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ORIGINAL ARTICLE

Doctoral profile of the medical radiation sciences: a baseline for Australia and New Zealand

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Abstract

Introduction: Research is critical to evidence-based practice, and the rapid developments in technology provide opportunities to innovate and improve practice. Little is known about the research profile of the medical radiation science (MRS) profession in Australia and New Zealand (NZ). This study provides a baseline of their doctoral activity. **Methods:** A cross-sectional survey of MRS professionals in Australia and NZ holding a doctorate or undertaking doctoral studies, was performed using an online tool (Bristol Online Survey[®], Bristol, UK). A chain-referral sampling technique was adopted for data collection. An email invitation with a link to the survey was generated and distributed through email and social media. The survey contained questions related to participant demographics, doctoral status, qualification route, funding and employment. **Results:** There were 63 responses to the survey comprising 50.8% diagnostic radiographers (DRs; $n = 32$), 23.8% radiation therapists (RTs; $n = 15$), with the remaining 25.4% ($n = 16$) equally split between sonographers and nuclear medicine technologists (NMTs). A total of 40 (63.5%) of respondents had completed their doctoral qualification. In NZ, only DRs held a doctoral award constituting 0.3% of DRs and 0.2% of the total registered MRS population. In Australia, there was a greater proportion of doctoral NMTs ($n = 8/1098$; 0.7%) than RTs ($n = 15/2394$; 0.6%) and DRs ($n = 27/12,001$; 0.2%). **Conclusion:** Similar to other countries, findings show a very small percentage of doctoral MRS professionals in Australia and NZ. Strategies to engage and support individuals in research, up to and beyond doctoral study, need to be embedded in practice.

Introduction

The development of new knowledge through research is critical to evidence-based practice and requires health professionals to engage with research as users, participants and leaders.^{1,2} Medical radiation science (MRS) professions comprise diagnostic radiography (DR), nuclear medicine technology (NMT), sonography and radiation therapy (RT) disciplines. The rapid advances in technology, service innovation and developments in roles mean that the evidence base must continue to evolve to support effective patient care. However, there is increasing concern about low research activity and publication

productivity.^{1,3–5} Research needs to be translated into practice to enhance patient care and the patient's experience. In particular, there is a lack of research on new models of service delivery and role development.⁶

The technical and professional skills required for research and subsequent communication of the findings need a programme of training.⁷ Individuals start this during undergraduate honours and continue through vocational awards and ultimately higher degrees such as masters by thesis, master of philosophy (MPhil) and doctor of philosophy (PhD or doctorate).^{8,9} Taught master's programmes are higher degrees often associated with skill development in an area of specialism and can

be a means to a new clinical role. Masters by thesis has little or no taught components and is awarded based on publications from student's research presented as a thesis. The format of the thesis varies regionally. MPhil is an advanced supervised research degree of shorter duration than PhD, and in many institutions is a prerequisite or preparation for transition into a doctoral degree. Research degrees such as masters by thesis, MPhil and PhD are research training and not aligned to any specialisation in imaging practice. Having received the highest degree related to research training, doctorate holders are a seed bed for independent research in their respective professions. Doctoral studies in a discipline are evidence of evolving and maturing research practice. A doctorate per se is not the end, but rather an essential entry point to a career in academia. Academic progression after a PhD strongly correlates with published papers and research grants.¹⁰ PhD graduates will require mentoring and support to become independent researchers. Successful transition from PhD to early career, then mid-career research is also a crucial stage in the development of any researcher.¹¹ Research roles and qualifications are not embedded in the clinical setting across health disciplines.^{12–14} However, increased number of MRS professionals with doctoral qualifications as well as research training and mentorship in the whole profession will add to the evidence base for practice.^{1,15}

There are some different routes to a doctoral degree, including the thesis-based doctor of philosophy (PhD), a PhD by publication, the doctorate in education (EdD) and professional or clinical doctorate (DProf).⁸ The PhD by thesis involves research and interpretation of the findings in the form of a dissertation. A PhD by publication is awarded based on an individual's research papers, which should demonstrate a contribution to their field and may be based on previous or a planned programme of research.⁸ EdD is designed to explore evidence relevant to policymaking for a profession, while DProf uses methodical approaches to explore and integrate academic knowledge into professional practice. EdD and professional or DProf contain many taught modules, are sometimes vocational in nature⁸ and are not recognised by some grant awarding bodies. It is important to distinguish the difference between the degrees and their purpose in preparation for a career in research, leadership or education.

In 2011, the Australian Bureau of Statistics reported that 25,610 individuals within the Australian health sector held a PhD, but no breakdown of different professions was stated.¹⁶ Little research has been conducted in the MRS professions within the region, but a 2009 survey of Australian RTs found that only seven individuals held a doctoral degree, and at that time, the authors suggested

that the 'professional body and universities need to continue providing academic and funding support' to encourage doctoral studies.¹⁵ Poor academic growth within the MRS profession regarding doctoral qualifications has also been identified internationally,¹⁷ with small numbers reported in both the United States (US)¹⁸ and United Kingdom (UK).¹⁹ In 2015, the UK radiography professional body updated their research strategy and set a challenging target to have at least 1% of radiographers engaged in a doctoral study by 2020.²⁰ No other countries have a similar plan.

While involvement in doctoral studies may be crucial to this strategy, it is important that doctoral degree holders develop and maintain a research culture. A particularly important aspect of this culture is early career mentorship. New PhD graduates might not be competent researchers, however, continued early and mid-career research can support a pathway to an independent research career. This post-doctoral experience is of particular importance to female academics with English as a second language.²¹

Currently, there is no published data regarding the percentage of MRS professionals holding a doctoral award in Australia and New Zealand (NZ). This study provides a baseline for future academic and workforce planning and allows international comparison.^{18,19}

Method

The study was a cross-sectional survey of MRS professionals in Australia and NZ and utilised an online tool for data collection (Bristol Online Survey[®], Bristol, UK). The survey contained both closed and open-ended questions related to participants' demographic data, doctoral status, qualification route, funding and employment.

There is no register of higher degree recipients in Australia and NZ. Therefore, a chain-referral (snowball) sampling technique was adopted for data collection. An email invitation with a link to the survey was distributed through social media via the Medical Radiation Research Network Facebook page and the #MedRadJClub on Twitter. Additionally, individuals known to the authors were invited by email and a list of potential participants with a doctoral qualification was established by scrutinising the author list from MRS journals and examining Australian and NZ university staff records online.

The study population was DR, NMT, sonography and RT professionals based in Australia and NZ who held, or were studying towards, a doctoral award. The population also included individuals who had undertaken their doctoral studies overseas but who now resided within the study area. Potential participants were asked to contact the researchers through email if they require further

information regarding survey access or clarify eligibility. The survey remained open from January to March 2016. Participants agreed to their responses being used for research purposes. Along with the parallel UK survey,¹⁹ this study was registered with the Mid Yorkshire Hospitals NHS Trust in England. The Health Research Authority (England) checklists confirmed that ethical approval was not required. By reading the survey instructions and proceeding with the study, participants' consent was implied.

The study collected data confidentially and included basic demographic and other information such as doctoral status, year of completion or planned year of completion, place of education, type of doctoral award and whether they undertook full-time or part-time studies. Other questions included funding, current employment, kind of research (qualitative, quantitative or mixed) during PhD, research output and activity in the past 2 years including grant writing, research, publications and supervision. These questions were to enable assessment of the profile of respondents and establish a baseline for future academic and workforce planning. The survey data were exported into Excel[®] (Microsoft Corporation, USA) for analysis.

Results

A total of 63 participants completed the questionnaire within the 2-month timeframe. The majority ($n = 40/63$; 63.5%) had already completed their doctorate. The respondents comprised 50.8% DRs ($n = 32$), 23.8% RTs ($n = 15$), with the remaining split equally between sonographers (12.7%; $n = 8$) and NMTs (12.7%; $n = 8$). The majority of Australian respondents lived in New South Wales ($n = 30/58$; 47.6%) and Victoria ($n = 12/58$; 19.1%), with smaller numbers elsewhere (Table 1). The total number of MRS professionals within the region has

been estimated as 22,873. As no single data source is available, the population was derived from the 4460²² accredited sonographers, and 15,510²³ Australian and 2903²⁴ NZ other MRS roles. Overall, this establishes the percentage of doctoral MRS professionals as 0.3%, although when compared to the locality of registrants, the greatest regional proportion reaches 0.5% (Table 1). In NZ, only DRs responded comprising 0.3% of DRs and 0.2% of the total registered MRS population. Restricting the analysis to Australian respondents there was a greater proportion of doctoral NMTs ($n = 8/1098$; 0.7%), with lower percentages of RTs ($n = 15/2394$; 0.6%) and DRs ($n = 27/12,001$; 0.2%).

Most of those who had completed their doctoral studies were over the age of 40 (31/40; 77.5%) (Fig. 1). Females comprised the majority of respondents, with similar gender splits between countries (58.7% female; Australia = 33; NZ: $n = 4$ vs. 41.3% males; Australia = 25; NZ: $n = 1$). Based on the Australian MRS registration data²⁰ (which excludes sonographers), the doctoral cohort represents a gender ratio of 1:1.8 (female 27/10,526; 0.3%; male $n = 23/4984$; 0.5%).

A greater number ($n = 43/63$; 68.3%) chose the PhD by thesis route, including those that had completed or were candidates at the time of the survey (Table 2). Seven of the respondents studied internationally with one individual studying both at home and abroad. All of those who completed their studies overseas pursued a PhD by thesis route. Part-time study was the most common approach ($n = 46/63$; 73.0%). A range of research methods was employed by respondents (Table 3). Mixed methods enquiry was the most common, with three individuals undertaking action research alongside quantitative and qualitative approaches.

The earliest award was obtained in 1994, and the latest expected date of completion for those surveyed was 2020, with the greatest number expecting to graduate in 2016

Table 1. The geographic location of doctoral MRS professionals.

Location	Diagnostic radiographers	Nuclear medicine technologists	Radiation therapists	Total (% of registered ^{20,21})	Sonographers (% of accredited ¹⁹)
Australian Capital Territory	–	–	–	–	–
New South Wales	16	5	4	25 (0.5)	5
Northern Territory	–	–	–	–	–
Queensland	4	–	–	4 (0.1)	1
South Australia	–	3	3	6 (0.5)	–
Tasmania	1	–	–	1 (0.3)	–
Victoria	4	–	6	10 (0.3)	2
Western Australia	2	–	2	4 (0.3)	–
New Zealand	5	–	–	5 (0.2)	–
Total	32	8	15	55 (0.3)	8 (0.2)

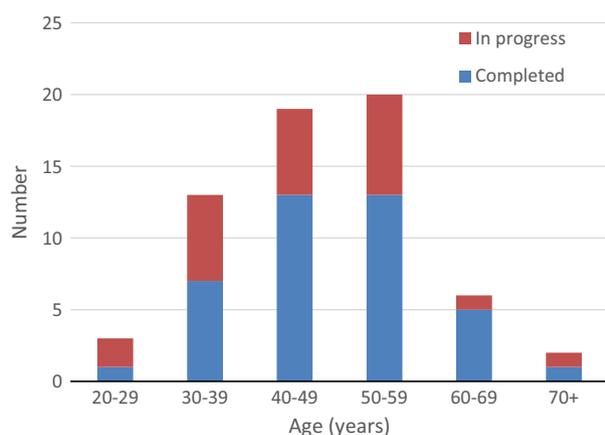


Figure 1. Age categories of the respondents by doctoral status.

Table 2. Doctoral route undertaken by MRS professionals.

Doctorate type	Number
PhD	43
PhD by published work	19
Professional doctorate	1
Total	63

(Fig. 2). At the time of their doctoral study, most respondents ($n = 29/63$; 46%) were working in academia, 20.6% ($n = 13$) were in clinical academic positions and 22.2% ($n = 14$) were employed in clinical roles. The remaining 7 (11.1%) respondents were full-time students or working in research assistant roles. Concerning employment after doctoral study, the greatest number ($n = 31/40$; 77.5%) were based in academia or had recently left the university sector, with a further 6 (15.0%) in clinical academic posts, with the remainder in clinical practice ($n = 3/40$; 7.5%).

The funding mechanism for the doctoral studies is shown in Table 4. Most respondents were subsidised by the government ($n = 18$; 28.6%) and/or self-funded ($n = 17$; 26.9%). In relation to their subsequent research funding, 47 (74.6%) respondents had received at least one grant and the highest cumulative grant received was 13 million dollars (AUD). Respondents identified grant funding including the Australian Institute of Radiography

(AIR), now renamed the Australian Society of Medical Imaging and Radiation Therapy (ASMIRT), and larger awards from funding bodies such as the National Breast Cancer Foundation and National Health and Medical Research Council in Australia. In relation to supporting the development of further research capacity, 28 (70.0%) of those holding a doctorate are actively supervising doctoral students.

Overall, 92.1% of the respondents ($n = 58$) had published the results of their doctoral studies in peer-reviewed journals, with the remaining 7.9% disseminating their research solely through national and international conferences. A total of 49 (77.7%) have undertaken research and 44 (69.8%) have published at least one paper in a peer-reviewed journal within the last 2 years.

Discussion

The findings of this study confirm that only a small number of individuals hold, or are studying for, a doctoral qualification in Australia and NZ. Interestingly, the overall proportion (0.3%) is almost identical to the UK level.¹⁹ These small numbers emphasise the need for professional bodies, supported by research leaders, to encourage research engagement up to and including higher degrees. Possible strategies may include more attractive stipends and support for doctorally qualified professionals by employers through part-time research positions. In 2010, the Australian professional body, ASMIRT, established a scholarship for postgraduate studies for research masters or PhD students.²⁵ This opportunity appears to have been utilised with two of those surveyed receiving such a grant during their studies.

Although numerically, more women are undertaking doctoral studies, proportionately there are more male doctoral MRS professionals. It is well known that fewer women pursue doctoral studies in Science, Technology, Engineering and Mathematics (STEM),^{26,27} although the gender gap has been narrowing.²⁸ Its persistence has been attributed to pressures of family life among other factors.^{29,30} Perhaps it is unsurprising to see a lower proportion of female doctoral candidates in the current study, but it does point to a potential equity issue. However, further research would be required to confirm

Table 3. Research approach taken by doctoral MRS professionals.

Research method	Diagnostic radiography	Nuclear medicine technology	Radiation therapy	Sonography	Total
Mixed methods	15 (51.7)	3 (10.3)	7 (24.1)	4 (13.7)	29
Qualitative	7 (58.3)	–	4 (33.3)	1 (8.3)	12
Quantitative	10 (45.5)	5 (22.7)	4 (18.2)	3 (13.6)	22
Total	32	8	15	8	63

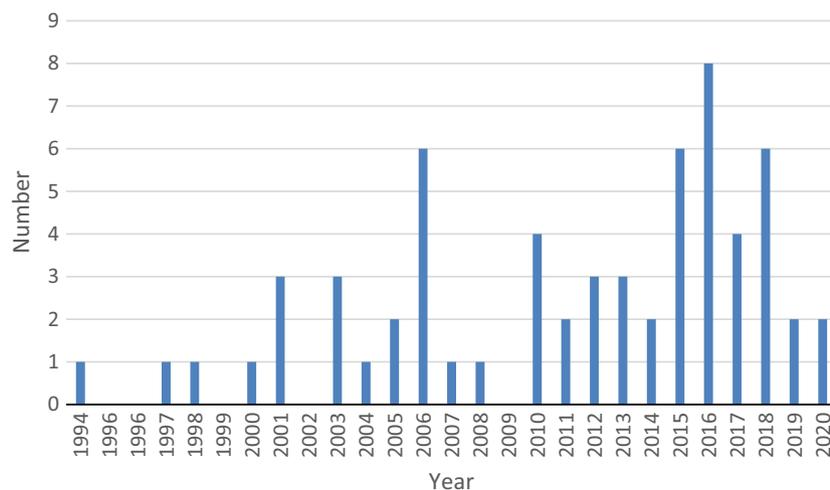


Figure 2. Year of doctoral award (or expected).

Table 4. Funding for doctoral studies.

Funding	Number
Employer funded	7
Fee waiver with time release by employer	5
Funded award	7
Funded fellowship/studentship	8
Government subsidised	18
Other	1
Self-funded	17
Total	63

this and to identify the reasons within the MRS professions.

The majority of MRS doctoral candidates are over the age of 40, reflecting the results of similar surveys in the US¹⁸ and UK.¹⁹ Interestingly, across all academic subjects in Australia the average age of a PhD student is 37.³¹ The low proportion of younger MRS candidates may be due to the ready availability of work after undergraduate training and the relatively high starting wages, estimated to be \$52,000 per annum in Australia. These factors together with the perceived low clinical relevance of a doctorate may undermine interest in further academic development through research. This issue may be challenged in the future with the expectation of research as a core skill in the advanced practice framework for DR and RT.³²

Most doctoral degree holders in the current study are academics, with a few in purely clinical roles. Clinical academic positions and the creation of hospital-based MRS research roles may encourage clinicians to undertake doctoral studies and provide a crucial link for the clinical translation of evidence. The low number of

PhD graduates is not unique to the MRS professions.³³ A recent report shows that only 0.3% of nurses in the United States held a doctoral degree.³⁴ It is also relevant to note that in the United States, radiology administrators (managers) were more likely to be undertaking doctoral study than practising clinical staff.¹⁸

Differences in engagement with higher degrees were noted across the MRS disciplines, with the highest proportionate involvement from NMT and RT. The existence of RT clinical research roles may have assisted this,¹⁵ however, the reason for limited development in DR and sonography is unclear and warrants further investigation. Although previous studies have demonstrated that publication productivity is greatest among DR,^{1,4,5} they comprise the largest number internationally, with NMT and RT disproportionately represented.^{1,5} The proportion of NMTs and RTs who chose quantitative research is perhaps unsurprising, given their closer working engagement with physics, where research pathways are more mature. The number of RTs adopting a purely qualitative approach is lower than in the UK,¹⁹ with the majority utilising mixed methods. A small number of respondents had chosen to pursue action research; this appears not to have been widely employed in MRS,³⁵ despite the opportunities afforded by rapid changes in practice and technological advancement.

Most Australian universities now support the PhD by publication,³⁶ where candidates include published research papers in their thesis. Interestingly, the number of MRS professionals in Australia and NZ choosing this route is higher than those in the UK,¹⁹ and likely represents a general Australian trend towards this style of doctorate.^{36,37} The reasons for this are unclear, but may be due to the greater acceptance of this award by

institutions and related to the higher number of publications encouraged and expected with this route. One key difference with the recent UK survey¹⁹ is that only one person holds a DProf and no one an EdD compared to 22% and 16%, respectively, in the UK.

Factors influencing the decision to pursue doctoral studies can include those related to educational systems, such as a candidate's previous qualifications, the supervision and doctoral positions available and those related to the individual, for example, funding and personal interest or drive.^{29,30} The current research shows that a significant number of respondents were either funded or had their fees waived or subsidised by the government. Higher degrees are subsidised for Australian citizens. Therefore, such support should encourage students.

Mentorship, training and education have been identified as factors that may improve MRS research productivity,¹ and ongoing research training is crucial. Globally, many of the most prolific MRS authors, and therefore active researchers, and institutions are based in Australia,^{1,4,5} which should support the development of greater research capacity. The number of grants held by respondents and their stated role in doctoral supervision confirms their ongoing research engagement, an important factor in maintaining and developing post-doctoral skills and research leadership.

The current work, as well as the UK¹⁹ and US¹⁸ surveys, underscore the need for coordinated interventions to increase the number of doctoral degree holders and research activities overall. Australia has a general strategy to increase the number of PhD students, and particularly encourages international applications.³⁸ However, to increase the number of doctoral MRS candidates greater investment in academic staff is required. Investment may have been a driver for the recruitment of the eight doctoral MRS professionals who studied overseas. The positive effect of migration on MRS research productivity in Australia has also been acknowledged previously.⁵

A limitation of the study is the lack of data regarding the actual response rate and therefore the potential for non-response bias. An alternative approach to establishing a more accurate profile would have been to contact institutions directly for graduate numbers and to ascertain from professional bodies the number of doctoral registrants. However, only the NZ Medical Radiation Training Board (NZMRTB) collects data on professional qualifications. Perhaps, the Medical Radiation Practice Board of Australia (MRBPA) could also collect and report higher qualifications at the point of initial registration and annual renewal of registration. The study employed a chain-referral sampling strategy and recruited

many participants through social media. Given that some potential respondents may not have been engaged with Facebook and Twitter at the time of the survey, some individuals may have been missed. Data presented in this paper have certainly not captured the complete doctoral profile, but it does provide an initial baseline on which to build. As the data on respondents were collected anonymously, unfortunately, no comparison with research outputs by individuals can be made. Further research is required to understand the barriers and enablers to research engagement up to and including doctoral level. Such information may be critical to training and establishing research active MRS professionals globally.

Conclusion

The study demonstrates a low percentage (0.3%) of doctoral MRS professionals in Australia and NZ, similar to other countries and professions. Strategies aimed at enabling motivated individuals to undertake doctoral studies are needed. Beyond this, mentorship of MRS early and mid-career researchers is necessary to support the ongoing development of the MRS evidence base.

Conflict of Interest

The authors declare no conflict of interest.

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