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# Research productivity among trainee anaesthetists in Ireland: a cross-sectional study

**James D. O'Leary · Owen O'Sullivan**

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**Abstract** Objective measures of research performance are necessary to facilitate academic advancement of trainee physicians. In this cross-sectional study, all anaesthetists ($n = 98$) in higher specialist training in Ireland were surveyed to determine bibliometrics of their scientific publications and individual and institutional characteristics that can influence research productivity. For trainees with publications, the median (range) h-index was 1 (0–4). There was a positive correlation between participation in a formal research program and increased research productivity using mean citations per publication ($r^2 = 0.26$, $P = 0.006$) and h-index ($r^2 = 0.26$, $P = 0.006$). There was a positive correlation between formal mentorship and mean citations per publication ($r^2 = 0.15$, $P = 0.04$) and h-index ($r^2 = 0.17$, $P = 0.03$).

**Keywords** Research productivity · Bibliometrics · Anaesthesia · Medical education and training

## Introduction

Integration of research principles into training is a basic standard of postgraduate medical education and trainee participation in research is a quality measure of postgraduate medical education. Objective measures of research performance are necessary to assess quality of postgraduate medical education and to facilitate academic advancement of trainee physicians who are motivated to participate in research activity as other subjective methods of evaluation, such as peer review, can be prone to bias (Ball 2007). Bibliometrics are being used to measure research productivity in various scientific fields, including anaesthesia (Ball 2007; Pagel and Hudetz 2011). The limitations of these indices are well described (Hirsch 2005; O'Leary and Crawford 2010).

J. D. O'Leary (✉)
Department of Anesthesia and Pain Medicine, Cork University Hospital, Wilton, Cork, Ireland
e-mail: j.d.oleary@umail.ucc.ie

J. D. O'Leary · O. O'Sullivan
Department of Anesthesia, Faculty of Medicine, University College of Cork, Cork, Ireland

Individual and institutional characteristics may also influence research productivity (Bland et al. 2005). For researchers in postgraduate medical education, individual characteristics may have an important role in becoming affiliated with high achieving academic departments and university faculties, and consequently in becoming productive researchers (Bland et al. 2005).

The bibliometric characteristics of the research output of trainee anaesthetists in Ireland have not been described, and it is not known which individual and institutional factors influence research productivity in this population. In this cross-sectional study, the primary outcome was to determine bibliometric characteristics [Hirsch-index (h-index)], mean citations per publication, total number of publications, total citation count, and year of first publication) of the research output of anaesthetists in higher specialist training in Ireland. The secondary outcome was to describe the association between individual and institutional characteristics and research productivity for anaesthetists in specialist training in Ireland.

## Methods

### Design and participants

With approval of the Clinical Research Ethics Committee of the Cork Teaching Hospitals, all trainee anaesthetists ($n = 98$) enrolled with the College of Anaesthetists of Ireland on the National Specialist Registrar Training Scheme from January 2011 were invited to participate. Data were collected using an online survey resource (SurveyMonkey™) during a four week period from February 2011. One reminder was sent after two weeks to all non-respondents by email. Non-response was categorized as no returned (complete or partial) internet-based questionnaire.

The internet-based questionnaire consisted of a 15 item instrument designed to determine participant demographics, details of scientific publications, and individual and institutional characteristics that can influence research productivity. Responses were elicited as text, numeric, binary (Yes/No), or 5 point Likert-type (1 = strongly agree, 2 = somewhat agree, 3 = neither agree nor disagree, 4 = somewhat disagree, and 5 = strongly disagree) formats.

Publication data were analyzed by two investigators independently using an internet-based citation resource (Thomson Reuters ISI Web of Science®) on March 12, 2011. The search methods were modified from a search strategy first reported by O'Leary et al. (O'Leary and Crawford 2010). Author details defined each search using the author finder function in Web of Science®. Each search excluded the 'arts and humanities' subject heading. Article types excluded from the search results were meeting abstracts, book reviews, biographies, corrections, news, reprints, and documents published prior to 1985. Search results were further refined by reviewing each profile individually to identify author, institution, and subject areas. Those articles that did not meet known name variations, institutional associations, and subject area were excluded. A citation report was created for each trainee based on the output of the search strategy. From the citation report the following data were collected (i) citation indices (h-index, mean citations per publication, total number of publications, total citation count, and year of first publication) (ii) relative contribution of the participant (authorship position) and (iii) publication type.

### Statistical analysis

A pilot survey—10% of the cohort (9 trainees)—was initially conducted to assess the validity of the online questionnaire and investigator database search methods to successfully identify scientific publications of trainee anaesthetists.

The sample frame was all trainee anaesthetists on the National Specialist Registrar Training Scheme in Ireland at the time of the survey. In consideration of the small sample size, all trainee anaesthetists were contacted to participate in the survey. We anticipated a response rate of approximately fifty percent.

Data were recorded in Numbers' 09 (version 2.0.5), and analyzed using Prism 5 (GraphPad Software, San Diego, CA, USA). Descriptive statistics (central tendency and distribution) were determined for h-index, mean citations per publication, total number of publications, total citation count, year of first publication. Linear regression analysis was used to show the relationship between each of the citation indices and formal research training, participation in formal research or mentoring. An alpha level of 0.05 was used for all analyses.

## Results

From the pilot study, our search strategy identified 87% of authors' publications and did not attribute any publications erroneously. The loss of sensitivity (the ability to identify known publications for each author) was a consequence of two events; an incorrect author name variation and a publication not indexed by Web of Science®.

The survey response rate was 41% (40/98). Demographic data are presented in Table 1. Twenty-eight trainees (29%) provided information to analyze scientific publications. Of these 28 trainees, our search strategy was unable to identify bibliometric data for one individual.

Forty-six percent of trainees (13/28) who provided information to analyze scientific publications have published at least one scientific paper. The median (range) time since first publication for trainees was three (1–12) years. Bibliometrics for the cohort are presented in Table 2.

Trainees in the cohort published 39 scientific papers (Table 3) in 28 scientific journals, and had first authorship on 28% of the publications. Most trainees considered themselves

**Table 1** Participant demographics

| | Trainee anaesthetists (n = 40) |
|---|---|
| Male: female | 20:20 |
| Year of graduation from medical school, M (range) | 2002 (1989–2006) |
| Current Training point on the National Specialist Training Scheme in Anaesthesia, M (range) | 3 (0–5.5) |
| Average time (hours) per week involved in research activity, M (IQR) | 2 (0–3) |
| Participated in a formal research program, *n* (%) | 14 (35) |
| Received formal training in the conduct of research in medicine, n (%) | 7 (18) |
| Received formal mentoring from a senior colleague, *n* (%) | 16 (40) |

*M* median; *IQR* interquartile range

**Table 2** Bibliometric characteristics of trainee anaesthetists in Ireland with scientific publications ($n = 28$)

| | Median (range) |
|---|---|
| H-index | 1 (0–4) |
| Citations per publication | 1.5 (0–20.9) |
| Total publications | 2 (1–8) |
| Total citations | 3 (0–146) |
| Time since first publication (years) | 3 (1–12) |

**Table 3** Types of scientific papers

| | Number of publications, *n* (%) |
|---|---|
| Editorial | 3 (8) |
| Letter | |
| Case report | 5 (13) |
| Case series | 1 (3) |
| Clinical research | 1 (3) |
| Comment | 3 (8) |
| Review article | 4 (10) |
| Research article | |
| Case report | 1 (3) |
| Case series | 1 (3) |
| Clinical study | 7 (18) |
| Laboratory study | 13 (33) |

internally driven to conduct research, to be up-to-date on the current literature in the fields of their research interests and to receive informal mentoring from senior colleagues (Table 4). Trainees perceived the most common barriers to improved research performance were perceived by trainees to be a lack of protected research time, long clinical hours, and the pursuit of other academic interests. The most common factor reported to have a positive influence on research performance was mentoring from senior colleagues.

There was a positive correlation between participation in a formal research program and increased research productivity using mean citations per publication ($r^2 = 0.26$, $P = 0.006$) and h-index ($r^2 = 0.26$, $P = 0.006$). There was also a positive correlation between formal mentorship and increased research productivity using mean citations per publication ($r^2 = 0.15$, $P = 0.04$) and h-index ($r^2 = 0.17$, $P = 0.03$). There was no correlation between formal training in research techniques and h-index ($r^2 = 0.05$, $P = 0.23$) or mean citations per publication ($r^2 = 0.04$, $P = 0.33$).

## Discussion

Comparing research productivity of trainee physicians using citation indices has the same challenges as comparing research productivity of more established researchers (Bould et al. 2011). Trainee physicians are not a homogenous population, individuals will be in different stages of their career, have differing research interests, and various levels of institutional and peer support. Trainee physicians may be highly motivated to succeed in their field of

**Table 4** Individual and institutional characteristics that may influence research productivity of trainee anaesthetists

| | Strongly agree | Somewhat agree | Neither agree nor disagree | Somewhat disagree | Strongly disagree |
|---|---|---|---|---|---|
| Is informal mentoring from a senior colleague available in your area(s) of research interest? | 6 (15) | 18 (45) | 11 (28) | 4 (10) | 1 (3) |
| Are you internally driven to conduct research? | 11 (28) | 12 (30) | 8 (20) | 9 (23) | 0 (0) |
| Are you "up-to-date" on the current literature in your research area(s)? | 5 (13) | 19 (48) | 8 (20) | 8 (20) | 0 (0) |

Data are number of trainees (%)

interest but as a consequence of their young 'research age' they may have few scientific publications and each publication may have few citations, hampering the use of bibliometrics.

Hirsch proposed the h-index as a bibliometric more suited to evaluating high performing researchers, he did not consider using the h-index for evaluating those researchers early in their career with relatively few publications and citations. The h-index values in this cohort were low, the highest value is 4, but these values may not reflect the actual impact of the research activity in the cohort as our assessment may precede the 'citation window' of the publications and citation databases used to measure bibliometrics have a lag time for including citations. For young researchers it may be appropriate to only use citation indices after a minimum period of time, for example five years after entry into a research program or first publication of an original research paper. Also, when h-index values of researchers with few publications are low, they can also be more easily distorted by a small number of lowly cited publications. For these reasons, it may be preferable to use citations indices other than the h-index.

Study design will influence the citation impact of the scientific paper (Patsopoulos et al. 2005). When determining citation profiles of 'young' researchers, non-original research may distort bibliometrics. When comparing researchers with few publications, letters or review articles may be of similar bibliometric value as more highly cited original research papers when calculating h-index values. In this cohort, 46% of publications were letters, editorials or review articles and only 56% of published research papers were indexed by journals as 'research articles'.

Additionally, the individual contribution of trainees to each publication was low, trainees had first authorship on 28% of publications, indicating that they were not the leading contributor to the majority of their research activity. Bibliometrics, such as the h-index, which do not differentiate between first authorship or co-authorship of scientific publications may inflate assessments of research productivity by not considering the relative contribution of each author to the paper. It is likely this effect is more significant when considering researchers with few publications.

Several multifaceted models of individual, institutional and leadership characteristics successfully predict productivity of researchers (Bland et al. 2005; Dundar and Lewis 1998). The individual and institutional characteristics that contributed to research productivity of trainees in this cohort included mentoring, protected research activity, and sufficient time for clinical work and other academic activity. The influence of mentoring on

research productivity in this cohort is not surprising, as it has been shown that influential and sustained mentorship enhances the research activity of postgraduate fellows (Steiner et al. 2004).

Our study has some limitations. The study population is small and the response rate was low, making comparison with other populations difficult and limiting data analysis due to lack of power. The calculation of citation indices will be influenced by the choice of citation database and the methods used for determining the citation profile of researchers (Kulkarni et al. 2009). Although the sensitivity and specificity of our pilot study were high, there is potential for error when determining citation profiles. This error could have been eliminated by asking study participants to provide details of each scientific publication but this may have decreased survey participation. There was also potential for bias in describing bibliometrics for the cohort, as trainees with higher numbers of publications may be more likely to participate in the study than trainees without publications.

One of the goals of evaluating the research output of trainee physicians should be to identify factors that are predictive of future research performance. Whether research productivity early in a physicians career measured by bibliometrics can successfully predict future knowledge production, dissemination, and ultimately translation is unknown. When using citation indices to evaluate research productivity of trainee physicians, more than one bibliometric should be used and only after a minimum period of time due to the low 'research age' of trainees. Citation indices should not be used exclusively to evaluate research productivity of trainee physicians in postgraduate medical education. This does not preclude the use of bibliometrics to rank research productivity of postgraduate medical education programs, but when comparing programs of different sizes it may be appropriate to use a modified h-index, such as the first author h-index (Butson and Yu 2010).

To conclude, bibliometrics of the research output of trainee anaesthetists were low, but this may reflect the young 'research age' of trainees. The most significant individual and institutional factors associated with increased research productivity in this population were formal mentorship and participation in a research program.

**Conflict of interest** None.

**Ethics approval** Ethical approval for this study (ECM 4 (o) 11/01/11) was provided by the Clinical Research Ethics Committee of the Cork Teaching Hospitals, Cork, Ireland (Chairperson Dr Michael Hyland) on 14th December 2010.

## Appendix A

Study questionnaire (administered by SurveyMonkey™)- version 02.11.2010.

1. Participant demographics:

    i. Your gender: male/female
    ii. What year did you graduate from medical school?
    iii. What is your current training point (e.g. year 1, year 1.5) on the National Specialist Training Scheme in Anaesthesia?

2. Individual and institutional characteristics influencing research productivity:

    i. Have you participated in a formal research program? Yes/No

ii. Have you received formal training in the conduct of research in medicine? Yes/No
iii. Have you ever been formally assigned a senior colleague to mentor your research? Yes/No
iv. Is informal mentoring and support from senior colleagues available in your area(s) of research interest?
(1 strongly agree, 2 somewhat agree, 3 neither agree nor disagree, 4 somewhat disagree, and 5 strongly disagree).
v. Would you describe yourself as being internally driven to conduct research?
(1 strongly agree, 2 somewhat agree, 3 neither agree nor disagree, 4 somewhat disagree, and 5 strongly disagree).
vi. Are you "up-to-date" on the current literature in your research area(s)?
(1 strongly agree, 2 somewhat agree, 3 neither agree nor disagree, 4 somewhat disagree, and 5 strongly disagree).
vii. On average, how many hours each week are you involved in research activity?
viii. Are there any other factors which you think strongly influence your research performance?

3. Scientific publication information:

   i. What variations of your name you have used for authorship of scientific publications?
   ii. What institutional affiliations have you used for publishing your research output?
   iii. In which year was your first scientific publication?
   iv. On how many scientific papers in peer-review journals have you been credited an authorship?

4. Contact email address for individual and aggregated results:

   Please enter your email address here if you would like to receive a copy of your individual citation profile (Web of Science®), and a summary profile of the bibliometric characteristics of the cohort when the study is completed.

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