ANZ Journal of Surgery

Royal Australasian College of Surgeons

SURGICAL EDUCATION AND TRAINING OPEN ACCESS

Outcomes of Foundational Learning in Research Methods Following Primary Medical Qualification on Surgical Research: A Retrospective Review

Meet Patel[1] | David Sun[1] | Maya Jane Starr[1,2] | Dhaval Solanki[1] | Jeet Upadhyay[1] | Dominic J. A. Edwards[3] | Arjun Raju[2] | Thomas Maouris[1,2] | Alexander Lombardo[1,4] | Daphne Wang[4] | Karamveer Nagi[1] | Nazim Bhimani[1] | Anthony R. Glover[1]

[1]Speciality of Surgery, School of Medicine, Faculty of Medicine and Health, The University of Sydney, Camperdown, New South Wales, Australia | [2]Royal Brisbane & Women's Hospital, Herston, Queensland, Australia | [3]Mater Mothers' Hospital, South Brisbane, Queensland, Australia | [4]Princess Alexandra Hospital, Woolloongabba, Queensland, Australia

Correspondence: Meet Patel (meet.patel@sydney.edu.au)

Received: 13 March 2025 | **Revised:** 30 April 2025 | **Accepted:** 6 May 2025

Funding: The authors received no specific funding for this work.

Keywords: education | outcomes | postgraduate | research | surgery

ABSTRACT

Introduction: Limited knowledge exists on how post-graduate surgical coursework programs impact surgical research outputs in Australia. This study evaluated the impact of university-based teaching in research methods and supervisor characteristics on research quality and short-term research output for students undertaking the Master of Surgery (MS) post-graduate coursework degree within Australia.

Methods: A retrospective cohort analysis of students enrolled in the dissertation for The University of Sydney MS program between 2010 and 2020. Grades for the dissertation and research subjects were extracted from the central university analytics. PubMed and Web of Science were used to determine if the dissertation was published and identify other publications by the students. A Google search was completed to identify supervisor characteristics. Statistical analysis involved logistic regression, multiple linear regression and negative binomial regression.

Results: Three hundred and seventy-nine students were included in this study. Fifty-three percent of the students had an associated publication from their dissertation at a median of 18 months post-enrolment and a median journal impact factor of 2.19. Students averaged 2.1 additional publications (range 0–30) 2 years post-dissertation completion. Students with a distinction/high distinction grade in the dissertation subject or ≥ three journal publications prior were significantly more likely to publish their dissertation (OR 2.26, 95% CI = 1.42–3.61, $p < 0.001$; OR 3.35, 95% CI = 1.90–5.92, $p < 0.001$ respectively). Students who received a distinction/high distinction in the research methods subject had 64% more first-author publications within 2 years of finishing the dissertation (95% CI = 1.20–2.23, $p = 0.002$).

Conclusion: Engagement in structured teaching in research methods and prior research experience significantly improve short-term research output amongst early surgical researchers.

JEL Classification: Surgical Education

1 | Introduction

Understanding research methods and surgical literature is a key facet of being a modern surgeon and remains vitally important for extending surgical frontiers and understanding surgical disease processes. Research enables evidence-based surgical practice, the discovery of innovative findings, progress towards cures for diseases and the standardisation of surgical practice. However, surgical research has historically been criticised for producing a high volume of research papers, but often of low quality and low clinical applicability [1]. Surgical training poses a unique challenge for the surgeon, where the pressure of acquiring technical skills in a short period means that trainees may perceive the development of academic pursuits as an obstacle to progressing through the surgical learning curve [2]. As such, recent evidence suggests that the research productivity of surgeons is dropping, and there has been reduced success in funding grants compared to other medical specialties [3]. Therefore, there is a need to improve surgical research quality and stimulate interest in surgical research among trainees.

Research projects that include multi-disciplinary teams, including clinicians, librarians, biostatisticians, epidemiologists and health economists, have been shown to produce high quality research. Research projects involving these multidisciplinary teams are more publishable in high-impact journals and receive higher citations [4]. Unfortunately, not all research groups have the funding or access to these resources, and therefore are required to upskill by acquiring these skills through a structured course or self-directed learning. Whilst it is impossible to replace such team members, research teams must persevere and use these acquired skills to undertake their research and look to build on the knowledge in their field of expertise.

The University of Sydney (USYD) offers a master's degree through coursework, the Master of Surgery (MS), that provides candidates with structured teaching on foundational research skills, including biostatistics and clinical epidemiology. This degree is available for admission to students who have completed a medical degree and is generally undertaken by students in Australia and New Zealand while preparing for surgical training [5]. Candidates can elect to complete the dissertation in a surgical field with a supervisor of their choice. In the dissertation subject, students receive support through their supervisor and unit faculty in study design, ethics approval, statistical analysis and academic writing. Students are required to complete the two dissertation subjects (Dissertation A and Dissertation B) sequentially over two semesters to fulfil the dissertation requirements. By offering structured support, the program is designed to assist students gain the primary skills necessary to pursue research. This gives students the opportunity to explore an area of interest, to gain support when learning a new research methodology, or to work with a specific supervisor/research team.

Currently, there is a dearth of literature that assesses the impact of education in research methods following the completion of a primary medical degree on surgical research and its influence on further publications. Therefore, this study aims to assess how structured post-graduate teaching in foundational research subjects aligned with a university curriculum and supervisor characteristics impact surgical research quality and short-term research output in an Australian context.

2 | Materials and Methods

2.1 | Ethics and Consent

Ethics approval for this study was granted by The USYD Human Research and Ethics Committee in accordance with the National Statement on Ethical Conduct in Human Research, 2007 (Approval no: 2023/268).

2.2 | Cohort

This study used a cohort of students who had completed the MS program at The USYD between 2010 and 2020. The inclusion criteria were students who had successfully completed the Dissertation B subject [SURG5051 or SURG5008] as part of the MS program. Students who had withdrawn from the unit prior to the census date or failed the subject were excluded. As part of the MS program, students are also required to complete at least one subject from the core research method selective units:

- Introductory Biostatistics [PUH5018 and FMHU5002]
- Introduction to Clinical Epidemiology [CEPI5100] (introduced in 2015)
- Surgical Research and Evaluation [SURG5035] (introduced in 2020)

Additionally, students could elect to complete multiple core research selective units and/or compete in elective research subjects:

- Introduction to Systematic Review (CEPI5315)
- Applied Epidemiology (PUBH5224)
- Biostatistics: Statistical Modelling (PUBH5217)
- Advanced Statistical Modelling (PUBH5218)

Students' grades for their respective subjects and the dissertation were obtained through the central USYD analytics department. Marks were converted to grades as per the university grading system (pass = 50–64, credit = 65–74, distinction = 75–85, high distinction = 85–100).

The title of the students' dissertation, research area, study type and main supervisor's name were extracted from the final assignment submission of Dissertation B subject. A manual search was undertaken to determine whether the dissertation was published, the number of publications the student had prior to starting the Dissertation B subject, and the number of publications within 2 years of completing the Dissertation B subject.

2.3 | Search Strategy

A manual search was conducted between the 1st of January 2024 and the 1st of May 2024. A manual search of the dissertation title was performed on PubMed to identify whether the dissertation had been published. First, the title of the dissertation was searched, and each title and author affiliation was screened. Second, a search of keywords from the dissertation title and student name was undertaken. If the publication criteria were not met, then the process was then repeated on Web of Science (see Figure 1). Abstracts for conference presentations were not included as a publication.

Publication criteria for the dissertation were defined as meeting two of the following criteria:

1. Similar title to the dissertation
2. The student was the first author, and the supervisor was listed as a co-author OR the student and supervisor were listed as co-authors

The following variables were collected:

- Time to publication after completing Dissertation B (months)
- Number of citations after 2 years of being published through cited by feature on Web of Science
- Impact factor of the journal at the time of publication using Journal Citation Reports by Clarivate

From the primary publication, affiliations were noted, and if possible, the student's Open Researcher and Contributor ID (ORCID) was extracted. Then, a search by the student's name was completed using PubMed and Web of Science to determine the publications prior to the Dissertation B and the subsequent publications within 2 years of completing Dissertation B (see Figure 1). Time to acceptance was not collected, as not all journals published when the article was accepted, and therefore, the first publication date was used as a metric to ensure uniformity in data collection.

Publications based on the student's name were included if they met the following inclusion criteria:

1. One author with the same name as the student AND one of the following:

i. Similar co-authors as other publications

ii. Similar affiliations as other publications

iii. Same contact email as other publications

iv. Affiliations of the same country as previous publications identified AND similar specialty focus

v. Same ORCID

Two independent reviewers undertook the manual search for each student and supervisor, and the search results were then compared. A third independent reviewer resolved any discrepancies by performing the manual search and a discussing findings with the two reviewers.

To determine the supervisors' specialty, location (state) and whether they had completed a PhD, a manual search for the supervisor's name was conducted using Google, and the first page of results was screened. This method of search strategy has been utilized in previous literature [6, 7].

2.4 | Statistical Analysis

Continuous variables that were normally distributed were presented as a mean and standard deviation. Continuous variables that were not normally distributed were presented as a median and range. Linear regression was performed to determine factors associated with higher dissertation grade. Logistic regression was performed to determine factors associated with publishing the dissertation. All univariable models with a p value < 0.20 were included in the multivariable model, and a backward elimination was performed. Negative binomial regression was performed to determine the factors

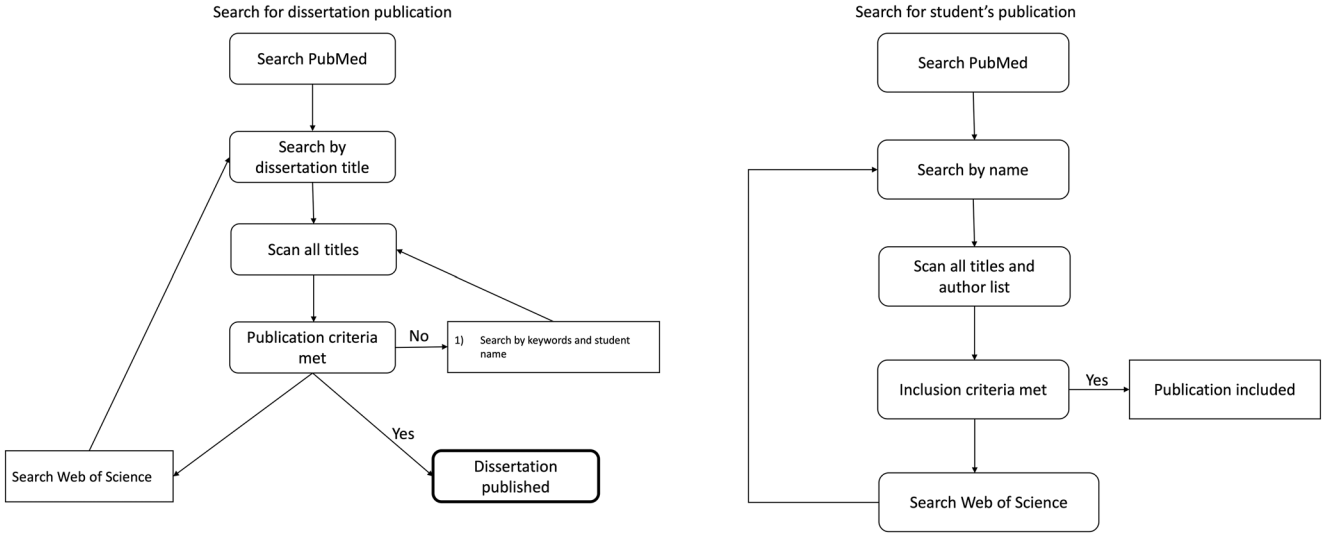

FIGURE 1 | Search strategy for dissertation and student publications.

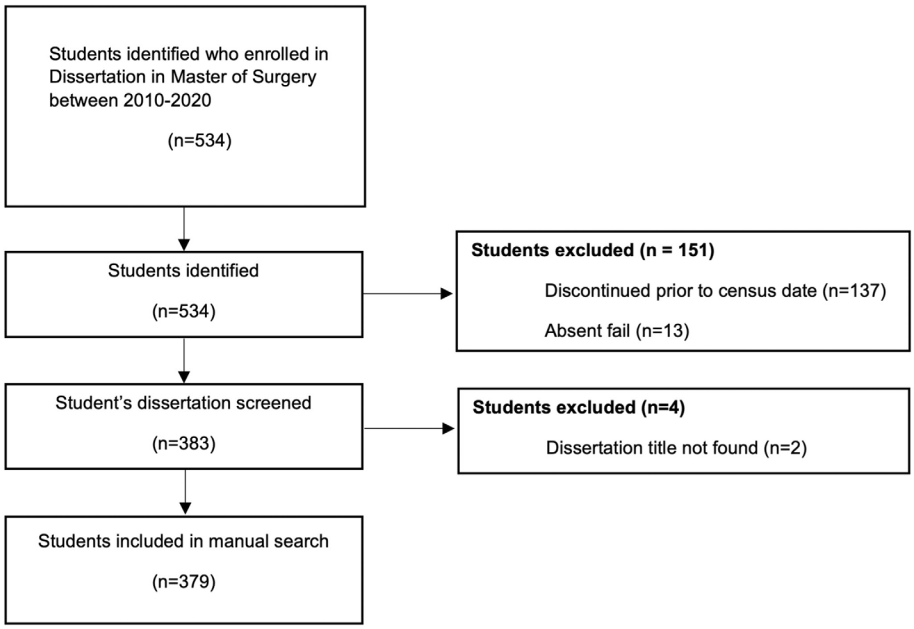

FIGURE 2 | Students included in the manual search.

associated with the total number of citations after 2 years for the dissertations that were published. Additionally, negative binomial regression was completed to determine the predictors of the total number of publications and the number of first author publications 2 years after completing the dissertation. All statistical analysis was conducted using SPSS 28 for Mac (IBM Corp., Armonk, N.Y., USA).

3 | Results

A total of 379 students were included in the manual search from 534 students who had enrolled in the dissertation subjects, of whom 151 were excluded as they unenrolled prior to the census date or had not completed the subject (see Figure 2). A further four students were excluded as full details of the dissertations were not found.

Table 1 describes the characteristics of the students' dissertation. Here, it is shown that most students had completed their dissertation in general surgery (39.8%), followed by plastic and reconstructive surgery (15.6%) and orthopaedic surgery (13.5%). Additionally, the most common study type for students' dissertation was a cohort study. Approximately one-fifth of the students elected to complete multiple core elective units. Table 2 describes the characteristics of the students' supervisors for the dissertation, where most supervisors were males (88.4%) and were from surgical specialties (89.7%). A significant proportion of supervisors had completed a PhD (55.7%) and 40% of supervisors also supervised other students who had completed the dissertations in the MS at USYD.

Fifty-three percent of students published their dissertation in a journal. The median time to publish their work following the completion of the dissertation was 18 months, and the average number of citations was 3.9, 2 years post-publication. The median number of citations at 2 years for published dissertations was 2 (Table 3). The mean impact factor of journals in which the papers were published was 2.85, with the highest impact factor being 50.5 (Table 3). Overall, students completed the dissertation and core research methods subjects to a high standard. The average grade of the dissertation subject was equivalent to a distinction, as were two out of three core research subjects (Table 3).

A little over half (53%) of students did not have a first author publication before starting the dissertation, and 48% of students did not have any publications before the dissertation. For students who had no publications prior to starting the dissertation ($n = 182$), 40.1% of those students published their dissertation and 30% had a first-author publication within 2 years of completing their dissertation. Across the entire cohort, the average total number of publications 2 years after completing the dissertation was 2.12, while the average total number of publications prior to the dissertation was 1.78 (Table 3).

The multivariable linear regression showed that receiving a distinction or high distinction in the student's core research methods subject was associated with an increased mark in the Dissertation B subject (coefficient 1.67, 95% CI = 0.09–3.24, $p = 0.038$). Additionally, if the student had published three or more publications prior to the starting Dissertation B, they were significantly more likely to have a higher Dissertation B mark (coefficient 2.76, 95% CI = 0.83–4.70, $p = 0.013$) (Table 4). In the univariate analysis, female supervisors were associated with higher marks in the dissertation (coefficient 2.96, $p = 0.019$, see Table S1); however, on the multivariable analysis, this was no longer statistically significant ($p = 0.074$).

Students who achieved distinction or high distinction in the Dissertation B subject were 2.26 times more likely to have their dissertation published (95% CI: 1.38–3.29, $p < 0.001$, Table 4), and those who had previous publications were much more likely to publish their dissertation (Table 5). Completing multiple

TABLE 1 | Descriptive statistics of student dissertation.

	Count (Percentage)
Dissertation specialty	
General surgery	152 (39.8)
Acute general surgery	6 (1.6)
Breast surgery	20 (5.3)
Colorectal surgery	51 (13.5)
Endocrine surgery	5 (1.3)
Head and neck surgery	13 (3.4)
Surgical oncology	15 (4.0)
Transplant surgery	5 (1.3)
Upper gastro-intestinal surgery	31 (8.2)
Trauma	5 (1.3)
Cardiothoracic surgery	12 (3.2)
Neurosurgery	21 (5.5)
Orthopaedic surgery	51 (13.5)
Otorhinolaryngology	23 (6.1)
Paediatric surgery	14 (3.7)
Plastics and reconstructive surgery	59 (15.6)
Urology	31 (8.2)
Vascular and endovascular	17 (4.5)
Study type	
Systematic review and/or meta-analysis	55 (14.5)
Randomised control trial	11 (2.9)
Cohort study	163 (43.0)
Cross-sectional study	12 (3.2)
Narrative review	12 (3.2)
Scoping review	3 (0.8)
Case study/series	9 (2.4)
Other/unknown	114 (30.1)
Dissertation published	
Yes	201 (53.0)
No	178 (47.0)
Multiple core research subjects completed	
Yes	83 (21.9)
No	296 (78.1)
Elective research subject completed	
Yes	4 (1.1)
No	375 (98.9)
Total publications before dissertation	
0	182 (48.0)
1–2	108 (28.5)
3 or more	89 (23.5)

research subjects or achieving a higher grade in core research methods subjects did not affect whether the dissertation was published. Similarly, the odds of publishing the dissertation were not affected by whether the supervisor had completed a PhD or supervised other dissertation students. Students with female supervisors were 73% less likely to publish their dissertation (OR 0.27, 95% CI = 0.12–0.62, $p = 0.002$). Table S2 shows the results of the univariable analysis for predictors of publishing the dissertation.

Students with non-medical supervisors had 68% fewer total publications within 2 years of completing the Dissertation B subject compared to those with surgeon supervisors (IRR = 0.32, 95% CI = 0.13–0.75, $p = 0.015$). Students with supervisors that had completed a PhD had 36% more total publications within 2 years of completing the Dissertation B subject (IRR = 1.36, 95% CI = 1.04–1.79, $p = 0.026$, Table 6). Students with female supervisors had 47% fewer total publications and 51% fewer first author publications within 2 years of completing the Dissertation B subject compared to students with male supervisors (IRR = 0.53, 95% CI = 0.32–0.88, $p = 0.015$; IRR = 0.49, 95% CI = 0.27–0.88, $p = 0.017$ respectively, Table 6). Students who had published prior to starting the Dissertation B subject had an increased number of total publications and first author publications within 2 years of completing the Dissertation B subject. Students who received a distinction or above in the research methods subject had 64% more first author publications within 2 years of completing the Dissertation B subject (IRR = 1.64, 95% CI = 1.20–2.23, $p = 0.002$, Table 6).

Higher grades in the dissertation subject were associated with a greater number of citations at 2 years for the published dissertation (OR 1.72, 95% CI = 1.16–2.53, $p = 0.007$, Table S3). Additionally, students who had supervisors from medical specialties had fewer citations at 2 years for the published dissertation compared to students with surgical specialties (OR 0.41, 95% CI = 0.19–0.86, $p = 0.049$, Table S3).

4 | Discussion

This study highlights the short-term outcomes of supervised surgical research aligned to a master's degree. Over the 10-year study period, the results show that a significant number of students successfully published their dissertation in a journal. A substantial number of students published in high-impact journals and received a high number of citations, indicating high quality manuscript development demonstrateded by higher quality dissertations being more likely to have higher citations. This is noteworthy, given that many of the students had limited

TABLE 2 | Descriptive statistics of supervisor characteristics.

	Count (Percentage)
Supervisor gender	
Male	335 (88.4)
Female	44 (11.6)
Supervisor state	
NSW	291 (76.8)
VIC	32 (8.4)
QLD	28 (7.4)
SA	11 (2.9)
WA	7 (1.8)
NT	2 (0.5)
TAS	2 (0.5)
ACT	3 (0.8)
Overseas	3 (0.8)
Supervisor specialty	
Surgeon	340 (89.7)
Medical, non-surgeon	22 (5.8)
Non-medical	17 (4.5)
Surgical supervisor specialty	
General surgery	127 (37.4)
Breast surgery	13 (3.8)
Colorectal surgery	41 (12.1)
Endocrine surgery	5 (1.5)
Head and neck surgery	7 (2.1)
Surgical oncology	10 (2.9)
Hepato-prancreatico-biliary	18 (5.3)
Upper gastro-intestinal surgery	21 (6.2)
Trauma	3 (0.9)
Cardiothoracic surgery	11 (3.2)
Neurosurgery	16 (4.7)
Orthopaedic surgery	46 (13.5)
Otorhinolaryngology	30 (8.8)
Paediatric surgery	13 (3.8)
Plastics and reconstructive surgery	47 (13.8)
Urology	31 (9.1)
Vascular and endovascular	16 (4.7)
Maxillofacial	3 (0.9)
Supervisor completed PhD	
Yes	168 (44.3)
No	211 (55.7)
Supervisor has had other MS dissertation students	
Yes	228 (60.2)
No	151 (39.8)

(Continues)

TABLE 2 | (Continued)

exposure to research prior to the MS program, and for many, this dissertation may have been their first time undertaking a research project. Reasons for not publishing the dissertation may include dissemination through other means (i.e., presentation at a conference, scientific meeting, local department), a lack of novel findings, loss of interest in the project, time constraints, or a decision to not pursue surgical training. Interestingly, the distribution of students' projects across surgical specialties aligns closely with national surgical training applications, reflecting expected patterns [8].

Participation in research is important for clinicians to develop skills in evidence-based practice. Australian medical students and junior doctors have demonstrated interest in pursuing research throughout their careers [9, 10]. However, both frequently cite career advancement and view research as a pre-requisite for specialist training as the primary motivator for undertaking research [11, 12]. This is particularly true for those interested in surgery, given the increasing competitiveness of surgical training selection and the fact that surgical publications are a critical component in securing Specialty Education and Training (SET) positions across Australian surgical subspecialties [5, 11, 12]. Without further training in research methods, this will only compound the issue of high-volume papers of low quality or limited clinical applicability, as more trainees seek to publish but also places them in a vulnerable position to publish in predatory journals [13]. Here, trainees would pay exorbitant fees to publish in journals that may not have as rigorous a peer review process, to just publish and include on their curriculum vitae; however, this may in fact impact credibility, possibly damage reputation, and cause career hindrance.

Previous literature on engaging in research education and structured supervision of trainees in research projects has shown significant benefits in developing an academic identity. In the United States, plastic surgeons that completed postdoctoral research fellowships or a PhD had a greater likelihood of attaining research grants and a higher h-index [14]. Similarly, a survey of doctors who had completed general surgery residency through McGill University showed that those who were enrolled in higher research degrees (HDR) and formal research programs produced twice as many papers per year and had greater success in achieving research funding compared to those who did not [15]. Additionally, an analysis of

TABLE 3 | Descriptive statistics for individual subject grades.

	Subject	Median	Range
Subject marks	Dissertation B ($n = 379$)	74	48–92
	Clinical Epidemiology ($n = 105$)	75	0–97
	Surgical Research and Evaluation ($n = 77$)	78	54–94
	Introductory Biostatistics ($n = 282$)	78	0–97
	Introduction to Systemic Review ($n = 3$)	66	65–78
	Advanced Biostatistical Modelling ($n = 2$)	67	46–87
Students who published dissertation ($n = 201$)	Time to publication after completing Dissertation B subject (months)	18	0–87
	Publication citations at 2 years	2	0–51
	Journal Impact Factor	2.19	0–50.5
All students ($n = 379$)	First author publications prior to Dissertation B	0	0–35
	Co-author publication prior to Dissertation B	0	0–36
	Total publications prior to Dissertation B	1	0–71
	Number of first author publication 2 years after completing Dissertation B	0	0–20
	Number of co-author publication 2 years after completing Dissertation B	0	0–14
	Total publications 2 years after completing Dissertation B	1	0–30

research output of Dutch medical students revealed that those who published prior to completing medical school were 1.9 times more likely to publish after graduation, produce more papers and have a slightly higher citation impact factor [16]. Therefore, the results of this study broadly align with previous literature, reinforcing the importance of prior research experience and revealing that strong engagement in the Dissertation B subject is profound for subsequent research output and quality. Thus, early exposure to research not only improves immediate academic outcomes but also sets the stage for continued academic engagement, contributing to a robust publication record over time.

Australian medical schools offer either direct entry from high school (undergraduate) or after completion of a bachelor's degree (post-graduate). Although medical schools require students to complete dedicated research projects, these are often insufficient, where undergraduate students find it more difficult to break into academia and are not actively encouraged to pursue research [12]. Commonly, the cited barriers for Australian medical students and junior doctors engaging in research include limited baseline research skills, time constraints and lack of adequate supervision [11, 12, 17]. The presented results shows that engagement in core research methods subjects that teach foundational research skills improves the quality of the dissertation and increases short-term research output. Hence, the MS program could serve as a bridge between medical school and HDR, providing students who lack research experience with the necessary skills to become comfortable with completing research independently and gain an insight into research without committing to a PhD or MPhil after medical school. This could be particularly beneficial for undergraduate entry medical graduates who generally lack exposure to research compared to post-graduate entry graduates [12]. Previously, Al-Busaidi et al. demonstrated that publications at an early stage of one's career are associated with completion of HDR and attaining future faculty positions, but the questions remain regarding the best method to provide early exposure to research, given the demanding nature of being a junior doctor [18]. This bridge between medical school and completing a HDR is of interest given the recent decline in the proportion of medical clinicians completing PhDs with respect to non-physicians and the lack of a formal pathway towards taking time away from clinical duties for research prior to gaining selection into accredited surgical training in Australia [19]. Further studies are required to ascertain the impact of higher degrees following primary medical qualifications on long-term academic output or completion of subsequent HDR. This could be completed through a retrospective review of research publications of SET trainees at the end of training, comparing those who have completed a higher degree when applying to SET to those who had not.

The gender disparity within surgical education and research has significant implications for the quality and breadth of scientific output. Despite progress in increasing the representation of women, barriers persist, as shown by this study where only 11.6% of students in the MS dissertation had female main supervisors. This aligns with broader trends in

TABLE 4 | Multivariable analysis (linear regression) of factors associated with Dissertation B mark.

	Coefficient (mark)	95% Confidence interval	*p*
Core research methods grade			0.038
Pass/credit	Reference		
Distinction/ high distinction	1.67	0.09–3.24	
Publications before Dissertation B			0.013
0	Reference		
1–2	0.08	−1.74 – 1.90	
3 or more	2.76	0.83–4.70	
Supervisor gender			0.074
Male	Reference		
Female	2.38	−0.23 – 4.99	
Supervisor specialty			0.074
Surgeon	Reference		
Medical (non-surgeon)	3.96	0.51–7.35	
Non-medical	0.75	−3.20 – 4.69	

TABLE 5 | Multivariable analysis (logistic regression) for predictors of publishing the dissertation.

	Odds ratio	95% Confidence interval	*p*
Dissertation grade			< 0.001
Pass/credit	Reference		
Distinction/ high distinction	2.26	1.42–3.61	
Publications before Dissertation B			< 0.001
0	Reference		
1–2	2.47	1.48–4.13	
3 or more	3.35	1.90–5.92	
Supervisor gender			0.002
Male	Reference		
Female	0.27	0.12–0.62	
Supervisor specialty			0.025
Surgeon	Reference		
Medical (non-surgeon)	2.13	0.75–5.93	
Non-medical	0.16	0.03–0.82	

the Australian surgical workforce, where between 2016 and 2021, women represented 15% of the active surgical workforce [20]. Therefore, gender disparities extend beyond the surgical workforce and into research output and academic supervision. This study showed that students with female supervisors were less likely to publish their dissertation and had fewer publications after completing the dissertation, which was an unexpected finding. This is despite students with female supervisors having a trend towards a higher dissertation mark, although this did not reach statistical significance. This would indicate that female supervisors had lower publication rates, despite producing higher quality manuscripts. The correlation between gender and publication rates is multifaceted and influenced by a range of factors, including underrepresentation in leadership positions affecting opportunities for mentorship and collaboration, institutional support and the presence of role models in the field [21–24]. This can affect the ability to publish work and gain recognition for their work, and some studies have identified potential biases in gender in academic journals [25, 26]. Sakowska and Toffoletti explored the publication bias female academics may face, analysing gender authorship trends in the ANZ Journal of Surgery, where only 11% of the senior authors were female and 20% of the first authors were females [21]. Although the representation of women in the surgical workforce is growing, the historical underrepresentation of women in surgical programs continues to influence surgical research, which highlights an important area for programs to develop and address.

The limitations of this study include using two databases, PubMed and Web of Science, to undertake the manual search, which may have underestimated the true publication rate. Embase was not included due to users' difficulty in searching by author name, which aligns with previous literature requiring a manual search of literature by name [17, 27]. Additionally, assessing the quality of research is a nuanced practice. This study uses the number of citations and journal impact factor to assess the quality of published work, which has been criticised in previous literature as these metrics assess the quality of the journal rather than the published work [28, 29]. Furthermore, data on students' gender was not available and this will be the focus of further research to understand the role of gender on surgical research output. Furthermore, this study assesses the lead supervisor rather than the whole supervisorial team, where differing teams would have varying amounts of input from different supervisors. Further research is needed to determine if the makeup of the supervisorial team impacts research outcomes.

TABLE 6 | Multivariable negative binomial regression for predictors of publications within 2 years of completing dissertation.

		IRR	95% CI	*p*
Total number of publications	Dissertation grade			0.337
	Pass/credit	Reference		
	Distinction/high distinction	1.15	0.86–1.53	
	Core research method grade			0.140
	Pass/credit	Reference		
	Distinction/high distinction	1.23	0.94–1.61	
	Multiple core research subjects	0.96	0.70–1.312	0.794
	Publications before Dissertation B			<0.001
	0	Reference		
	1–2	2.89	2.09–3.99	
	3 or more	4.41	3.19–6.09	
	Supervisor gender			0.015
	Male	Reference		
	Female	0.53	0.32–0.88	
	Supervisor specialty			0.015
	Surgeon	Reference		
	Medical (non-surgeon)	1.31	0.73–2.35	
	Non-medical	0.32	0.13–0.75	
	Supervisor completed PhD	1.36	1.04–1.79	0.026
	Supervisor has supervised multiple students	0.82	0.61–1.10	0.188
	Supervisor based in NSW	1.36	0.96–1.93	0.087
Number of first author publications	Dissertation grade			0.318
	Pass/Credit	Reference		
	Distinction/High distinction	1.18	0.86–1.62	
	Core research method grade			0.002
	Pass/Credit	Reference		
	Distinction/High distinction	1.64	1.20–2.23	
	Multiple core research subjects	0.88	0.62–1.27	0.520
	Publications before Dissertation B			<0.001
	0	Reference		
	1–2	2.79	1.95–4.00	
	3 or more	3.04	2.12–4.37	
	Supervisor gender			0.017
	Male	Reference		
	Female	0.49	0.27–0.88	
	Supervisor specialty			0.138
	Surgeon	Reference		
	Medical (non-surgeon)	1.09	0.55–2.18	
	Non-medical	0.39	0.15–1.02	
	Supervisor completed PhD	1.29	0.95–1.76	0.10
	Supervisor has had other MS dissertation students	0.99	0.71–1.37	0.929
	Supervisor based in NSW	1.05	0.71–1.54	0.815

5 | Conclusion

Strong engagement in structured teaching in research methods subjects improves short-term research output among early surgical researchers. The high-quality surgical research output following a student's dissertation in the MS program is likely a combination of structured faculty support in research projects and formal teaching on foundational research skills. There is a strong correlation between early research involvement and future publication rates, suggesting that fostering research skills early in medical training is beneficial for developing an academic identity.

Author Contributions

Meet Patel: conceptualization; writing – original draft; methodology; writing – review and editing; data curation; formal analysis. **David Sun:** data curation; writing – original draft. **Maya Jane Starr:** writing – original draft; data curation. **Dhaval Solanki:** data curation; writing – review and editing; visualization. **Jeet Upadhyay:** data curation; writing – review and editing; visualization. **Dominic J. A. Edwards:** data curation. **Arjun Raju:** data curation; writing – review and editing. **Thomas Maouris:** data curation. **Alexander Lombardo:** data curation. **Daphne Wang:** data curation. **Karamveer Nagi:** data curation. **Nazim Bhimani:** formal analysis; validation; methodology; conceptualization; supervision; writing – review and editing. **Anthony R. Glover:** conceptualization; investigation; methodology; supervision; writing – review and editing.

Acknowledgements

Open access publishing facilitated by The University of Sydney, as part of the Wiley - The University of Sydney agreement via the Council of Australian University Librarians.

Disclosure

Dr. Meet Patel, Mr. Nazim Bhimani, A/Prof Anthony Glover are employed as faculty for the University of Sydney Medical School.

Data Availability Statement

The participants of this study did not give written consent for their data to be shared publicly, so due to the sensitive nature of the research, supporting data are not available.

References

1. W. Silen, "Publish or Perish Revisited," *Archives of Surgery* 131, no. 8 (1996): 798, https://doi.org/10.1001/archsurg.1996.01430200008001.

2. C. V. L. Jarry, F. Navarro, J. Cerda, E. Grasset, and M. Gabrielli, "Research in Surgery: The Adversities That Every Surgeon Should Know and Face," *Health Sciences Review* 2 (2022): 100016, https://doi.org/10.1016/j.hsr.2022.100016.

3. S. G. Keswani, C. M. Moles, M. Morowitz, et al., "The Future of Basic Science in Academic Surgery: Identifying Barriers to Success for Surgeon-Scientists," *Annals of Surgery* 265, no. 6 (2017): 1053–1059, https://doi.org/10.1097/SLA.0000000000002009.

4. C. H. Liao, "How to Improve Research Quality? Examining the Impacts of Collaboration Intensity and Member Diversity in Collaboration Networks," *Scientometrics* 86 (2011): 747–761, https://doi.org/10.1007/s11192-010-0309-2.

5. Royal Australasian College of Surgeons (RACS), "Guide to SET—2024," A Comparative Guide of Surgical Specialties and an Overview of Surgical Education and Training. Royal Australasian College of Surgeons (RACS), 2024, https://www.surgeons.org/-/media/Project/RACS/surgeons-org/files/becoming-a-surgeon-trainees/guide-to-set.pdf?rev=8e0ea1e9418b44ecb9ad65c8e6666aba&hash=2FD671C47C0B4911B5EC353F35528B55.

6. M. J. Lambrechts, J. C. Heard, Y. A. Lee, et al., "Predictors of Academic Productivity Among Spine Surgeons," *Journal of the American Academy of Orthopaedic Surgeons* 31, no. 10 (2023): 505–510, https://doi.org/10.5435/JAAOS-D-22-01011.

7. A. Rompala, S. Y. Sudah, A. S. Miller, et al., "Predicting Academic Productivity Among American Shoulder and Elbow Surgeons Fellowship Faculty From Publications Acquired Before and During Surgical Training," *Journal of Shoulder and Elbow Surgery* 33, no. 10 (2024): e523–e528, https://doi.org/10.1016/j.jse.2024.02.025.

8. Royal Austaliasian College of Surgeons (RACS), "Activities Report," Royal Austaliasian College of Surgeons (RACS), 2022, https://www.surgeons.org/-/media/Project/RACS/surgeons-org/files/reports-guidelines-publications/workforce-activities-census-reports/2022_RACS_ActivitiesReport_Web_final.pdf?rev=9536e2ab9e9149a1a24e2d2d0d5a6dea&hash=9B9D0982964DABDA4FFC0A52432EC37B.

9. J. J. Reinders, T. J. Kropmans, and J. Cohen-Schotanus, "Extracurricular Research Experience of Medical Students and Their Scientific Output After Graduation," *Medical Education* 39, no. 2 (2005): 237, https://doi.org/10.1111/j.1365-2929.2004.02078.x.

10. A. Gowda, S. Bacchi, J. G. Kovoor, A. K. Gupta, G. J. Maddern, and W. O. Chan, "Should Research Success Be Predicted Amongst Medical Students and Junior Doctors?," *ANZ Journal of Surgery* 93, no. 7–8 (2023): 1742–1743, https://doi.org/10.1111/ans.18460.

11. V. Kieu, E. Moore, D. Hunter-Smith, B. Spychal, and D. Nestel, "How Can We Improve Research Opportunities for Australian Junior Doctors?," *ANZ Journal of Surgery* 81, no. 12 (2011): 852–854, https://doi.org/10.1111/j.1445-2197.2011.05895.x.

12. J. Muhandiramge, T. Vu, M. J. Wallace, and E. Segelov, "The Experiences, Attitudes and Understanding of Research Amongst Medical Students at an Australian Medical School," *BMC Medical Education* 21, no. 1 (2021): 267, https://doi.org/10.1186/s12909-021-02713-9.

13. H. Deora, M. Tripathi, B. Chaurasia, and J. A. Grotenhuis, "Avoiding Predatory Publishing for Early Career Neurosurgeons: What Should You Know Before You Submit?," *Acta Neurochirurgica* 163, no. 1 (2021): 1–8, https://doi.org/10.1007/s00701-020-04546-9.

14. J. Lopez, A. Ameri, S. M. Susarla, et al., "Does Formal Research Training Lead to Academic Success in Plastic Surgery? A Comprehensive Analysis of U.S. Academic Plastic Surgeons," *Journal of Surgical Education* 73, no. 3 (2016): 422–428, https://doi.org/10.1016/j.jsurg.2015.12.001.

15. H. Hsieh, F. Paquette, S. A. Fraser, et al., "Formal Research Training During Surgical Residency: Scaffolding for Academic Success," *American Journal of Surgery* 207, no. 1 (2014): 141–145, https://doi.org/10.1016/j.amjsurg.2013.04.011.

16. C. J. F. Waaijer, B. W. C. Ommering, L. J. van der Wurff, T. N. van Leeuwen, F. W. Dekker, and Education NSIGoS, "Scientific Activity by Medical Students: The Relationship Between Academic Publishing During Medical School and Publication Careers After Graduation," *Perspectives on Medical Education* 8, no. 4 (2019): 223–229, https://doi.org/10.1007/s40037-019-0524-3.

17. J. L. Fox, J. Cribb, K. Cumming, and P. Martin, "Medical Student Interest and Participation in Research at One Rural Clinical School: Insights From the Last Six Years," *Australian Journal of Rural Health* 31, no. 3 (2023): 569–574, https://doi.org/10.1111/ajr.12970.

18. I. S. Al-Busaidi, C. I. Wells, and T. J. Wilkinson, "Publication in a Medical Student Journal Predicts Short- and Long-Term Academic Success: A Matched-Cohort Study," *BMC Medical Education* 19, no. 1 (2019): 271, https://doi.org/10.1186/s12909-019-1704-x.

19. C. L. Traill, A. S. Januszewski, R. Larkins, A. C. Keech, and A. J. Jenkins, "Time to Research Australian Physician-Researchers," *Internal Medicine Journal* 46, no. 5 (2016): 550–558, https://doi.org/10.1111/imj.13043.

20. M. Boot, "Gender Equality in Surgery: Where Does Ausrtalia Stand?," *ANZ Journal of Surgery* 93, no. S1 (2023): 248–250, https://doi.org/10.1111/ans.18424.

21. M. M. Sakowska and K. Toffoletti, "The Persistent Publication Glass Ceiling: An Analysis of Gender Authorship Trends in ANZ Journal of Surgery," *ANZ Journal of Surgery* 93, no. 1–2 (2023): 98–102, https://doi.org/10.1111/ans.17822.

22. V. Graham and B. Arora, "Women in Surgery: Trends in Nine Surgical Specialties," *ANZ Journal of Surgery* 93, no. 10 (2023): 2344–2349, https://doi.org/10.1111/ans.18600.

23. H. R. Jamali and A. Abbasi, "Gender Gaps in Australian Research Publishing, Citation and Co-Authorship," *Scientometrics* 128, no. 5 (2023): 2879–2893, https://doi.org/10.1007/s11192-023-04685-7.

24. O. Bruck, "A Bibliometric Analysis of the Gender Gap in the Authorship of Leading Medical Journals," *Communications Medicine (Lond)* 3, no. 1 (2023): 179, https://doi.org/10.1038/s43856-023-00417-3.

25. N. Rinaldo, G. Piva, S. Ryder, et al., "The Issue of Gender Bias Represented in Authorship in the Fields of Exercise and Rehabilitation: A 5-Year Research in Indexed Journals," *Journal of Functional Morphology and Kinesiology* 8, no. 1 (2023): 18, https://doi.org/10.3390/jfmk8010018.

26. A. R. Kern-Goldberger, R. James, V. Berghella, and E. S. Miller, "The Impact of Double-Blind Peer Review on Gender Bias in Scientific Publishing: A Systematic Review," *American Journal of Obstetrics and Gynecology* 227, no. 1 (2022): 43–50, https://doi.org/10.1016/j.ajog.2022.01.030.

27. M. Khajehnoori, D. Stupart, and D. Watters, "Publication Rate of General Surgery Abstracts Presented at the Royal Australasian College of Surgeons Annual Scientific Congress," *ANZ Journal of Surgery* 88, no. 1–2 (2018): 16–19, https://doi.org/10.1111/ans.14103.

28. E. Mech, M. M. Ahmed, E. Tamale, M. Holek, G. Li, and L. Thabane, "Evaluating Journal Impact Factor: A Systematic Survey of the Pros and Cons, and Overview of Alternative Measures," *Journal of Venomous Animals and Toxins Including Tropical Diseases* 26 (2020): e20190082, https://doi.org/10.1590/1678-9199-JVATITD-2019-0082.

29. J. Neuberger and C. Counsell, "Impact Factors: Uses and Abuses," *European Journal of Gastroenterology & Hepatology* 14, no. 3 (2002): 209–211, https://doi.org/10.1097/00042737-200203000-00001.

Supporting Information

Additional supporting information can be found online in the Supporting Information section.