The correlation between trainee gender and operative autonomy during trauma and orthopaedic training in Ireland and the UK

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Aims

The aim of this study was to explore differences in operative autonomy by trainee gender during orthopaedic training in Ireland and the UK, and to explore differences in operative autonomy by trainee gender with regard to training year, case complexity, index procedures, and speciality area.

Methods

This retrospective cohort study examined all operations recorded by orthopaedic trainees in Ireland and the UK between July 2012 and July 2022. The primary outcome was operative autonomy, which was defined as the trainee performing the case without the supervising trainer scrubbed.

Results

A total of 3,533,223 operations were included for analysis. Overall, male trainees performed 5% more operations with autonomy than female trainees (30.5% vs 25.5%; 95% CI 4.85 to 5.09). Female trainees assisted for 3% more operations (35% vs 32%; 95% CI 2.91 to 3.17) and performed 2% more operations with a supervising trainer scrubbed (39% vs 37%; 95% CI 1.79 to 2.06). Male trainees performed more operations with autonomy than female trainees in every year of training, in each category of case complexity, for each orthopaedic speciality area, and for every index procedure except nerve decompression. When adjusting for year, training level, case complexity, speciality area, and urgency, male trainees had 145% (95% CI 2.18 to 2.76) increased odds of performing an operation with autonomy and 35% (95% CI 1.25 to 1.45) increased odds of performing an operation under trainer supervision, than assisting, compared to female trainees.

Conclusion

Male trainees perform more operations with autonomy during orthopaedic training than female trainees. Female orthopaedic trainees assist for a greater proportion of cases than their male counterparts. A comprehensive review of trauma and orthopaedic training is needed to identify any additional differences in training opportunities between female and male trainees, particularly with regard to progression through training.

Take home message

- This paper evaluates ten years of operative logbook data for all orthopaedic trainees in Ireland and the UK for differences in operative training opportunities by trainee gender.
- Female trainees perform 5% fewer operations with autonomy than male trainees during orthopaedic training in Ireland and the UK.
- There is a greater difference in assisting rates in the earlier years of training, with

female trainees assisting for 3% more operations in speciality training (ST) years 3, ST4, and ST5; however, by ST8 there is no difference in assisting rates.

Introduction

Operative competency is the fundamental objective of surgical training and is a progression metric for trauma and orthopaedic (T&O) trainees in Ireland and the UK. Trainees must log a minimum of 1,800 operations over six years, of which 1,260 must be performed as primary operator.[1] There are 13 defined index surgical procedures that a trainee must be skilled in to allow independent practice. Trainees must achieve competency in these procedures by performing indicative numbers of each in order to be eligible for certification of completion of training.

Training programmes should ensure that training opportunities are equitable among trainees. There are numerous variables that will determine the number of cases an orthopaedic trainee performs during training and the degree of autonomy given to them. A previous study of UK T&O trainees reported no difference in autonomy between female and male trainees, but reported that male trainees perform 3% more cases as lead operator during training.[2] This study was estimated to include 21% of UK orthopaedic trainees and was not powered to detect a difference in trainees in the later stages of training (speciality training (ST) years ST6 to ST8). To our knowledge, logbooks from the entire trainee cohort in Ireland and the UK have not been evaluated for differences in operative autonomy by trainee gender.

Orthopaedic surgery has the lowest number of women across all surgical and non-surgical specialities.[3] Women in surgical training have higher attrition rates and are more likely to have their progression delayed during training than men.[4-6] Women who do pursue a career in orthopaedics are more likely to practise in hand and paediatric orthopaedics, with smaller proportions of women practising in spine, hip, and knee subspecialities.[7,8] Disparities between men and women in income, industry sponsorship, and leadership roles have been documented in orthopaedic surgery.[9–11]

Studies in the orthopaedic literature have shown that female orthopaedic surgeons have equivalent surgical outcomes to male orthopaedic surgeons.[12,13] Furthermore, it has been shown more generally that patient outcomes are positively impacted in hospitals with higher proportions of female surgeons and anaesthetists.[14–16] There is also evidence to suggest that patient-surgeon gender concordance influences patient outcomes, and it is likely that orthopaedic patients would benefit if the gender balance improved among orthopaedic consultant surgeons.[17]

The aim of this study was to explore potential differences in operative autonomy by trainee gender during orthopaedic training in Ireland and the UK. We hypothesized that there would be a difference in operative autonomy by trainee gender. The secondary aims of this study were to explore potential differences in operative autonomy by trainee gender with regard to training year, case complexity, index procedures, and speciality area.

Methods

Anonymized logbook data for all orthopaedic trainees with a national training number in Ireland and the UK between July 2012 and July 2022 were obtained from the Joint Committee on Surgical Training (JCST) and the Royal College of Surgeons in Ireland (RCSI). ST years ST3 to ST8 were included. Cases logged in ST1 and ST2 do not count towards certification and were therefore excluded. Gender was recorded as that reported by the trainee at the time of registration. Cases recorded as assisting (A), supervised trainer scrubbed (STS), supervised trainer unscrubbed (STU), performed (P), and training a junior colleague (T) were included. Cases recorded as observed (O) were excluded as the trainee is not scrubbed for the procedure. Autonomy was defined as the trainee performing the case without a supervising trainer scrubbed, i.e. STU, P, and T. Cases are categorized as complex major operation (CMO), major (MAJ), intermediate (INT), minor (MIN), and sub-minor (SUB) by the RCSI. Cases recorded as SUB were excluded as they do not contribute towards trainee progression or eligibility for certification. Procedures were classified by speciality area by two authors (RMC, DD) into eight categories; foot & ankle, hand & wrist, hip & femur, knee & lower leg, paediatrics, pelvis & acetabulum, shoulder & elbow, and spine.

Statistical analysis

Descriptive statistics (percentages) were used to summarize the data. Chi-squared and proportions tests were used to explore differences between autonomy and gender, complexity level, and year of training. The threshold for statistical significance was set at $p = 0.05$. Unadjusted and adjusted multivariable logistic regression models were used to explore potential associations between trainee gender and operative autonomy. Models were adjusted for year, training level, case complexity, index procedure, speciality area, and urgency, and results reported as odds ratios (ORs) and 95% CI. Statistical analysis was performed using Stata v. 18 (StataCorp, USA).

Results

A total of 3,666,809 T&O procedures were recorded during the study period. After excluding 9,310 cases recorded as O and 123,276 cases recorded as SUB, 3,533,223 cases were included for analysis. Female trainees recorded a total of 653,935 cases (18.5%) and male trainees recorded a total of 2,879,288 cases (81.5%).

Overall, female trainees performed 5% (95% CI -5.09 to -4.85) fewer operations with autonomy than male trainees (25.5% (n = 166,915) vs 30.5% (n = 878,315); $p < 0.001$). Female trainees assisted for 3% (95% CI 2.91 to 3.17) more cases (35% (n = 231,273) vs 32% (n = 930,661); $p < 0.001$) and performed 2% (95% CI 1.79 to 2.06) more cases with a supervising trainer scrubbed than their male counterparts (39% (n = 255,711) vs 37% (n = 1,070,312); $p < 0.001$). Male trainees had 40% increased odds of performing an operation with autonomy than assisting, and 5% increased odds of performing an operation under supervision than assisting, compared to female trainees in the unadjusted multivariable analysis (crude odds ratio (cOR) 1.4; 95% CI 1.38 to 1.43; $p < 0.001$; and cOR 1.05; 95% CI 1.03 to 1.06; $p < 0.001$). When controlling for the confounding factors of year, training level, case complexity, speciality area, and urgency, male trainees had 145% increased odds of performing an operation with autonomy than assisting, and 35% increased odds of performing an operation under trainer supervision than assisting, compared

Table I. Unadjusted and adjusted multivariable logistic analysis exploring for associations between trainee autonomy and level, year, gender, complexity, and speciality area.

Variable	cOR	p-value*	95% CI	aOR	p-value*	95% CI
Training level						
ST3	Ref			Ref		
ST4	1.34	< 0.001	1.31 to 1.37	1.65	< 0.001	1.6 to 1.69
ST5	1.71	< 0.001	1.67 to 1.75	2.37	< 0.001	2.31 to 2.44
ST6	2.14	< 0.001	2.09 to 2.19	3.07	< 0.001	2.98 to 3.16
ST7	2.68	< 0.001	2.61 to 2.74	4.36	< 0.001	4.24 to 4.49
ST8	3.62	< 0.001	3.53 to 3.70	6.65	< 0.001	6.45 to 6.85
Year						
2012	Ref			Ref		
2013	0.99	0.823	0.98 to 1.01	1.00	0.54	0.98 to 1.02
2014	0.94	< 0.001	0.93 to 0.95	0.92	< 0.001	0.90 to 0.94
2015	0.89	< 0.001	0.88 to 0.91	0.84	< 0.001	0.82 to 0.85
2016	0.89	< 0.001	0.87 to 0.90	0.79	< 0.001	0.77 to 0.80
2017	0.88	< 0.001	0.87 to 0.90	0.74	< 0.001	0.72 to 0.75
2018	0.81	< 0.001	0.80 to 0.83	0.66	< 0.001	0.65 to 0.67
2019	0.85	< 0.001	0.84 to 0.87	0.69	< 0.001	0.68 to 0.71
2020	0.93	< 0.001	0.91 to 0.94	0.6	< 0.001	0.59 to 0.61
2021	0.85	< 0.001	0.83 to 0.86	0.56	< 0.001	0.55 to 0.57
2022	0.91	< 0.001	0.90 to 0.93	0.62	< 0.001	0.61 to 0.64
Gender						
Female	Ref			Ref		
Male	1.4	< 0.001	1.38 to 1.43	2.45	< 0.001	2.18 to 2.76
Complexity						
Complex major	Ref			Ref		
Major	9.05	< 0.001	8.92 to 9.19	4.35	< 0.001	4.07 to 4.65
Intermediate	19.56	< 0.001	19.26 to 19.86	38.05	< 0.001	35.53 to 40.74
Minor	36.42	< 0.001	35.80 to 37.04	51.53	< 0.001	48.12 to 55.18
Speciality area						
Foot & ankle				Ref		
Hand & wrist				1.95	< 0.001	1.88 to 2.02
Hip & femur				1.13	< 0.001	1.08 to 1.19
Knee & lower leg				1.86	< 0.001	1.78 to 1.94
Paediatrics				1.04	0.103	0.99 to 1.09
Pelvis & acetabulum				0.05	< 0.001	0.03 to 0.08
Shoulder & elbow				0.84	< 0.001	0.80 to 0.88
Spine				2.06	< 0.001	1.94 to 2.18
Unspecified				2.08	< 0.001	2.01 to 2.15

*Logistic regression.
aOR, adjusted odds ratio; cOR, crude odds ratio; ST, speciality training.

to female trainees (adjusted odds ratio (aOR) 2.45; 95% CI 2.18 to 2.76; p < 0.001; and aOR 1.35; 95% CI 1.25 to 1.45; p < 0.001) (Table I and Table II).

Training year

Autonomy increased with training year from 22% in ST3 to 39% in ST8. Male trainees performed more operations with

Table II. Unadjusted and adjusted multivariable logistics analysis exploring for associations between trainee supervised operating and level, year, gender, complexity, and speciality area.

Variable	cOR	p-value*	95% CI	aOR	p-value*	95% CI
Training level						
ST3	Ref			Ref		
ST4	1.15	< 0.001	1.13 to 1.17	1.24	< 0.001	1.22 to 1.27
ST5	1.24	< 0.001	1.22 to 1.26	1.41	< 0.001	1.38 to 1.43
ST6	1.24	< 0.001	1.22 to 1.27	1.46	< 0.001	1.43 to 1.49
ST7	1.32	< 0.001	1.30 to 1.35	1.61	< 0.001	1.57 to 1.64
ST8	1.46	< 0.001	1.43 to 1.49	1.81	< 0.001	1.77 to 1.85
Year						
2012	Ref			Ref		
2013	1.09	< 0.001	1.07 to 1.11	1.09	< 0.001	1.08 to 1.11
2014	1.18	< 0.001	1.16 to 1.19	1.16	< 0.001	1.15 to 1.18
2015	1.21	< 0.001	1.19 to 1.22	1.19	< 0.001	1.17 to 1.20
2016	1.27	< 0.001	1.25 to 1.29	1.23	< 0.001	1.22 to 1.25
2017	1.3	< 0.001	1.28 to 1.32	1.26	< 0.001	1.24 to 1.27
2018	1.37	<0.001	1.35 to 1.39	1.3	< 0.001	1.28 to 1.32
2019	1.49	< 0.001	1.47 to 1.52	1.4	< 0.001	1.38 to 1.42
2020	1.65	< 0.001	1.62 to 1.67	1.44	< 0.001	1.42 to 1.47
2021	1.67	< 0.001	1.65 to 1.70	1.49	< 0.001	1.46 to 1.51
2022	1.82	< 0.001	1.79 to 1.85	1.68	< 0.001	1.65 to 1.71
Gender						
Female	Ref			Ref		
Male	1.05	< 0.001	1.03 to 1.06	1.35	< 0.001	1.25 to 1.45
Complexity						
Complex major	Ref			Ref		
Major	1.92	< 0.001	1.90 to 1.93	1.73	< 0.001	1.68 to 1.78
Intermediate	2.67	< 0.001	2.65 to 2.69	4.31	< 0.001	4.17 to 4.45
Minor	2.6	< 0.001	2.57 to 2.63	4.89	< 0.001	4.71 to 5.08
Speciality						
Foot & ankle	Ref			Ref		
Hand & wrist				1.3	< 0.001	1.27 to 1.34
Hip & femur				0.71	< 0.001	0.69 to 0.74
Knee & lower leg				1.2	< 0.001	1.17 to 1.24
Paediatrics				0.91	< 0.001	0.88 to 0.95
Pelvis & acetabulum				0.33	< 0.001	0.29 to 0.36
Shoulder & elbow				0.86	< 0.001	0.84 to 0.89
Spine				0.7	< 0.001	0.66 to 0.73
Unspecified				1.21	< 0.001	1.18 to 1.24

*Logistic regression.
aOR, adjusted odds ratio; cOR, crude odds ratio; ST, speciality training.

autonomy than female trainees in every year of training (ST3 to ST8) (Figure 1 and Table III). The greatest difference in autonomy between male and female trainees was observed in ST5, with male trainees performing 6% more operations with

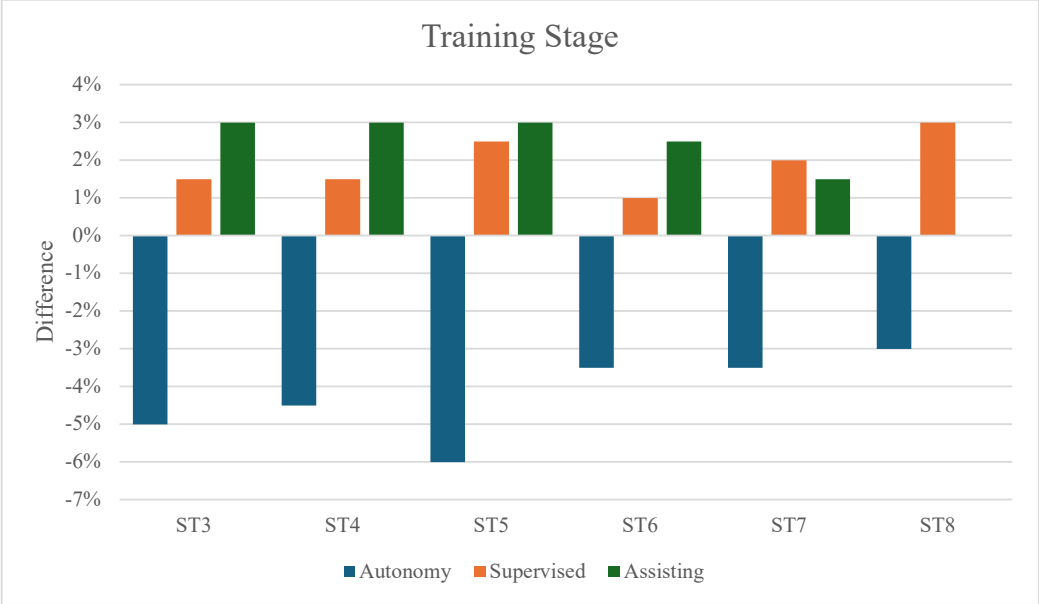

Fig. 1
Comparison of female trainee supervision by training stage to male trainee supervision. ST, speciality training.

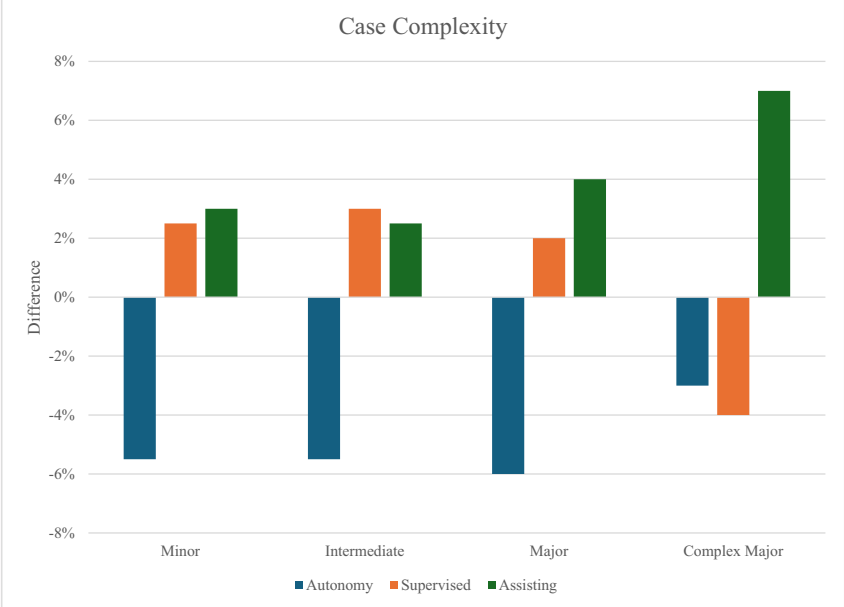

Fig. 2
Comparison of female trainee supervision by case complexity to male trainee supervision.

autonomy. The smallest difference was observed in ST8, with male trainees performing 3% more operations with autonomy. Female trainees assisted for a greater proportion of cases in every year of orthopaedic training except ST8. A greater difference was observed in the first three years of higher specialist training, with female trainees assisting for 3% more operations in ST3, ST4, and ST5.

Complexity

Male trainees performed more operations with autonomy than female trainees in each category of case complexity (Figure 2 and Table IV). With regards to case complexity, the greatest difference in autonomy between female and male trainees was observed for MAJ operations. Female trainees performed 6% fewer MAJ operations with autonomy. The smallest difference in autonomy was observed for CMO, with female trainees performing 3% fewer CMO cases with autonomy. However, male trainees also performed a greater proportion of CMO cases with a trainer scrubbed (4%) and therefore female trainees assisted for 7% more CMO cases. The smallest difference in assisting rates was observed with INT cases, with female trainees assisting for 2.5% more INT cases.

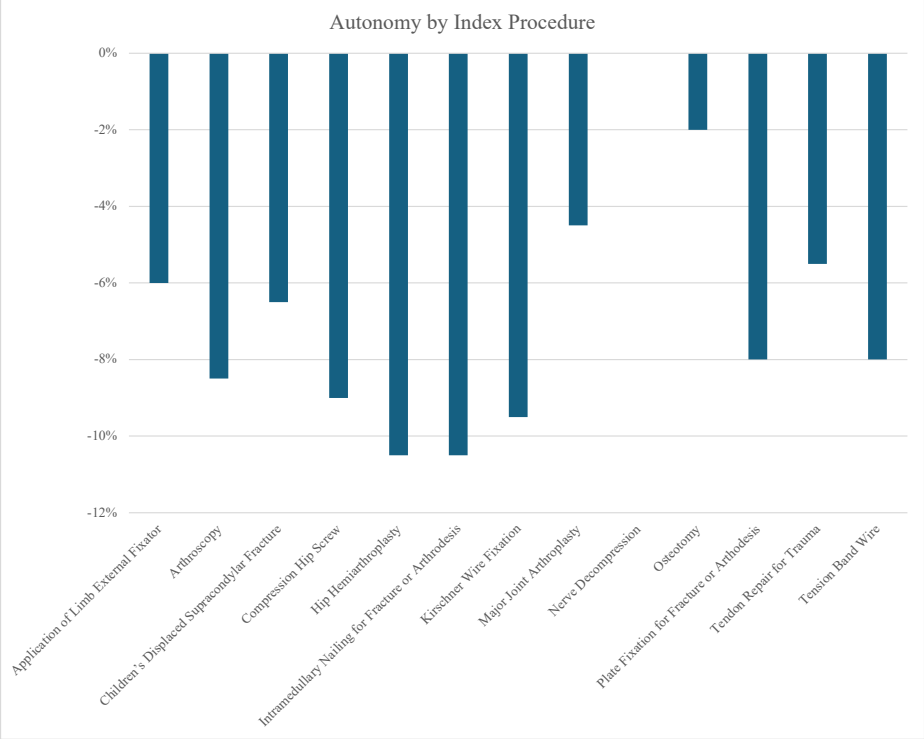

Fig. 3
Comparison of female trainee autonomy by index procedure to male trainee autonomy.

Table III. Supervision level by training year by trainee gender.

Level	Supervision	Female, n (%)	Male, n (%)	Difference, %	95% CI	p-value*
ST3	Autonomy	24,741 (18)	112,776 (23)	-5	-4.8 to -4.3	< 0.001
	Supervised	53,217 (39)	86,497 (37)	1.5	1.1 to 1.7	< 0.001
	Assisted	59,066 (43)	199,242 (40)	3	2.8 to 3.4	< 0.001
ST4	Autonomy	925,481 (21)	123,181 (25)	-4.5	-4.7 to -4.2	< 0.001
	Supervised	49,159 (40)	188,930 (39)	1.5	1.0 to 1.6	< 0.001
	Assisted	47,076 (39)	171,679 (35)	3	2.8 to 3.4	< 0.001
ST5	Autonomy	27,543 (24)	147,965 (30)	-6	-6.0 to -5.4	< 0.001
	Supervised	46,380 (41)	188,152 (38)	2.5	2.2 to 2.9	< 0.001
	Assisted	40,515 (35)	159,772 (32)	3	2.8 to 3.4	< 0.001
ST6	Autonomy	28,266 (28)	147,835 (32)	-3.5	-3.7 to -3.1	< 0.001
	Supervised	38,953 (39)	177,873 (38)	1	0.4 to 1.1	< 0.001
	Assisted	33,383 (33)	143,526 (31)	2.5	2.2 to 2.9	< 0.001
ST7	Autonomy	27,174 (31)	156,527 (34)	-3.5	-3.8 to -3.1	< 0.001
	Supervised	33,710 (38)	165,698 (36)	2	1.5 to 2.2	< 0.001
	Assisted	27,054 (31)	132,870 (29)	1.5	1.2 to 1.9	< 0.001
ST8	Autonomy	33,746 (37)	190,031 (40)	-3	-3.6 to -2.9	< 0.001
	Supervised	34,292 (37)	163,162 (34)	3	2.6 to 3.3	< 0.001
	Assisted	24,179 (26)	123,572 (26)	0	-0.0 to 0.6	0.056

*Two-sample test of proportions.
ST, speciality training.

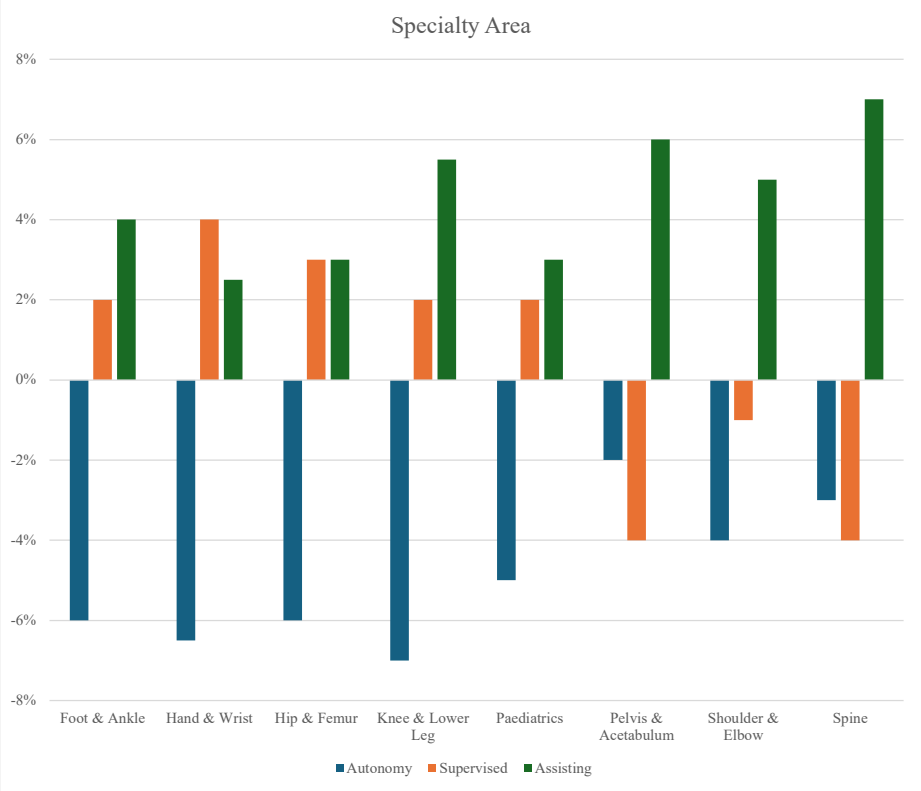

Fig. 4
Comparison of female trainee supervision by speciality area to male trainee supervision.

Table IV. Supervision level by case complexity by trainee gender.

Case complexity	Supervision	Female, n (%)	Male, n (%)	Difference, %	95% CI (of difference)	p-value*
Minor	Autonomy	33,519 (46)	63,008 (52)	-5.5	-5.9 to -5.1	< 0.001
	Supervised	22,625 (31)	89,728 (29)	2.5	2.3 to 3.0	< 0.001
	Assisted	15,966 (22)	60,385 (19)	3	2.5 to 3.1	< 0.001
Intermediate	Autonomy	83,381 (32)	415,076 (37)	-5.5	-5.9 to -5.5	< 0.001
	Supervised	107,655 (41)	418,391 (38)	3	2.9 to 3.3	< 0.001
	Assisted	72,420 (27)	275,522 (25)	2.5	2.4 to 2.8	< 0.001
Major	Autonomy	48,521 (19)	282,019) (25)	-6	-6.3 to -5.9	< 0.001
	Supervised	104,240 (41)	438,373 (39)	2	1.6 to 2.1	< 0.001
	Assisted	99,256 (39)	390,468 (35)	4	4.0 to 4.4	< 0.001
Complex major	Autonomy	1,530 (2)	18,212 (5)	-3	-3.0 to -2.8	< 0.001
	Supervised	21,191 (32)	123,820 (36)	-4	-4.2 to -3.4	< 0.001
	Assisted	43,631 (66)	204,286 (59)	7	6.3 to 7.1	< 0.001

*Two-sample test of proportions.

Index procedure

Male trainees performed more operations with autonomy for every index procedure except nerve decompression (Figure 3 and Table V). The greatest difference in autonomy was observed with hip hemiarthroplasty and intramedullary nailing for fracture or arthrodesis, with male trainees performing 10.5% more of these procedures independently. Male trainees performed a greater proportion of cases with a trainer scrubbed, as well as autonomously, for osteotomy and major joint arthroplasty. Female trainees assisted for a greater proportion of all index procedures except nerve decompression and tension band wire for fracture or arthrodesis. The greatest difference was observed for children's displaced

Table V. Supervision level by index procedure by trainee gender.

Index procedure	Supervision	Female, n (%)	Male, n (%)	Difference, %	95% CI (of difference)	p-value*
Application of limb external fixator	Autonomy	1,542 (19)	9,126 (25)	-6	-7.0 to -5.1	< 0.001
	Supervised	4,025 (49)	18,090 (50)	0	-1.3 to 1	0.749
	Assisted	2,573 (32)	9,224 (25)	6	5.1 to 7.4	< 0.001
Arthroscopy	Autonomy	7,731 (12)	66,892 (21)	-8.5	-8.8 to -8.3	< 0.001
	Supervised	26,247 (42)	124,815 (39)	2.8	2.4 to 3.2	< 0.001
	Assisted	28,593 (46)	127,513 (40)	6	5.3 to 6.1	< 0.001
Children's displaced supracondylar fracture	Autonomy	928 (20)	5,171 (26)	-6.5	-7.7 to -5	< 0.001
	Supervised	2,393 (50)	10,218 (51)	-1	-2.5 to 0.5	0.221
	Assisted	1,422 (30)	4,474 (23)	7.5	6 to 8.8	< 0.001
Compression hip screw	Autonomy	16,233 (64)	82,399 (74)	-9	-9.7 to -8.4	< 0.001
	Supervised	7,069 (28)	23,553 (21)	7	6.4 to 7.6	< 0.001
	Assisted	1,905 (8)	6,107 (5)	2	1.7 to 2.4	< 0.001
Hip hemiarthroplasty	Autonomy	10,975 (35)	62,397 (45)	-10.5	-11.1 to -9.99	< 0.001
	Supervised	15,897 (50)	58,627 (43)	8	7.1 to 8.3	< 0.001
	Assisted	4,664 (15)	16,451 (12)	3	2.3 to 3.2	< 0.001
Intramedullary nailing for fracture or arthrodesis	Autonomy	6,462 (23)	40,777 (34)	-10.5	-11.0 to -9.9	< 0.001
	Supervised	15,995 (57)	62,575 (51)	6	4.9 to 6.2	< 0.001
	Assisted	5,601 (20)	18,348 (15)	5	4.3 to 5.3	< 0.001
Kirschner wire fixation	Autonomy	6,681 (33)	35,120 (45)	-9.5	-10.4 to -8.9	< 0.001
	Supervised	9,115 (44)	32,334 (39)	6	4.7 to 6.2	< 0.001
	Assisted	4,758 (23)	15,875 (19)	5	3.4 to 4.7	< 0.001
Major joint arthroplasty	Autonomy	2,118 (2)	27,443 (6)	-4.5	-3.8 to -3.5	< 0.001
	Supervised	32,682 (37)	176,252 (39)	-2	-2.6 to -1.9	< 0.001
	Assisted	54,180 (61)	247,737 (55)	6	5.6 to 6.3	< 0.001
Nerve decompression	Autonomy	12,150 (35)	47,913 (35)	0	-0.5 to 0.5	0.976
	Supervised	12,926 (37)	48,775 (35)	2	1.0 to 2.1	< 0.001
	Assisted	10,006 (29)	41,691 (30)	-2	-2.1 to -1.0	< 0.001
Osteotomy	Autonomy	1,269 (5)	99,638 (7)	-2	-2.2 to -1.6	< 0.001
	Supervised	11,329 (45)	47,552 (48)	-2	-3.0 to -1.6	< 0.001
	Assisted	12,365 (50)	45,089 (45)	4	3.5 to 4.9	< 0.001
Plate fixation for fracture or arthrodesis	Autonomy	16,039 (18)	99,296 (26)	-8	-8.3 to -7.7	< 0.001
	Supervised	41,666 (46)	168,985 (44)	2	1.8 to 2.6	< 0.001
	Assisted	32,300 (36)	115,371 (30)	6	5.4 to 6.1	< 0.001
Tendon repair for trauma	Autonomy	3,179 (26)	16,425 (31)	-5.5	-6.5 to -4.7	< 0.001
	Supervised	5,631 (45)	22,440 (43)	3	1.6 to 3.6	< 0.001
	Assisted	3,586 (29)	13,617 (26)	3	2.1 to 3.8	< 0.001
Tension band wire	Autonomy	565 (25)	3,124 (33)	-8	-9.9 to -5.8	< 0.001
	Supervised	1,432 (64)	5,400 (57)	7	4.3 to 8.8	< 0.001
	Assisted	248 (11)	916 (10)	1	-0.08 to 2.7	0.056

*Two-sample test of proportions.

supracondylar fracture, with female trainees assisting for 7.5% more of these cases.

Table VI. Supervision level by body part by trainee gender.

Speciality	Supervision	Female, n (%)	Male, n (%)	Difference	95% CI (of difference)	p-value*
Foot & ankle	Autonomy	15,058 (18)	82,347 (25)	-6	-6.5 to -5.9	< 0.001
	Supervised	37,866 (46)	147,407 (44)	2	1.8 to 2.6	< 0.001
	Assisted	28,647 (35)	104,051 (31)	4	3.5 to 4.3	< 0.001
Hand & wrist	Autonomy	35,292 (32)	160,000 (38)	-6.5	-6.9 to -6.3	< 0.001
	Supervised	46,026 (41)	155,572 (37)	4	3.6 to 4.3	< 0.001
	Assisted	30,444 (27)	102,944 (25)	2.5	2.3 to 2.9	< 0.001
Hip & femur	Autonomy	37,583 (29)	210,603 (35)	-6	-6.3 to -5.8	< 0.001
	Supervised	51,245 (39)	219,369 (36)	3	2.5 to 3.1	< 0.001
Knee & lower leg	Autonomy	11,997 (12)	99,316 (19)	-7	-7.3 to -6.9	< 0.001
	Supervised	41,658 (42)	207,013 (40)	2	1.3 to 2.0	< 0.001
	Assisted	46,436 (46)	212,295 (41)	5.5	5.1 to 5.7	< 0.001
Paediatrics	Autonomy	7,720 (25)	35,925 (30)	-5	-5.5 to -4.4	< 0.001
	Supervised	12,536 (41)	46,370 (39)	2	1.3 to 2.5	< 0.001
	Assisted	10,523 (34)	37,268 (31)	3	2.4 to 3.6	< 0.001
Pelvis & acetabulum	Autonomy	29 (1)	377 (3)	-2	-2.6 to -1.5	< 0.001
	Supervised	483 (21)	2,793 (25)	-4	-5.9 to -2.2	< 0.001
	Assisted	1,814 (78)	8,050 (72)	6	4.3 to 8.1	< 0.001
Shoulder & elbow	Autonomy	7,011 (12)	43,473 (16)	-4	-4.2 to -3.6	< 0.001
	Supervised	22,833 (38)	108,350 (39)	-1	-1.3 to -0.05	< 0.001
	Assisted	29,974 (50)	125,032 (45)	5	4.5 to 5.3	< 0.001
Spine	Autonomy	5,611 (23)	35,464 (27)	-3	-3.8 to -2.6	< 0.001
	Supervised	5,339 (22)	34,982 (26)	-4	-4.5 to -3.4	< 0.001
	Assisted	13,045 (54)	62,868 (47)	7	6.5 to 7.8	< 0.001

*Two-sample test of proportions.

Speciality area

Male trainees performed more operations with autonomy in every speciality area of orthopaedics (Figure 4 and Table VI). The greatest difference in autonomy was observed in knee & lower leg, with male trainees performing 7% more cases independently. The smallest difference was observed in pelvis & acetabulum, with male trainees performing 2% more cases independently. The speciality areas that male trainees performed a greater proportion of cases with a trainer scrubbed, in addition to performing more cases independently, were pelvis & acetabulum (4%), spine (4%), and shoulder & elbow (1%). Female trainees assisted for a greater proportion of cases in every speciality area. The greatest difference in assisting was observed in spine, with female trainees assisting for 7% more spine operations, and the smallest difference was observed in hand & wrist, with female trainees assisting for 2.5% more hand & wrist procedures.

Discussion

During orthopaedic training in Ireland and the UK, male trainees perform 5% more cases with autonomy than female trainees. Female trainees assist for 3% more cases than male trainees, and perform 2% more cases under trainer supervision. Male trainees perform more operations with autonomy during each year of training, for each category of case complexity, for each orthopaedic speciality area, and for every index procedure except nerve decompression. Male trainees also perform a greater proportion of more complex operations under trainer supervision than female trainees, and female trainees assist for a greater proportion of these cases than intermediate and minor operations. In a structured training programme, there should not be a difference in surgical autonomy or assisting rates by trainee gender. The difference in autonomy between the genders recorded by the JCST and reported in this paper needs to be addressed by the training bodies in Ireland and the UK.

The discrepancy in meaningful autonomy by trainee gender has been reported in various surgical specialities and in different geographical areas.[18–22] The only other study examining the effect of gender on operative autonomy in orthopaedics in the UK reported no difference in autonomy between male and female trainees, but reported that female trainees performed 3% fewer cases as lead surgeon.[5] This was a much smaller study of 285,915 operations which relied on voluntary submission of logbook data, thus introducing the risk of selection bias. Unlike our study, data from

ST1 and ST2 trainees were included, as well as operations recorded as O and categorized as SUB, which do not count towards certification. The gender breakdown of the study was 33% female; however, only 19% of specialist registrars the UK are female.[23] Similar to our results, Bond et al[24] reported that female trainees performed 6% fewer cases with autonomy than male trainees during orthopaedic training in New Zealand. Equal operative autonomy by trainee gender has been reported in some surgical specialities. Parr et al[25] reported equal autonomy in the New Zealand plastic surgery training programme. The authors attributed this to gender balance among the trainee cohort. Olumolade et al[26] reported equal autonomy in a single USA urology training programme with a female residency programme director. Based on the findings of these studies, it is possible that increasing the gender balance among orthopaedic trainees and the proportion of women in leadership positions may be strategies to promote equitable opportunities for operative autonomy.

The level of autonomy is assigned by the trainee. It is possible that the difference in autonomy observed between female and male trainees is due to female trainees' perception of lower autonomy. It has been shown that female surgical trainees rate themselves lower in autonomy than their male counterparts.[27] This may be a reflection of treatment experienced by female trainees in the workplace. Female trainees and surgeons experience lower levels of trust from patients, staff, and trainers.[28–30] Furthermore, it has been shown that surgical trainers rate female trainees lower in autonomy than male trainees, especially with increasing surgical complexity and in later stages of training.[27,31] Trainer entrustment has been shown to be the main driver of trainee entrustability in the operating theatre.[32]

Based on a minimum of 1,800 cases at completion of T&O training, female trainees assist for 54 (3%) more cases than male trainees and perform a minimum of 90 (5%) fewer cases with autonomy, which equates to 2.16 to 3.6 months of training. In 2021, the surgical curriculum in Ireland and the UK was updated.[33] Trainees may progress through training at a faster pace if supervising trainers deem that they have the necessary capabilities. One of the five key capabilities in practice essential for progression is managing an operating list. The reduced operative autonomy that female trainees record during training may result in prolonged training time for women compared to men. Furthermore, it has been shown that autonomy during surgical training reduces trainee burnout and thoughts of attrition.[34] The reduced autonomy observed among the female trainee cohort in Ireland and the UK could have a negative impact on female orthopaedic trainee wellbeing, and contribute to a higher attrition rate among female surgical trainees.

Strengths and limitations

The strength of this study is that it is the largest quantitative examination of operative autonomy in orthopaedic trainees based on trainee gender. We examined data submitted by all orthopaedic specialist registrars in two countries over a ten-year period. We provide a breakdown by case complexity, body part, and index procedure. There are a number of limitations to this study. First, supervision level is recorded by trainees who might overestimate or underestimate their participation in a case. We used independent operating to define autonomy (i.e. STU, P, T) to mitigate against this. For recording purposes, there is greater ambiguity with regard to supervised operating and assisting (STS and A) than autonomous operating (STU, P, T) as the trainer is not scrubbed for autonomous cases. Second, our study did not evaluate the influence of deanery on operative autonomy by trainee gender. Third, although this study shows that there is a difference in training opportunities with regard to surgical autonomy between female and male orthopaedic trainees, it does not explain why this difference exists. Finally, we acknowledge that operative autonomy is only one aspect of surgical training, albeit an important one. There is much to be learned from assisting and supervised operating with experienced surgeons.

Female trainees perform fewer operations with autonomy during orthopaedic training in Ireland and the UK, and assist for a greater proportion of cases than their male counterparts. It is likely that the cause of the difference in autonomy between trainees is multifactorial. However, the training bodies and trainers must be cognisant of the difference in training opportunities between trainees by trainee gender, and create conditions that promote equity. A comprehensive review of orthopaedic training is needed to identify any additional differences in training opportunities, particularly with regard to progression through training, between men and women.

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