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International perspectives on radiography practice education

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ABSTRACT

Introduction: The radiography profession is built upon strong educational foundations which help ensure graduate radiographers have the required knowledge, skills, and competence to practise safely and effectively. Changing clinical practices, service needs, technological developments, regulatory changes, together with our growing professional evidence-base, all contribute to the need for our curricula to responsive and continually reviewed and enhanced. This study aims to explore similarities and differences in training curricula and follows a 2012 global survey on radiography education and more recent surveys undertaken by the European Federation of Radiographer Societies (EFRS).
Methods: An online questionnaire, based on previous EFRS education and clinical education surveys, which comprised of open and closed questions and consisted of sections designed to ascertain data on: type, level and duration of education programmes leading to an initial or pre-registration qualification in radiography/medical radiation practice, pre-clinical skill development and clinical placement within programmes. The survey was distributed via social media channels and through an international network of professional societies. Descriptive statistics are reported for most analyses while open questions were analysed thematically.
Results: Responses were received from 79 individuals from 28 identified countries across four continents. This represented a total of 121 different pre-registration/entry level programmes offered across these institutions. While dedicated diagnostic radiography programmes were most common (42/121), almost one-third of programmes (40/121) offered two or more areas of specialisation within the curriculum. The average of total hours for clinical placement were 1397 h for diagnostic radiography programmes; 1300 h for radiation therapy programmes; 1025 h for nuclear medicine programmes; and 1134 h for combined specialisation programmes, respectively. Institutions provided a range of physical and virtual systems to support pre-clinical skills development.
Conclusion: Around the world, radiography programmes vary considerably in terms of their level, duration, programme type, pre-clinical and clinical training, use of simulation, and also in terms of class sizes, student/staff ratios, and graduate employment prospects. The ability of graduates to work independently in areas covered within their programmes varied considerably. While some changes around simulation use were evident, given the impact of COVID-19 it would be beneficial for future research to investigate if pre-clinical and clinical education hours or use of simulation resources has changed due to the pandemic.
Implications for practice: The heterogeneity that exists between radiography programmes presents a significant challenge in terms of the mutual recognition of qualifications and the international movement of the radiographer workforce.
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Introduction

Radiography education is the cornerstone to the profession and an essential element in helping generate competent radiographers who can practise safely and effectively. Training curricula are generally guided by national regulatory requirements and service

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needs. These dynamic drivers are ever changing, because of developments in healthcare and imaging equipment. Radiography educators, typically universities, technical institutes and vocational colleges, are responsible for providing training.[1]

In their 2015 surveys, the European Federation of Radiographer Societies (EFRS) reported that 90% of European programmes at are Bachelor's level.[2] Despite this, the EFRS reported significant variations in the duration, format and curricula. Similar differences have also been highlighted outside of Europe. Cowling in 2012,[3] on behalf of the International Society of Radiographers and Radiologic Technologists (ISRRT), indicated that radiographers in 94% of responding institutions (Europe, Africa, Americas and Asia/Oceania) were also educated at Bachelor's level. Cowling further confirmed that programme duration varied significantly (1.5–5 years) as did scope of practice.

Clinical placements remain a core component of radiography education.[1,4] However, again significant variations have been reported in clinical placement time, inclusion of skills labs and simulators, clinical supervision and methods of quality assurance.[1] With greater emphasis on digital technologies and virtual environments within education, there are reports of the use of digital teaching libraries,[5] and a range of computer-based and virtual reality simulations embedded within curriculum.[6–11] Such pedagogical practises are likely to be based on a multitude of factors. In addition to publications from the EFRS,[1,2,12] several institutions have documented their own practices around radiography education.[13–19]

With radiographic practice changes, when combined with technological developments and education, it is important to understand the key components of radiography training programmes worldwide. The last global survey was undertaken in 2012[3] and the radiographic profession has changed significantly during this time. Demand for imaging and radiation therapy are higher, recruitment and retention of radiographers is variable, and the scope of practise is continuing to broaden. Improved understanding on radiography curricula and pedagogical techniques would be highly advantageous for the profession. The aim of this study was to undertake a global survey of radiography educators to look for similarities and differences in training curricula.

Methods

Prior to the start of the study ethics approval was attained from Human Research Ethics Committee of the University of Canberra (Reference: 2019/1924).

Design

The research design was an online survey using Qualtrics™ platform (Qualtrics, Drive Provo, UT). Participants were provided an information statement that outlined the aims, requirements, and confidentiality of the study. The initial question to the survey was an informed consent agreement that required the participant to complete before access to the questionnaire was granted. The questionnaire was based on two previous questionnaires developed by the EFRS Educational Wing focussing on key issues relating to radiography education.[1,2] The survey was presented to participants in English language only as this was the approach previously adopted. The questionnaire comprised of open and closed questions and consisted of sections designed to ascertain data on: type, level and duration of education programmes leading to an initial or pre-registration qualification in radiography practice; pre-clinical skill development and clinical placement within programmes. The survey was open to participants between May and October 2019.

Participants

To obtain an international perspective a link to the survey with the participant information form was distributed via social media channels and the network of professional societies, including the EFRS. Direct email contact with programme leaders, known to the authors or via names on university web sites, was also made.

Data analysis

Data were uploaded to IBM SPSS Version 23 (IBM, Armonk, NY). Descriptive statistics are reported for most analyses while open questions were analysed thematically against the quantitative question themes, to provide further context and a more nuanced understanding of education programmes.

Results

Responses were received from 79 individuals. Of the 75 (95%) respondents who chose to identify the country in which initial or pre-registration programme(s) were offered, 28 different countries were represented (Fig. 1).

Types of programme

Respondents were asked to identify the type of programmes offered (Fig. 2). As educational institutions could offer one or more programmes of study leading to an initial or pre-registration qualification in an area of radiography practice, the number of educational programmes (n = 121) exceeds the number of respondents (n = 79). The majority of programmes for initial or pre-registration qualification in radiography are for a single area of specialisation (79 out of 121 programmes). Almost one-third of programmes (40/121) offered two or more areas of specialisation within the curriculum. Diagnostic radiography is present in the majority of individual (42/121) and combined (40/121) areas of specialisation within programmes. Not all combined programmes of study afford the graduate the ability to immediately undertake independent practice in their area or areas of specialisation. Graduates from combined programmes require additional compulsory clinical placement (16/40), satisfactorily complete an external examination (7/40), and/or undertake compulsory additional formal education (11/40). Of the 121 educational programmes, the primary professional areas that graduates from the programme are reported to be fully qualified to safely perform were provided for 102 programmes (Table 1).

Level of qualification

A broad range of level of qualifications are currently utilised internationally for entry into the radiography profession (Fig. 3). The majority of programmes are offered at the undergraduate level, with Bachelor's degrees accounting for 84% (73/87) of undergraduate entry qualifications. Entry into the profession by postgraduate qualification (graduate entry initial or preregistration qualification) varied from postgraduate certificate to doctoral level. Postgraduate certificate and Master's were the most frequently reported graduate entry level qualifications for initial entry into the radiography professions.

Duration of initial qualification

The total duration of the undergraduate and graduate entry programmes providing an initial or preregistration qualification in radiography practice is shown in Fig. 4. For undergraduate entry

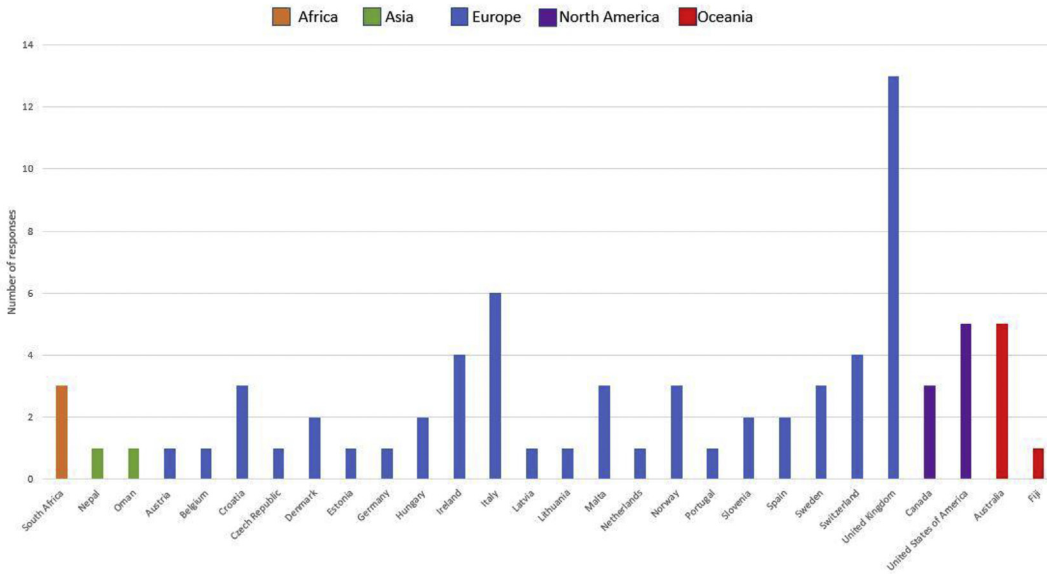

Figure 1. Programme information illustrating the breakdown of respondents by country/continent.

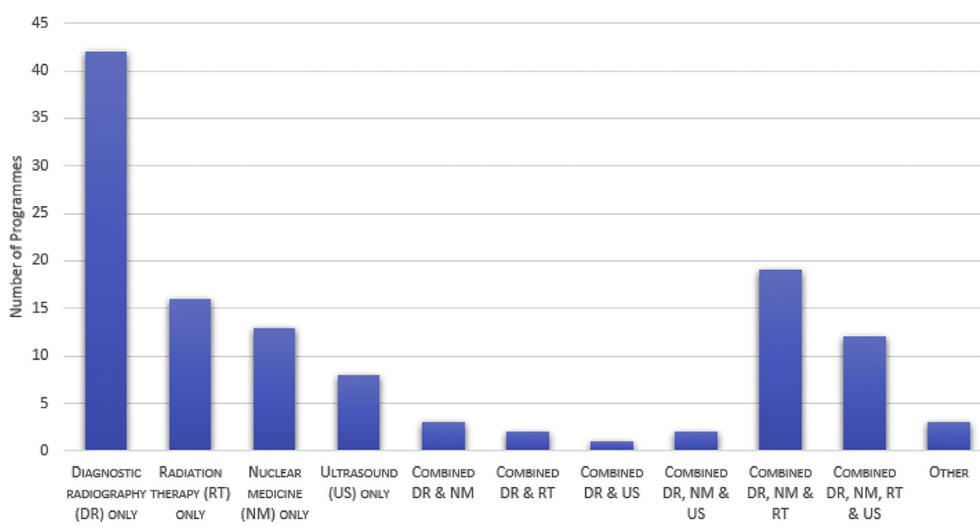

Figure 2. Programme types and areas of specialisation of new graduates.

Table 1
Primary area of professional practice that graduates from programmes are fully qualified to safely perform.

	Graduates are fully qualified to safely perform							
Type of Programme	General radiography	Fluoroscopy	Computed Tomography	Sonography	MRI	Radiation Therapy Planning	Radiation therapy treatment	Nuclear Medicine
Diagnostic radiography (DR) only (n = 42)	42	40	32	3	17	5	5	7
Radiation Therapy (RT) only (n = 14)	2		4			12	14	
Nuclear Medicine (NM) (n = 8)	2	1	5			2	2	8
Combined DR and NM (n = 3)	3	3	3	1	2	1	1	2
Combined DR and RT (n = 3)	3	2	3		3	2	3	1
Combined DR and Sonography (S) (n = 2)	2	2	1		1			1
Combined DR, NM and S (n = 4)	4	2	3	1	3		1	3
Combined DR, NM and RT (n = 15)	15	13	15		14	11	15	15
Combined DR, NM, RT and S (n = 11)	11	9	10	4	10	7	8	8

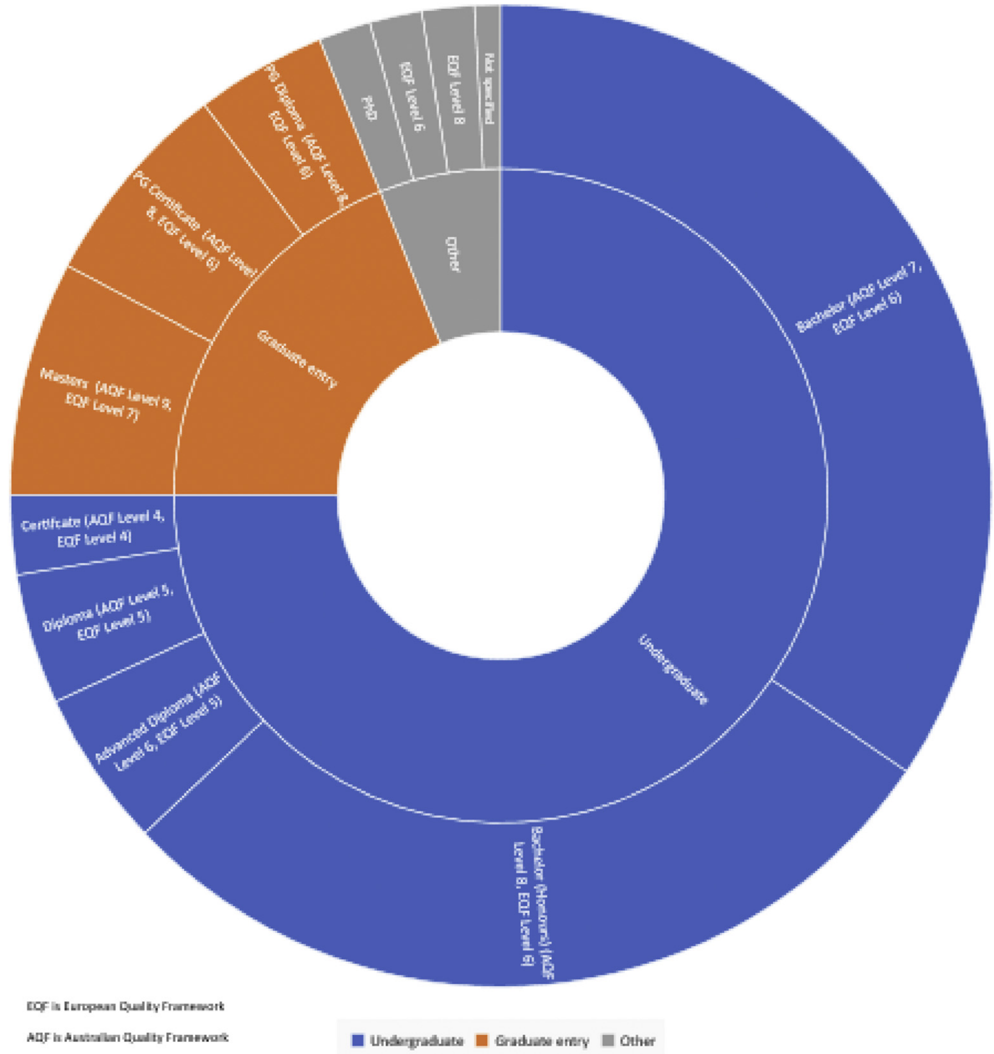

Figure 3. Type (Undergraduate or Postgraduate (Graduate Entry), name, and level (EQF and AQF) of qualification for entry into profession.

programmes total duration varied between 1.5 and 4 years, with most programmes (67/75) at least 3 years in total duration. Total duration of postgraduate entry initial or preregistration programmes varied between 1 and 4 years with most programmes (31/35) at least 2 years in total duration.

Pre-clinical and clinical skills development

The number of hours per year students undertake pre-clinical skills development and clinical placement as part of their programme of study for six different programme types is presented in Fig. 5. Across the different types of undergraduate programmes of study, the average of total hours for clinical placement and pre-clinical skill development were: *diagnostic radiography only* 1397, 262 h; *radiation therapy only* 1300, 250 h; *nuclear medicine only* 1025, 224 h; and *combined specialisation programmes* 1134, 497 h, respectively. For postgraduate (graduate entry) qualifications (Fig. 5) clinical placement and pre-clinical skill development were: *diagnostic radiography only* 886, 120 h and *sonography only* 334, 28 h, respectively.

Institutions provide a range of functioning physical and virtual systems to support pre-clinical skills development (Fig. 6). The most commonly provided physical systems were digital radiography and ultrasound. Virtual simulation was adopted, but less frequently than physical systems by programmes to support pre-clinical skill development, with radiography and Virtual Environments for Radiotherapy (VERT) most common.

Pre-clinical skill development included use of clinical systems in a university laboratory, computer simulation and a range of other learning opportunities (Fig. 7). Other learning opportunities as stated by participants in open text responses included, imaging of anthropomorphic phantoms and cadavers, image evaluation and image interpretation, role plays with students, use of actors for communication training and patient care workshops, practicals in the mould room, access to datasets and imaging processing, dosimetry and dose management, venepuncture, radio-pharmacy, pathology case studies and interprofessional learning workshops.

Sixty percent (36/60) institutions using simulation reported that they did not intend to change the current amount of simulation time within their programme of study. Only one institution reported that they intended to decrease the amount of simulation time, whereas 38% (23/60) intended to increase the amount to time used in simulation. The focus for increasing the time for simulation, as stated by participants in open text responses, included the increased availability of a range of simulation systems, increasing communication and interprofessional activities, increasing radiation therapy

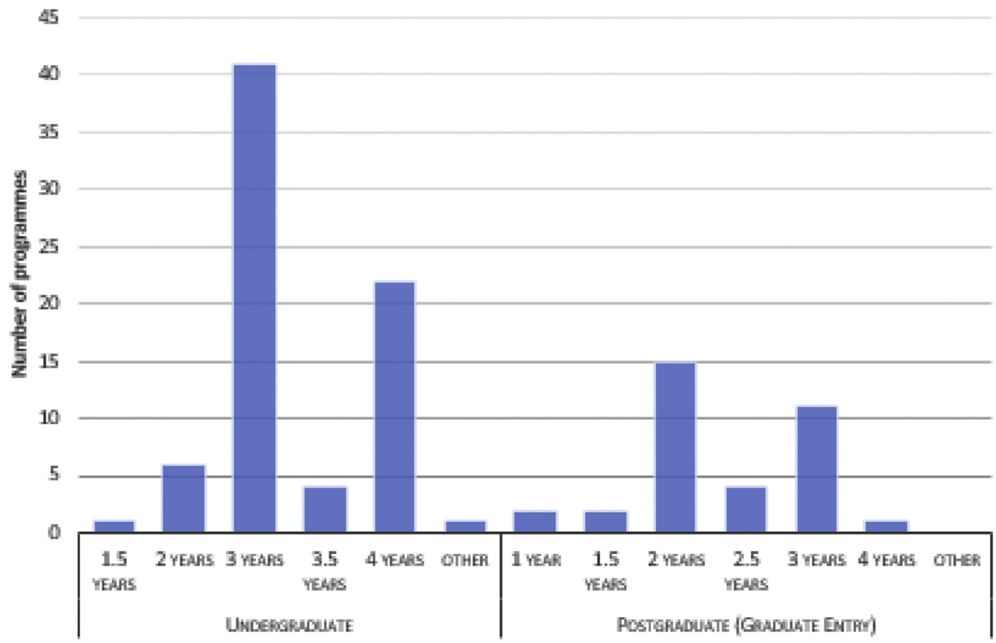

Figure 4. Type and duration of programme leading to an initial qualification for entry into the profession.

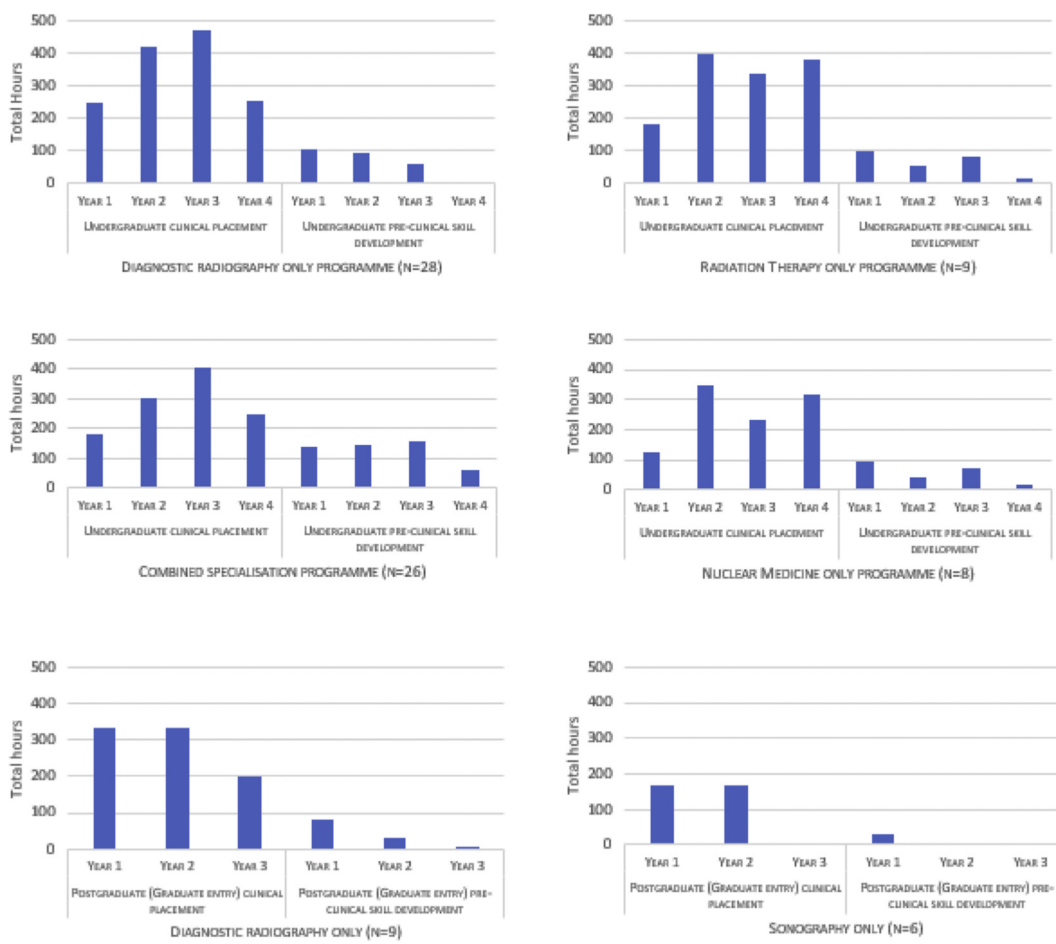

Figure 5. Reported average number of clinical and pre-clinical placement hours each year for six programme types leading to entry/initial qualification into the radiography profession *(programme types with less than five responses were not reported for total hours for clinical placement and pre-clinical skill development).*

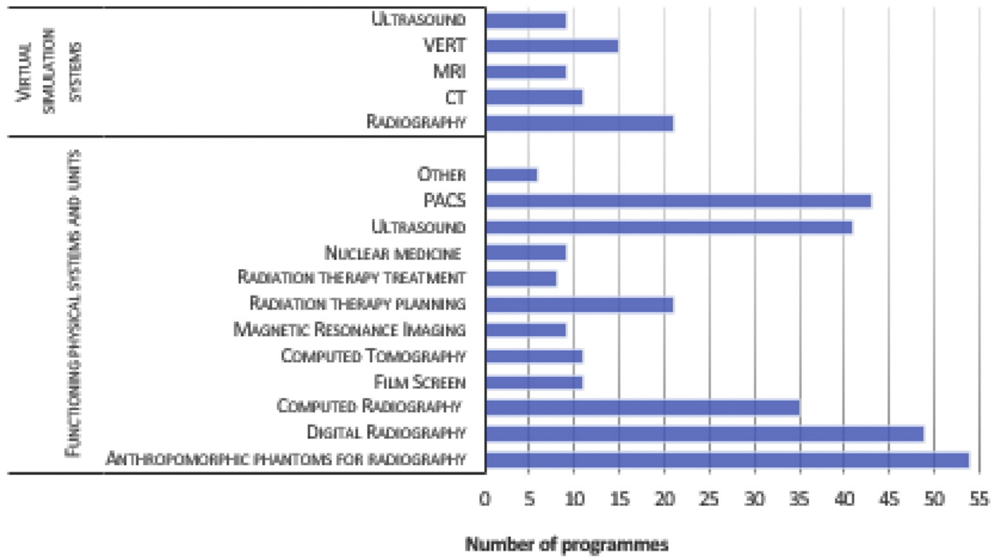

Figure 6. On-campus (university) physical and simulation systems for pre-clinical learning.

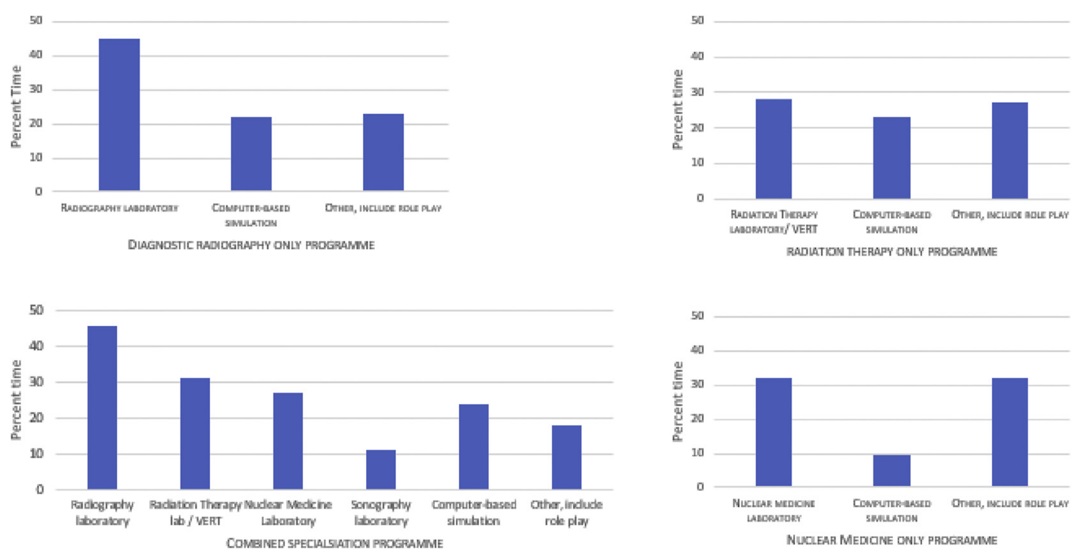

Figure 7. Components of pre-clinical skill development as percent of total time for four programme types.

planning, increased student numbers with limitation on clinical placements. Seventy percent (42/60) of participants reported that they did not intend changing the total number of clinical hours in their programme. Twenty percent (12/60) reported that they intended to increase the number of clinical hours in their programme. The reasons provided included to increase the nuclear medicine component, to get hours closer to the European average for clinical hours, and to improve student and programme quality. Ten percent (10/60) reported that they intended to decrease the number of clinical hours in their programme; no reason was provided.

Student numbers

Fifty-four respondents reported both first-year intake and graduating number of students for their initial or pre-registration radiography practice programmes. Half of the programmes, 27 (50%) had less than 50 students in the first year, 18 (33.3%) had between 50 and 100 students, six (11.1%) had between 100 and 150 students, and three (5.6%) had more than 150 students. The number of students (mean ± SD) in the first year of study was 60.1 ± 44.2, with a reported graduating number of 44.6 ± 32.9. For this set of paired data, the percent difference between first year student intake and graduating number of students was −21.4 ± 19.2. The majority of programmes, 32 (59.3%) had 20% or lower reported graduating number of student than first year intake, and of these programmes 20 (37.0%) had less than a 10% lower graduating number than first year intake. Seven (13.0%) programmes reported higher than 40% difference between first year intake and graduating student number. These programmes included both relatively small first year intakes (n = 35, 40, 45) as well as larger intakes (n = 80, 115, 120, 125). The two programmes with the highest percent difference (−78.2% and −84.1%) both reported that their students included full-time and distance learning students.

Job vacancies for recent graduates

The job vacancy situation for recent graduates of initial or preregistration radiography practice programmes, as reported by survey respondents, is presented in Table 2. Job vacancies on graduation vary across areas of specialisation. 53 (86.9%) programmes offering diagnostic radiography initial or preregistration qualification reporting jobs for most or all their graduates. Uncertainty regarding job vacancies for recent graduates was more common from respondents offering programmes specialising in nuclear medicine (n = 6, 21%) and sonography (n = 3, 27%).

Programme staff

Survey respondents were asked to report the student/staff (per full-time equivalent (FTE)) ratio of their programme(s). The calculated student/staff ratio (mean ± SD) was 16.6 ± 9.8. As demonstrated in Fig. 8. Where respondents reported multiple radiography practice programmes at their institution, the student/staff ratio was higher for diagnostic radiography than was reported for radiation therapy, sonography, or nuclear medicine.

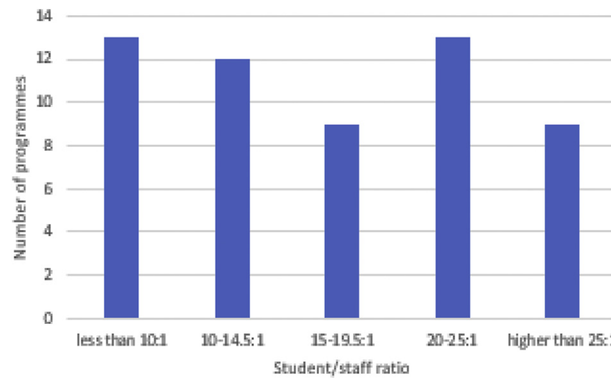

Figure 8. Reported staff/student ratios for entry level radiation practice programmes.

Discussion

Research exploring radiography education, has in the past, primarily focussed on Europe.[2,18,20,21] This study sought to provide a more global perspective on trends in radiography education. The European model of radiography education typically offers a qualification with multiple areas of specialisation[2,20] including two or more of the following specialisms, namely diagnostic radiography, radiation therapy and/or nuclear medicine. This current study demonstrates that from an international perspective, the most common model of radiography education, with approximately two-thirds of programmes (79/121) is to provide a qualification with a single area of specialisation (Fig. 1). Diagnostic radiography was the most common single area of study for specialisation (42/79). Of these 42 programmes that provide a qualification in diagnostic radiography, graduates from the majority of programmes (Table 2) are fully qualified to safely perform generally radiography (42/42), fluoroscopy (40/42) and computed tomography (32/42) examinations. Overall, a wide variation in professional practice areas that graduates from single and combined programmes of study are reported to be fully qualified to safely perform on graduation, was apparent. Identification of key professional areas of practice that graduates are qualified to safely perform from single and combined area of specialisation degrees has, to the authors' knowledge, not been previously reported. The inclusion of practice areas in radiography education research is an important addition to the knowledge base of the profession as it is these area of professional practice that form professional competencies that regulate professions[22]

The European qualification in radiography is typically three years in duration[2,18,20] and results in a Bachelor degree.[20,21] This current study similarly reports that a three year Bachelor (40/87) degree is the most common undergraduate qualification for entry into the radiography profession. As previously reported[20] there continues to exist a broad range in undergraduate qualifications currently adopted for entry into radiography profession from certificate (3/87) to Bachelor with honours (33/87). In addition, this study identifies entry into the profession now also occurs at a postgraduate level, varying from postgraduate certificate (8/22) to Master's (9/22) level qualifications. The offering of post-graduate entry qualification for students who already hold a Bachelor's degree, typically shortens the duration of the entry qualification to the profession to two (15/35) or three years (11/35) duration. With such diversity in training duration, academic level and professional practice capabilities upon graduation remains across radiography education global transportability of radiography qualification will not be realised.

Clinical education is a core component of European radiography education programmes.[1,18] This current study identifies that clinical placement occurs across all years of study, with average total hours of clinical placement typically higher for single specialisation than combined degrees. In contrast pre-clinical skill development hours is higher in combined programmes of study than for those with a single area of specialisation. For single area of specialisation qualifications, the ratio of pre-clinical to clinical placement hours approximates 1:5, whilst combined programmes of study approximates 2:5. In a study examining clinical education in Europe programmes, England et al.,[1] reported average pre-clinical to clinical placement ratio of 1:4. The findings of this current study, suggests that there has been little change in ratio since that reported by England et al.,[1] As the global pandemic has impacted clinical practice of radiography,[23–27] it would be beneficial to investigate if pre-clinical and clinical education hours or use of simulation resources changed during and/or after the COVID-19 pandemic.

Limitations

Gaining a snapshot of global radiography education is a challenge and it is possible that a greater number of respondents could have been recruited if the survey was deployed in languages in addition to English. It should be noted that no responses were

Table 2
Reported job vacancies for most recent graduates for four programme types.

	Enough	Most *(75–95%)*	A lot *(50–75%)*	Not Enough *(< 50%)*	Not Sure
Diagnostic Radiography	40 (65.6%)	13 (21.3%)	3 (4.9%)	4 (6.6%)	1 (1.6%)
Radiation Therapy	22 (62.9%)	3 (8.6%)	3 (8.6%)	2 (5.7%)	5 (14.3%)
Nuclear Medicine	16 (55.2%)	1 (3.5%)	3 (10.3%)	3 (10.3%)	6 (20.7%)
Sonography	8 (72.7%)				3 (27.3%)

received from South American radiography training institutions and responses from Asia were also low. Two or more people from the same educational institution may have responded independently to the survey. While no set of responses from the same country were identical, we cannot exclude this occurring. Study findings and conclusions must, therefore, be interpreted with these points in mind. There are potentially improvements that could have been made to the questionnaire, more extensive piloting and validation could have assisted. The deployed survey was, however, adapted from a previously successful international survey.

Conclusion

Results presented in this publication represent the most recent evaluation of global radiography education with data obtained from 28 countries (four continents). Globally, most education institutions support the delivery of a single programme. Such programmes can contain multiple areas of specialisation (medical imaging/nuclear medicine/radiotherapy), but diagnostic radiography dominates. Skill development included the split of time between clinical and academic practice, and the inclusion of different learning opportunities varied between providers. While some changes around the utilisation of simulation are evident, given the impact of COVID-19 it would be beneficial for future research to investigate if pre-clinical and clinical education hours or use of simulation resources has changed due to the pandemic.

Conflict of interest statement

None.

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