within and between constituent countries of the UK including an illustration using mortality rates. *BMJ open* 2016;6(11):e012750-e50. doi: 10.1136/bmjopen-2016-012750
158. Higher Education Statistics Agency. Rounding and suppression to anonymise statistics 2018 [Available from: <https://www.hesa.ac.uk/about/regulation/data-protection/rounding-and-suppression-anonymise-statistics> accessed 12/09/2019 2019.
159. *Stata Statistical Software: Release 15*. [program]: College Station TX: StataCorp LLC, 2017.
160. Okike K, Utuk ME, White AA. Racial and Ethnic Diversity in Orthopaedic Surgery Residency Programs. *JBJS* 2011;93(18)
161. Bellini M, Graham Y, Hayes C, et al. A woman's place is in theatre: women's perceptions and experiences of working in surgery from the Association of Surgeons of Great Britain and Ireland women in surgery working group. *BMJ Open* 2019;9(1)
162. Esmail A, Roberts C. Academic performance of ethnic minority candidates and discrimination in the MRCGP examinations between 2010 and 2012: analysis of data. *BMJ : British Medical Journal* 2013;347:f5662. doi: 10.1136/bmj.f5662
163. Woolf K, Potts HW, McManus IC. Ethnicity and academic performance in UK trained doctors and medical students: systematic review and meta-analysis. *BMJ (Clinical research ed)* 2011;342:d901. [published Online First: 2011/03/08]
164. General Medical Council. Differential attainment 2021 [cited 2021 05/01/2021]. Available from: <https://www.gmc-uk.org/education/standards-guidance-and-curricula/projects/differential-attainment/what-are-we-doing-to-address-it> accessed 05/01/2021 2021.
165. Joint Committee on Surgical Training. The Joint Committee on Surgical Training; About us 2018 [cited 2020 09/03/2020]. Available from: <https://www.jcst.org/about-us/> accessed 09/03/2020 2020.
166. Joint Committee on Surgical Training. Certification 2018 [cited 2020 09/03/2020]. Available from: <https://www.jcst.org/uk-trainees/str-trainees/certification/> accessed 09/03/2020 2020.
167. General Medical Council. Promoting excellence 2020 [cited 2021 07/01/2021]. Available from: <https://www.gmc-uk.org/education/standards-guidance-and-curricula/standards-and-outcomes/promoting-excellence> accessed 05/01/2021 2021.
168. Hope C, Boyd-Carson H, Phillips H, et al. Personal characteristics associated with progression in general surgical specialty training: A longitudinal cohort study (Short Papers). *BJS (British Journal of Surgery)* 2020;107(S4):11-37. doi: <https://doi.org/10.1002/bjs.12067>
169. Woolf K, Jayaweera H, Unwin E, et al. Effect of sex on specialty training application outcomes: a longitudinal administrative data study of UK medical graduates. *BMJ Open* 2019;9(3):e025004. doi: 10.1136/bmjopen-2018-025004

170. Kumwenda B, Cleland JA, Prescott GJ, et al. Geographical mobility of UK trainee doctors, from family home to first job: a national cohort study. *BMC medical education* 2018;18(1):314. doi: 10.1186/s12909-018-1414-9
171. Cleland J, Prescott G, Walker K, et al. Are there differences between those doctors who apply for a training post in Foundation Year 2 and those who take time out of the training pathway? A UK multicohort study. *BMJ Open* 2019;9(11):e032021. doi: 10.1136/bmjopen-2019-032021
172. Seicean A, Alan N, Seicean S, et al. Surgeon specialty and outcomes after elective spine surgery. *Spine* 2014;39(19):1605-13. doi: <https://dx.doi.org/10.1097/BRS.0000000000000489>
173. Hope C, Reilly J-J, Griffiths G, et al. Factors Associated with Attrition and Performance Throughout Surgical Training: A Systematic Review and Meta-Analysis. *World Journal of Surgery* 2021;45(2):429-42. doi: 10.1007/s00268-020-05844-0
174. Meyerson J, Yang M, Pearson G. Attrition in Plastic Surgery Residencies. *Plast Reconstr Surg Glob Open* 2016;4(10):e1102. doi: 10.1097/GOX.0000000000001102
175. Bauer JM, Holt GE. National Orthopedic Residency Attrition: Who Is At Risk? *Journal of Surgical Education* 2016;73(5):852-57.
176. Prager JD, Myer CMt, Myer CM, 3rd. Attrition in otolaryngology residency. *Otolaryngol Head Neck Surg* 2011;145(5):753-4. doi: 10.1177/0194599811414495 [published Online First: 2011/07/13]
177. Adams S, Ginther DN, Neuls E, et al. Attitudes and factors contributing to attrition in Canadian surgical specialty residency programs. *Canadian journal of surgery Journal canadien de chirurgie* 2017;60(4):247-52.
178. Shweikeh F, Schwed AC, Hsu C-H, et al. Status of Resident Attrition From Surgical Residency in the Past, Present, and Future Outlook. *Journal of surgical education* 2018;75(2):254-62. doi: <https://dx.doi.org/10.1016/j.jsurg.2017.07.015>
179. Renfrow JJ, Rodriguez A, Liu A, et al. Positive trends in neurosurgery enrollment and attrition: Analysis of the 2000-2009 female neurosurgery resident cohort. *Journal of Neurosurgery* 2016;124(3):834-39.
180. Lynch G, Nieto K, Puthenveetil S, et al. Attrition rates in neurosurgery residency: analysis of 1361 consecutive residents matched from 1990 to 1999. *J Neurosurg* 2015;122(2):240-9. doi: 10.3171/2014.10.Jns132436 [published Online First: 2014/11/22]
181. Lu DW, Hartman ND, Druck J, et al. Why Residents Quit: National Rates of and Reasons for Attrition Among Emergency Medicine Physicians in Training. *The western journal of emergency medicine* 2019;20(2):351-56. doi: 10.5811/westjem.2018.11.40449 [published Online First: 2019/02/11]
182. Yehia BR, Cronholm PF, Wilson N, et al. Mentorship and pursuit of academic medicine careers: a mixed methods study of residents from diverse backgrounds. *BMC medical education* 2014;14:26. doi: 10.1186/1472-6920-14-26 [published Online First: 2014/02/12]
183. Wong RL, Sullivan MC, Yeo HL, et al. Race and surgical residency: results from a national survey of 4339 US general surgery residents. *Ann Surg* 2013;257(4):782-7. doi: 10.1097/SLA.0b013e318269d2d0 [published Online First: 2012/09/25]
184. Turner PL, Lumpkins K, Gabre J, et al. Pregnancy among women surgeons: Trends over time. *Archives of Surgery* 2012;147(5):474-79.

185. Altieri MS, Salles A, Bevilacqua LA, et al. Perceptions of Surgery Residents About Parental Leave During Training. *JAMA Surgery* 2019;154(10):952-58. doi: 10.1001/jamasurg.2019.2985
186. Zheng J, Hundeyin M, He K, et al. General surgery chief residents' perspective on surgical education during the coronavirus disease 2019 (COVID-19) pandemic. *Surgery* 2020:S0039-6060(20)30354-8. doi: 10.1016/j.surg.2020.06.003
187. Osama M, Zaheer F, Saeed H, et al. Impact of COVID-19 on surgical residency programs in Pakistan; A residents' perspective. Do programs need formal restructuring to adjust with the "new normal"? A cross-sectional survey study. *International journal of surgery (London, England)* 2020;79:252-56. doi: 10.1016/j.ijssu.2020.06.004 [published Online First: 2020/06/09]
188. Stambough JB, Curtin BM, Gililland JM, et al. The Past, Present, and Future of Orthopedic Education: Lessons Learned From the COVID-19 Pandemic. *The Journal of arthroplasty* 2020;35(7S):S60-S64. doi: 10.1016/j.arth.2020.04.032 [published Online First: 2020/04/18]
189. World Health Organisation. SARS (Severe Acute Respiratory Syndrome) 2020 [cited 2020 24/07/2020]. Available from: <https://www.who.int/ith/diseases/sars/en/> accessed 24/07/2020 2020.
190. Sherbino J, Atzema C. "SARS-Ed": severe acute respiratory syndrome and the impact on medical education. *Annals of emergency medicine* 2004;44(3):229-31. doi: 10.1016/j.annemergmed.2004.05.021
191. Schull MJ. Sex, SARS, and the Holy Grail. *Emergency medicine journal : EMJ* 2003;20(5):400-01. doi: 10.1136/emj.20.5.400
192. Marriott JC, Purdie H, Millen A, et al. The lost opportunities for surgical training in the NHS. *Ann R Coll Surg Engl* 2011;93:202-06.
193. Joint Committee on Surgical Training. Nearly 900K elective training cases lost to #COVID19. In: @JCST\_Surgery, ed. Nearly 900K elective training cases lost to #COVID19 We need 755K EXTRA training cases ABOVE normal training activity EVERY MONTH to recover in 12 months or 373K extra every month for a 24/12 recovery #NoTrainingTodayNoSurgeonsTomorrow: Twitter, 2021.
194. Dewey C, Hingle S, Goelz E, et al. Supporting Clinicians During the COVID-19 Pandemic. *Annals of Internal Medicine* 2020;172(11):752-53. doi: 10.7326/M20-1033
195. Lai J, Ma S, Wang Y, et al. Factors Associated With Mental Health Outcomes Among Health Care Workers Exposed to Coronavirus Disease 2019. *JAMA Netw Open* 2020;3(3):e203976. doi: 10.1001/jamanetworkopen.2020.3976 [published Online First: 2020/03/24]
196. Huang JZ, Han MF, Luo TD, et al. [Mental health survey of medical staff in a tertiary infectious disease hospital for COVID-19]. *Zhonghua lao dong wei sheng zhi ye bing za zhi = Zhonghua laodong weisheng zhiyebing zazhi = Chinese journal of industrial hygiene and occupational diseases* 2020;38(3):192-95. doi: 10.3760/cma.j.cn121094-20200219-00063 [published Online First: 2020/03/05]
197. Pulcrano M, Evans SR, Sosin M. Quality of Life and Burnout Rates Across Surgical Specialties: A Systematic Review. *JAMA Surg* 2016;151(10):970-78. doi: 10.1001/jamasurg.2016.1647 [published Online First: 2016/10/21]
198. Low ZX, Yeo KA, Sharma VK, et al. Prevalence of Burnout in Medical and Surgical Residents: A Meta-Analysis. *Int J Environ Res Public*

- Health* 2019;16(9) doi: 10.3390/ijerph16091479 [published Online First: 2019/04/28]
199. Balasubramanian A, Paleri V, Bennett R, et al. Impact of COVID-19 on the mental health of surgeons and coping strategies. *Head & neck* 2020;42(7):1638-44. doi: 10.1002/hed.26291 [published Online First: 2020/05/28]
  200. Seah KM. Redeployment in COVID-19: old dogs and new tricks. *Emergency Medicine Journal* 2020;37(7):456-56. doi: 10.1136/emmermed-2020-210052
  201. Sarpong NO, Forrester LA, Levine WN. What's Important: Redeployment of the Orthopaedic Surgeon During the COVID-19 Pandemic: Perspectives from the Trenches. *The Journal of bone and joint surgery American volume* 2020;102(12):1019-21. doi: 10.2106/JBJS.20.00574
  202. Backhus LM, Lui NS, Cooke DT, et al. Unconscious Bias: Addressing the Hidden Impact on Surgical Education. *Thoracic surgery clinics* 2019;29(3):259-67.
  203. Sprow HN, Hansen NF, Loeb HE, et al. Gender-Based Microaggressions in Surgery: A Scoping Review of the Global Literature. *World J Surg* 2021;45(5):1409-22. doi: 10.1007/s00268-021-05974-z [published Online First: 2021/02/13]
  204. Fnais N, Soobiah C, Chen MH, et al. Harassment and Discrimination in Medical Training: A Systematic Review and Meta-Analysis. *Academic Medicine* 2014;89(5)
  205. Rothwell CR. A study to identify the factors that either facilitate or hinder medical speciality trainees in their Annual Review of Competence Progression (ARCP), with a focus on adverse ARCP outcomes. Durham University, 2017.
  206. Wehrwein EA, Lujan HL, DiCarlo SE. Gender differences in learning style preferences among undergraduate physiology students. *Advances in Physiology Education* 2007;31(2):153-57. doi: 10.1152/advan.00060.2006
  207. Berlin N, Dargnies M-P. Gender differences in reactions to feedback and willingness to compete. *Journal of Economic Behavior & Organization* 2016;130:320-36. doi: <https://doi.org/10.1016/j.jebo.2016.08.002>
  208. Fitzgerald JEF, Tang S-W, Ravindra P, et al. Gender-related perceptions of careers in surgery among new medical graduates: results of a cross-sectional study. *The American Journal of Surgery* 2013;206(1):112-19. doi: <https://doi.org/10.1016/j.amjsurg.2012.04.009>
  209. Park J, Minor S, Taylor RA, et al. Why are women deterred from general surgery training? *The American Journal of Surgery* 2005;190(1):141-46. doi: <https://doi.org/10.1016/j.amjsurg.2005.04.008>
  210. Gargiulo DA, Hyman NH, Hebert JC. Women in Surgery: Do We Really Understand the Deterrents? *Archives of Surgery* 2006;141(4):405-08. doi: 10.1001/archsurg.141.4.405
  211. Richardson HC, Redfern N. Why do women reject surgical careers? *Ann R Coll Surg Engl* 2000;82(9 Suppl):290-3. [published Online First: 2000/11/23]
  212. Lumb AB, Vail A. Comparison of academic, application form and social factors in predicting early performance on the medical course. *Medical education* 2004;38(9):1002-5. doi: 10.1111/j.1365-2929.2004.01912.x [published Online First: 2004/08/26]
  213. Cooper RA. Impact of trends in primary, secondary, and postsecondary education on applications to medical school. II:

- considerations of race, ethnicity, and income. *Academic medicine : journal of the Association of American Medical Colleges* 2003;78(9):864-76. [published Online First: 2003/09/26]
214. Morris-Stiff G, Ball E, Torkington J, et al. Registrar operating experience over a 15-year period: More, less or more or less the same? *The Surgeon* 2004;2(3):161-64. doi: [https://doi.org/10.1016/S1479-666X\(04\)80078-7](https://doi.org/10.1016/S1479-666X(04)80078-7)
  215. Sher J, Reed M, Calvert P. Influencing the national training agenda. The Uk and Ireland orthopaedic eLogbook. *J Bone Joint Surg Br* 2005;87:1182-86.
  216. Oakley J, Clewer G, Cool W, et al. The effect of the EWTD on orthopaedic specialist training. *Ann R Coll Surg Engl* 2005;87:320-21.
  217. Wood S, James OP, Hopkins L, et al. Variations in competencies needed to complete surgical training. *BJS Open* 2019
  218. Luton O, James OP, Mellor K, et al. Surgical curriculum concordance: requiem for the educational dream. *Postgraduate Medical Journal* 2021:postgradmedj-2020-139385. doi: 10.1136/postgradmedj-2020-139385
  219. Joint Committee on surgical Training. The new surgical curriculum for August 2021 2021 [cited 2021 06/07/2021]. Available from: <https://www.iscp.ac.uk/iscp/curriculum-2021/> accessed 06/07/2021 2021.
  220. Sandhu G, Thompson J, Matusko N, et al. Greater faculty familiarity with residents improves intraoperative entrustment. *Am J Surg* 2020;219(4):608-12. doi: 10.1016/j.amjsurg.2019.06.006 [published Online First: 2019/06/22]
  221. Sandhu G, Magas CP, Robinson AB, et al. Progressive entrustment to achieve resident autonomy in the operating room: A national qualitative study with general surgery faculty and residents. *Annals of Surgery* 2017;265(6):1134-40.
  222. Adams S, Ginther DN, Neuls E, et al. Attitudes and factors contributing to attrition in Canadian surgical specialty residency programs. *Canadian journal of surgery* 2017;Journal canadien de chirurgie. 60(4):247-52.
  223. Alobuia W, Salles A, Gibson M, et al. Physician Wellness in Surgical Residency. *Current Surgery Reports* 2018;6(1):1-16. doi: 10.1007/s40137-018-0200-2
  224. Sandher S, Gibber M. Assessing Surgical Residents; Challenges and Future Options. *MedEdPublish* 2017;6(4)
  225. Hope C, Reilly JJ, Griffiths G, et al. The impact of COVID-19 on surgical training: a systematic review. *Techniques in coloproctology* 2021 doi: 10.1007/s10151-020-02404-5