Rate and predictors of publication by medical and health science summer research students: a 14-year analysis from Auckland, New Zealand

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Abstract

Introduction
Undergraduates are capable of making valuable contributions to the medical sciences. At The University of Auckland, many students complete summer studentship projects. Anecdotally, students have enjoyed these projects, developed an interest in academia, and published peer-reviewed articles. This study aimed to i) determine the publication rate following the studentship programme from 2001-2013, and ii) identify factors correlated with publication.

Methods
Students completing summer studentships at the Faculty of Medical and Health Sciences, The University of Auckland from 2001-2013 were identified. Seven databases were searched for articles with student and supervisor as named authors. Outcomes of interest were; i) publication within 3 years of studentship completion, ii) publication at any time, and iii) publication with the student as the first author.

Results
Over the 13-year period, 1345 studentship projects were completed, with 666 identified subsequent publications by 425 students. At 3 years follow-up after studentship completion, 22% had published, increasing to 32% at any time following studentship completion. Degree, department, and research category were all significantly correlated with successful publication.

Conclusion
Summer studentships provide New Zealand undergraduates with opportunities to make valuable contributions to science. Further investigation may facilitate improvement strategies and maximise benefits for students, supervisors,
Undergraduate students have been responsible for many significant advances in the medical sciences. Notably, insulin, heparin, ether anaesthesia, and the heart’s sinoatrial node were all discovered due to significant intellectual contributions from students. Modern students continue to make valuable contributions to science, and many universities offer programmes aiming to equip undergraduates with the skills and experience required to conduct high-quality research.

Undergraduates with research experience are more likely to complete higher degrees, pursue academic careers, and have long term success in academia. Students also develop valuable interpersonal, professional, and scientific skills during their research experiences. Undergraduates may engage with research through a variety of opportunities, including summer studentships, compulsory research requirements, voluntary extracurricular research, elective/selective placements, intercalated degrees such as the Bachelor of Medical Science (Honours) for medical students, or other equivalent qualifications.

At The University of Auckland, the Faculty of Medical and Health Sciences (FMHS) offers 10-week summer studentship projects for undergraduate students, which are completed under the supervision of senior researchers. Summer studentships are a significant contributor to the research exposure of FMHS undergraduates, with a 2007 study showing 70% of medical students with research experience had completed a summer studentship. Anecdotally, students have enjoyed these projects, received mentorship from supervisors, developed an interest in academic careers, and been able to publish in the peer-reviewed literature.

Dissemination of research is vital for the development and career progression of young researchers. Research may be communicated in a variety of forms, though publication in peer-reviewed journals is considered the “gold standard” of academic success. Student contributions to the New Zealand Medical Journal (NZMJ) have more than quadrupled since 2000, suggesting an increasing interest of New Zealand undergraduates in research. A recent analysis of The University of Otago’s Bachelor of Medical Science (Honours) programme was published in the NZMJ with a reported publication rate of 33%. However, the relatively low uptake of intercalated degrees amongst New Zealand medical students necessitates evaluation of other undergraduate research activities.

The aims of this study were twofold; i) to determine the publication rate of the FMHS studentship programme at The University of Auckland from 2001 to 2013, and ii) to identify factors correlated with publication following studentship completion.

**Methods**
Approval from The University of Auckland Human Participants Ethics Committee was obtained (UAHPEC 016921) before data retrieval.

All students undertaking an FMHS summer studentship project at the University of Auckland from 2001 to 2013 inclusive were identified from faculty records. The following variables were collected for each project: student name, degree programme and year level, studentship category (biomedical, clinical, or public health), supervisor name, university department, funding of studentship award, and year of the award.

A systematic literature search was conducted during April 2016, using the PubMed, EMBASE, Scopus, Web of Science, CINAHL, PsycINFO, and International Pharmaceutical Abstracts databases. The last name and truncated first initial of each student and their primary supervisor were used as queries in the author field, and author affiliation was queried for "Auckland". Each of these terms was then combined with the Boolean operator "AND". (i.e., Smith J*[Author] AND Jones R*[Author] AND Auckland[Affiliation]). Thereafter, "OR" terms were used to combine searches for student-supervisor pairs from each year. Syntax was altered for each database as appropriate.

The New Zealand Medical Student Journal (NZMSJ) is a journal in which summer studentship projects may be published but is not indexed in a searchable database (correspondence with editor). A hand search of all NZMSJ issues from inception to April 2016 was performed by one investigator (SM) to identify additional articles attributable to an FMHS studentship project.

Results were exported into a reference management software programme (EndNote X7, Thomson Reuters, Toronto, Canada). Duplicate articles in each year group were removed, first by the automatic feature in Endnote, and subsequently by manual review. Two study investigators (CW and HW) hand-screened results and developed a list of articles for analysis. Articles were only included if both student and supervisor were named authors, as this would imply they arose from the summer studentship. Exclusion criteria were articles published prior to the completion of the project, those unable to be conclusively attributed to a student-supervisor pair, or clearly unrelated to the medical and health sciences. Conference abstracts and publications other than journal articles were also excluded. Prior to analysis, a single investigator (CW) reviewed the full text of each article, and any that could not be attributed to a student-supervisor pair were excluded from further analyses.

The following data were recorded for each article; title, journal name, date of publication, the number of authors, student position in authorship, and type of article. The type of article (original article, review, systematic review, or case report) was determined by full-text review. The number of citations indexed in Google Scholar was also recorded for each article.

Outcomes of interest were recorded for each student-supervisor pair and included: i) publication within 3 years of studentship completion, ii) publication at any time following studentship completion, and iii) publication with the student as the first author at any time following studentship completion. Students begin their projects in November, and for the purposes of analysis, each studentship was deemed as ending on 1 February of the year following the start of the project. The 'number needed to publish' was defined as the number of studentships required to result in at least one publication by a student and supervisor.

Statistical analysis was performed using SPSS for Macintosh (Version 22; IBM Corp, Armonk, NY). Univariate analysis was carried out using the chi-squared test. A $p$-value <0.05 was deemed statistically significant.
Results

In total, 1345 studentship projects were identified over the 13-year period. The number of projects per year increased from 76 in 2001 to 142 in 2013 (Figure 1). Table 1 shows the characteristics of these students and projects. The median follow-up after studentship completion was 6.3 years (range 2.2-14.4 years).

Figure 1 Annual number of studentship projects, 2001-2013

Table 1 Cohort characteristics
| Degree                  | n (%)     |
|------------------------|----------|
| Medicine               | 586 (46.9%) |
| Science                | 423 (31.4%) |
| Pharmacy               | 107 (8.6%)  |
| Health Science         | 70 (5.2%)   |
| Nursing                | 19 (1.5%)   |
| Optometry              | 15 (1.2%)   |
| Other                  | 29 (2.3%)   |

| Year Level | n (%) |
|------------|-------|
| I          | 8 (0.7%) |
| II         | 363 (31.6%) |
| III        | 652 (53.8%) |
| ≥IV        | 169 (13.9%) |

| Category             | n (%) |
|----------------------|-------|
| Biomedical           | 663 (49.4%) |
| Clinical             | 362 (27.0%) |
| Public Health        | 317 (23.6%) |

| Department                     | n (%) |
|--------------------------------|-------|
| Physiology                    | 154 (11.5%) |
| Pharmacy                      | 121 (9.0%)  |
| Molecular Medicine & Pathology| 99 (7.4%)   |
| Liggins Institute             | 96 (7.1%)   |
| Ophthalmology                 | 82 (6.1%)   |
| Medicine                      | 77 (5.7%)   |
| Obstetrics & Gynaecology      | 68 (5.1%)   |
| Population Health             | 65 (4.8%)   |
| Surgery                       | 63 (4.7%)   |
| Psychological Medicine        | 62 (4.6%)   |
| Anatomy with Radiology        | 62 (4.6%)   |
| Paediatrics                   | 59 (4.4%)   |
| General Practice & Primary Care| 59 (4.4%)  |
| Nursing                       | 57 (4.2%)   |
| Pharmacology                  | 50 (3.7%)   |
| Cancer Research Centre        | 38 (2.8%)   |
| Other                         | 132 (9.8%)  |

| Funding            | n (%) |
|--------------------|-------|
| Internal           | 945 (70.7%) |
| External           | 392 (29.3%) |
The database search yielded 4840 results, which were narrowed to a total of 865 articles attributable to a student and primary supervisor (Figure 2). Some articles were matched to more than one project (i.e. multiple student authors on a single paper, or one student completed multiple projects with the same supervisor). Thus, a total of 666 unique articles were identified, corresponding to 425 student-supervisor pairs. Of these articles, 571 (86% of 666) were original articles, while a minority were systematic reviews (7%), review articles (6%), and case reports (1%). Articles were published in a total of 352 different journals, with the most common being the NZMJ (4% of all articles). Four articles from the NZMSJ were identified. Only 66 articles (10%) were from Australasian journals, with the remainder published in the international literature. The median lag from studentship completion to publication was 3.2 years.

**Figure 2** Literature search and screening process

![Diagram showing literature search and screening process]

IPA = International Pharmaceutical Abstracts; NZMSJ = New Zealand Medical Student Journal

At a 3-year follow-up, 300 student-supervisor pairs (22% of 1345) had published at least one journal article, which increased to 425 (32%) at any time following studentship completion. This corresponded to a ‘number needed to publish’ of 3.2 studentship projects. Only 157 student-supervisor pairs (12%) published more than one article. The highest number of publications from a single student-supervisor pair was 28. Of 1365 studentship projects, 27 (2%)
were responsible for 241 (27% of 865) publications. The median student position in authorship was second of six authors. Across the entire cohort, 192 studentship projects (14%) resulted in at least one publication with the student as the first author.

A total of 15,188 indexed citations were identified. The median number of citations per article was 11 (range 0-903), over a median of 4.0 years since publication (range 0-13.8 years). Only 90 articles (10% of 865) had not been cited.

Table 2 shows variables correlated with publication. At 3-year follow-up, medical (26%), science (22%), and health science (21%) students were most likely to have published at least one paper with their supervisor \((p=0.01)\). However, when considering the overall follow-up period, science students (35%) were most likely to have published \((p=0.001)\). Clinical research projects (compared with biomedical or public health) were most likely to be published at both time points \((p<0.001)\).

Higher student year level was correlated with a higher rate of publication as a first author \((\geq 4^{th} \text{ year}, 27\% \text{ vs. } 2^{nd} \text{ or } 3^{rd} \text{ year, 11\% each respectively; } p<0.001)\). Students completing science and health science degrees were most likely to publish as first author \((p<0.001)\). Furthermore, clinical (16%) and biomedical (15%) research projects were more likely to result in a publication with the student as the first author compared with projects in public health (10%) \((p=0.04)\).

Table 2 Correlates of publication at 3 years, overall, and with the student as the first author
Figure 3 demonstrates the variation in departmental publication rates. At 3-year follow-up, the departments with highest publication rates were Surgery (40%), Obstetrics & Gynaecology (36%), and Medicine (32%) (*p*<0.001). These findings were similar when evaluating publication during the overall follow-up, with Surgery (48%), Obstetrics & Gynaecology (42%) and Physiology (40%) demonstrating the highest publication rates (*p*<0.001). Surgery (32%), Physiology (22%), and Pharmacology (22%) were the departments most likely to publish with the student as first author (*p*<0.001).
This study is the first to investigate the research outputs of medical and health science summer studentships in New Zealand, and has demonstrated that studentships provide undergraduates with an opportunity to make meaningful contributions to the scientific literature. These findings have implications for universities and other organisations (such as District Health Boards and charitable organisations) funding summer studentship projects, as well as for undergraduate students and studentship supervisors.

The present study, which included undergraduate summer students from a range of health-related degrees, reported an overall publication rate of 32%. This was remarkably similar to the 33% publication rate in a recent analysis of the Bachelor of Medical Science (Honours) programme at The University of Otago, with comparable rates of first authorship in the two cohorts (17% vs 14%, respectively). These findings are congruent with a recent international meta-analysis, which estimated 30% (95% CI 0.19-0.44) of research conducted by medical students results in a peer-reviewed publication, while only 13% (95% CI 0.05-0.30) results in a publication with the student as the first author.

Overall, the articles published by students and supervisors in this cohort made a substantial impact in the scientific literature, with a median of 11 citations per article at a 4-year follow-up. This compares favourably with an analysis of medical undergraduates' publications from 10 leading universities, which demonstrated a median of three citations per article after 2 years. Other analyses of articles published by medical students have suggested the majority have never been cited, in contrast with only 10% of articles in this study. Journal impact factors were not used as a metric of quality in this study, as they would be inappropriate to use in such a diverse cohort, and are not statistically representative of individual publications.
Another important consideration is the possible factors contributing to non-publication by 68% of student-supervisor pairs in this study, and how these may be addressed. This phenomenon is not unique to undergraduate research, with half of all studies in the medical sciences remaining unpublished.\textsuperscript{21} It is considered unethical to not publish findings of medical research, particularly when patient data is involved, as no scientific benefit is gained from their contributions or the research funding provided.\textsuperscript{22,23} Common reasons for non-publication include a lack of time, confidence, or support from supervisors, negative or unimportant results, and fear of being rejected.\textsuperscript{15,21,24} Despite this, undergraduate students are keen to write for publication if given time and encouragement.\textsuperscript{15} This highlights the importance of providing mentorship and support for young researchers, and the presence of a mentor has been shown to predict publication, research productivity, and long-term success in academia.\textsuperscript{25,26} Several other strategies to increase publication rates have been identified,\textsuperscript{27} and it may be beneficial for universities to implement interventions such as providing writing workshops, or alternative mentors, to further support students to publish their findings.

This study identified several correlates of undergraduate publication, though the reasons underlying some of these remain unclear. Further evaluation of the experiences of students and supervisors is warranted to identify factors which correlate with research productivity, and may be utilised in the future to improve the publication rate of the studentship programme and other undergraduate research opportunities.

While this study investigated the publication rate of The University of Auckland FMHS studentship programme, many other research opportunities are available to undergraduates and were not examined as part of our analysis. Furthermore, it was not possible to determine whether identified articles were a direct result of work conducted during each 10-week project. The true publication rate of the FMHS studentship programme may therefore be lower than we have suggested. Other factors which may have impacted on our results include individuals who have changed names, or with alternative spellings of names. It is also possible our search strategy may have missed publications not indexed in the databases we investigated. Regardless, this study was able to demonstrate ongoing and productive relationships between some students and supervisors over a long-term period. This study was also unable to assess the rate of further postgraduate study by students in this cohort, or publication with collaborators other than their primary studentship supervisor.

\textbf{Conclusion}

The overall publication rate in this study of undergraduate summer research projects was 32%. Several correlates of publication were identified, including degree, type of research, and department. This study has demonstrated that summer studentships provide New Zealand undergraduates with an opportunity to make valuable contributions to science. Further assessment of the impact of studentships on the motivations and perceptions of students regarding research is warranted. Identification of factors underlying positive and negative outcomes may facilitate implementation of strategies to maximise benefits for students, supervisors, and universities.

\textbf{Take Home Messages}

\textbf{Notes On Contributors}

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Appendices

Declarations

The author has declared that there are no conflicts of interest.

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