Blind title page: Original Paper.

Access to statistical support for medical imaging research: Questionnaire survey of United Kingdom radiology trainees.

Introduction:

Research is essential to progress any medical discipline in order to optimise patient care. For this reason, research experience during training is often stipulated so that trainees understand both the process and objectives. For example, the Royal College of Radiologists (RCR) training curriculum requires trainees to demonstrate engagement and understanding of the research process.[1] Previous authors have questioned the methodological rigour of radiology research and the RCR is concerned that radiology research output falls behind other specialties.[2,3] While a recent survey concluded that many radiology trainees wish to engage with research, it identified multiple barriers to participation, of which limited experience with medical statistics was reported within the top three.[4] There is also evidence of UK regional inequality regarding indexed radiology research publications that may, in part, be attributable to differential access to statistical support.[5]

Medical statisticians ensure that research studies are designed to answer a clearly stated hypothesis and to do so with adequate power, and as little bias as possible given available resources. It has been suggested that attempting research without adequate statistical support is scandalous, not least because clinicians may harm patients inadvertently if treatment is based on flawed research findings.[6]

Accordingly, we aimed to investigate the level of statistical support available to UK radiology trainees, and to gather opinions regarding how support may impact on their current and future research aspirations.

Materials and methods:

The concept for this survey arose from discussions within the UK Radiology Academic Network for Trainees (RADIANT), who then engaged with senior radiology academics and a medical statistician in order to design the survey. Junior members of the research team identified relevant questions regarding access to statistical support, which were then refined by senior members of the team during face-to-face discussion. During the design phase it was deemed useful to extend the survey to consultant radiologists, since it would be beneficial to identify any discrepancy in access between trainees and research-interested consultants.

The following domains were assessed: Current role, location, and research experience within the radiological field; experience and nature of statistical support to date (including self-help); future research aspirations within radiology and the nature of statistical support for this, where available. Respondents were also asked whether they desired statistical support and, if so, where they believed this was most needed, and to gauge impact on their current and future research aspirations.

Text preceding the questionnaire stated that “research” applied to any activity that might potentially benefit from statistical advice (including local hospital audit, for example). A “statistician” was defined as either a qualified medical statistician or an individual possessing significant methodological expertise, for example a qualified research methodologist or epidemiologist. We also stipulated that respondents only consider their personal experience within the radiological domain, and to discount any experience of statistical support obtained in other disciplines prior to their radiology training.

The questionnaire consisted predominantly of multiple choice and Likert scale questions with some open format responses possible in order to gain more granular and potentially valuable insights unanticipated by the research team. The questionnaire was piloted amongst the research team and local trainees, and refined subsequently, with the aim to improve comprehension and facilitate straightforward completion.

Ethics statement: Ethical permission was not sought formally. Respondents completed the survey in response to a newsletter emailed to all RADIANT members that described our aims, and which contained a voluntary link to the questionnaire. There was no direct intervention, and no identifiable data were collected. The questionnaire was administered online via Google Forms (Google, Mountain View, CA, USA). The questionnaire administered is available at online Appendix 1. The invitation was also emailed to all RCR UK training programme directors (TPD's) so that it could be accessed by radiology trainees who were not RADIANT members. Recipients were also asked to pass details onto research-interested consultant colleagues; consultants were not approached directly by us.

Responses were collated over 5 months from October 2021 to February 2022 inclusive. During this period, three reminders were sent on a two weekly basis following the initial distribution of the questionnaire. Responses were interpreted and presented as descriptive summary statistics.

Results:

Responses were received from all 19 UK Local Education Training Boards (LETBs)/Deaneries. 79 responses were received in total, all from trainees; no consultant responded. Respondents comprised similar numbers of first to fifth year trainees (12, 13, 18 ,18 and 15 respectively), with fewer sixth year trainees and fellows (2 and 1 respectively); “fellows” were defined as trainees in positions outside the formal RCR training programme. The very large majority of respondents (77, 97%) were in posts without allocated research time; just 2 (3%) respondents had allocated research time.

Only 3 (4%) respondents were content with the statistical support currently available to them, two of whom were actively undertaking a research-related higher degree at the time of their response (DPhil and MRes respectively). 25 (32%) reported insufficient statistical support, 13 (52%) of whom indicated that they believed this impacted “considerably” on their future research aspirations; the remainder felt it was a “moderate” issue. The remaining 51 (65%) of respondents were unaware if any statistical support was available to them or not.

Most respondents, 72 (91%), had various levels of research aspirations in the near to medium term with only a small minority declaring none (7, 9%) (Fig. 1). Projects that were of most interest included being first or last author on a paper published in an indexed journal (43, 54%) and local departmental audit and quality improvement presentations (44, 56%) (Fig. 1).

66 (84%) of respondents expressed a desire for provision of dedicated statistical support, 40 (61%) of whom indicated they would likely require a “moderate” amount of support and 26 (39%) a “significant” amount. The remaining 13 (16%) felt they would need “minimal” statistical support in the future.

Areas in which respondents felt statistical support would help most was, “performing analysis after data collection” (41, 54%), followed by “research planning” (i.e. study design and analysis planning); 25, 33%. Areas rated less useful by respondents included helping interpret the results and helping draft the final report (Table 1).

The majority of respondents (60, 76%) reported accessing self-help methods in an attempt to learn research statistics, with 40 (67%) using YouTube and 29 (48%) using books. However only 21 (35%) stated that self-help methods were useful. 57 (72%) declared an interest in being directed to high quality, concise YouTube tutorials on research statistics, if available.

Discussion:

A recent UK survey found that while a large proportion of radiology trainees wanted to participate in research, around half cited, “limited experience in research statistics”, as a deterrent.[4] Indeed, a survey conducted at the 2022 RADIANT annual meeting found that attendees deemed "statistical analysis" as their most pressing educational need (cited by 60% of respondents). The present study focussed specifically on the extent to which statistical support is available to radiology trainees. Like Kamaladeen and co-workers, we found that the large majority of

120 respondents expressed a desire to engage in research projects, ranging from poster
121 presentations through to first authorship on a paper published in an indexed journal.[4]
122 However, only 4% stated they were content with the statistical support available to
123 them. Many described this lack of support as a considerable hindrance to their
124 research aspirations, a finding directly at odds with the RCR stipulation that trainees
125 engage with research and record this in their portfolios.[1] Free text responses
126 indicated that trainees found medical statistics “overwhelming” and described their
127 lack of statistical understanding as, “stats fear”, citing unfamiliarity as a direct barrier
128 to conducting research. One of the very few respondents working currently within a
129 research-dedicated post admitted to previously restricting themselves to simpler
130 projects, so that they could manage statistical issues themselves because support
131 was unavailable.

132 To our mind, trainees (and indeed medical researchers in general) should not be
133 expected to tackle any but the simplest of statistical tasks themselves; that is the job
134 of a qualified medical statistician. It is illogical to expect trainees to somehow acquire
135 skills that are both outside their immediate training domain and which take
136 statisticians many years of dedicated study to acquire. Rather, it is understanding
137 when to seek advice, and access to that advice, that is the pivotal issue. At this
138 stage we should consider whether trainees should be seeking statistical advice at
139 all? It is unrealistic to expect trainees to generate research hypotheses, design and
140 execute a study to test these, analyse the data, and then interpret and publish the
141 results. These duties are clearly the responsibility of an experienced research
142 supervisor yet the senior authors of this paper have all witnessed trainees given
143 these tasks by “supervisors” barely more able than the trainee. Free text responses
144 cited lack of opportunity and/or lack of experienced supervision because **there were**

no competent researchers within the training scheme. Some stated they were afraid to ask for help for, “fear of looking stupid”.

Perhaps because of deficient research supervision, a large majority of respondents expressed a desire for statistical support, with 61% stating they expected to require “moderate” amounts of provision. Our survey provided useful insight into trainees’ general understanding of a statistician’s role, and unearthed some misunderstanding around this. Notably, more respondents indicated a desire to seek statistical help for analysis of data already collected, rather than to seek help with study design and analysis planning in advance of data collection. However, it is well-established that statistical input is most valuable at the design stage when advice regarding outcomes, endpoints, and their powering is needed.[8,9] We are continually surprised by how often even experienced researchers fail to define their study outcomes and endpoints precisely. It is also well-known that underpowered studies overwhelm the medical literature.[6,10] Poor methodology generates poor data that is frequently unsalvageable. Consulting a statistician upfront helps avoid these issues. Furthermore, statisticians also play an important role after analysis, by helping clinicians interpret study findings, and to do so in an unbiased fashion thereby avoiding unjustified “spin”.[11,12] Statisticians will also direct researchers towards appropriate guidelines that ensure the research is reported properly.[13] Indeed, statisticians will point to such guidelines at the design stage, so that all aspects critical for good research are incorporated upfront. One respondent who was finally able to access a statistician during their higher degree described the experience as “transformative”, and something that “gave meaning” to their results.

The majority of respondents were also unsure what statistical support was available (if at all), or how to access it. While respondents currently undertaking higher degrees were able to access formal statistical support via their affiliated university, others admitted to simply asking the radiological colleague who appeared the most statistically literate. Inability to access a qualified statistician drove most respondents towards self-help methods, but a minority rated these as useful. While helpful to some extent, self-help leaves trainees vulnerable to error, **especially if they cannot differentiate good from bad advice. In an attempt to help, Appendix 2 lists online videos, divided into nine modules, that our statisticians consider particularly helpful for those seeking basic statistical education.** Most UK NHS hospitals will have a Research and Development (R&D) office, whose primary role will be to administer local research funding and approvals, and this should be the first port of call when searching for advice. Hospitals with University affiliations will often have joint R&D offices that oversee medical research. It may be beneficial for deaneries to describe local arrangements during trainee inductions and/or research education. Inequalities in statistical support access, both regional and between district general and tertiary centres, may be diminished by increasing hospital networks with shared services and consultant-supported trainee research collaborations such as RADIANT.[4]

We found that 97% of respondents declared they had no allocated research time. Clearly it is completely unrealistic to expect trainees to engage with research without allocated time. Surprisingly, research is neither required nor recognised by the Annual Review of Competence Progression (ARCP), something that will clearly diminish motivation and incentive. While research can be used to evidence one of the RCR radiology curriculum “capabilities in practice” (CiP- 4), it competes against

193 other markedly less time-consuming activities such as reflection pieces, attendance
194 or participation in journal clubs and courses, and is therefore less likely to be
195 prioritised.[1]

196 Ultimately, we would argue that it is far from essential for trainees to conduct
197 research; a very small minority will complete a postgraduate thesis and even fewer
198 will ultimately become productive independent researchers. Rather, the focus for
199 most trainees should be around acquiring skills that facilitate critical appraisal of new
200 data that may impact on patient management in day-to-day clinical practice. Here,
201 medical statistics is central to sensible interpretation and also extends to local audit
202 and quality improvement data; projects compulsory for annual ARCP. Statistical
203 knowledge is also crucial for evidence-based practice and life-long-learning required
204 by the RCR and General Medical Council (GMC).[1,14] Deficient research training
205 within the FRCR curriculum has previously been recognised as a major barrier to
206 trainees undertaking research.[3] Our findings highlight a desire for dedicated research
207 education, including medical statistics, within radiology training schemes that are
208 heavily clinically focussed currrently.[3]

209 Our study does have weaknesses. Most obviously, there will be a spectrum bias
210 towards research-interested trainees because questionnaire distribution was via the
211 RADIANT network. We attempted to mitigate against this by simultaneous
212 administration to all trainees via RCR TPDs. Ultimately, we are unable to identify the
213 proportion of respondents who were RADIANT members rather than non-member
214 trainees because we did not collect individually identifiable data. Also, while we
215 decided to extend the survey to consultant radiologists, none responded. Whether

this represents general disinterest in research or failure of trainee recipients to pass on questionnaire details to their consultant colleagues is unknown to us.

In summary, despite the fact that radiology trainees are expected to engage with research, we found that access to statistical support is extremely limited. If training guidelines continue to stipulate research experience, then training schemes must improve the provision, access to, and awareness of statistical support so that any research efforts are performed to a high standard. Ultimately, training schemes should not expect trainees to participate in research without providing sufficient time, mentorship, and statistical support.

References:

1. Royal College of Radiology. Clinical Radiology Specialty Training Curriculum. 2020. [accessed 2022 March 12]. Available from: https://www.rcr.ac.uk/sites/default/files/clinical_radiology_curriculum_2020.pdf

2. Cooper LS. The poor quality of early evaluations of Magnetic Resonance Imaging. JAMA: The Journal of the American Medical Association. 1988;259(22):3277.

3. Booth TC, Mehrzad H, Wardlaw JM, Jackson A, Gilbert FJ. Training the next generation of radiology researchers. Report on a joint meeting of the Royal College of Radiologists and the Wellcome Trust and an overview of College strategies in developing radiology research. Clinical radiology. 2012; 1;67(5):411-6.

4. Kamaledeen S, Brown P, Gangi A, Pantelidou M, Chan N. Survey of research participation amongst UK radiology trainees: aspirations, barriers, solutions and the Radiology Academic Network for Trainees (RADIANT). Clinical Radiology. 2021; 1;76(4):302-9.

5. Yoong P, Johnson CA, Rehman JM, Toms AP. Regional inequality in radiology research output in the UK: a 5-year bibliometric study. The British Journal of Radiology. 2012; 85(1019):1513-6.

6. Altman DG. The scandal of Poor Medical Research. BMJ. 1994;308(6924):283–4.

7. Nair T. Medical Statistics Made Easy for the Medical Practitioner. Hypertension Journal. 2015;1(2):63–7.

8. Levine D, Bankier AA, Halpern EF. Submissions to Radiology: Our Top 10 List of Statistical Errors. Radiology. 2009;253(2):288–90.

9. Shreffler J, Huecker MR. Common Pitfalls In The Research Process [Internet]. PubMed. Treasure Island (FL): StatPearls Publishing; 2021. Available from: https://www.ncbi.nlm.nih.gov/books/NBK568780/

10. Ioannidis JP. Why most published research findings are false. PLoS Medicine. 2005;2(8).

11. DAMOCLES study group. A proposed charter for Clinical Trial Data Monitoring Committees: Helping them to do their job well. The Lancet. 2005;365(9460):711–22.

12. Ochodo EA, de Haan MC, Reitsma JB, Hooft L, Bossuyt PM, Leeflang MM. Overinterpretation and misreporting of Diagnostic Accuracy Studies: Evidence of “spin.” Radiology. 2013;267(2):581–8.

13. Your one-stop-shop for writing and publishing high-impact health research [Internet]. Equator network. [accessed 2022 Apr 26]. Available from: https://www.equator-network.org/

14. General Medical Council. Domain 1: Knowledge skills and performance. 2019. [accessed 2022 March 12] Available from: https://www.gmc-uk.org/ethical-guidance/ethical-guidance-for-doctors/good-medical-practice/domain-1---knowledge-skills-and-performance#paragraph-7

Legends for illustrations:

Figure 1: Histogram detailing research aspirations of United Kingdom radiology trainees. Multiple responses were possible.

Funding:

BLINDED FOR REVIEW

Acknowledgements:

BLINDED FOR REVIEW

Role of the funding source:

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Table 1: Table indicating respondents' ranking of where they believed statistical help would be most useful, with rank "1" being most helpful and rank "4" least helpful.

	Number of respondents			
Ranked order:	**1**	**2**	**3**	**4**
Research planning and study design.	25	24	12	15
Analysis of data already collected	41	17	14	4
Helping interpret the results	5	29	37	5
Helping draft the final report	5	6	13	52

N=76; 3 respondents excluded due to failure to complete the question.