The use of the h-index to measure quality and output: A bibliometric analysis in health service research.

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ABSTRACT

Objective – To describe measures of the volume and quality of research outputs from health service researchers.

Design – Online survey with bibliometric analysis.

Participants – A convenience volunteer sample of researchers mainly in the UK, North America and Australasia.

Main outcome measures – Self reported form Google Scholar: h-index; number of papers; number of citations; number of papers with ≥ 10 citations.

Results – There were 763 responses from health service researchers based in a number of different countries; 65% (n = 498) were from the UK. Of the bibliometric measures the h-index appeared to be among the best discriminator between other measures of quality (e.g., seniority; entry into the last UK RAE). The overall median h-index was 12, with 90th and 95th quantiles of 40 and 52 respectively. Statisticians had the highest h-index with qualitative researchers the lowest (median 16 and 7 respectively). The h-index was predicted to increase by approximately 1 point annually with the biggest increase in statisticians and smallest in qualitative researchers when estimated by quantile regression.

Conclusions-This bibliometric survey found that the h-index is a useful summary measure of output and quality of health services researchers. However, any accurate interpretation of bibliometric measures needs to account for research discipline.

Introduction

Evaluation of the output of researchers is important and there are a variety of ways in which this is achieved at both the individual and the collective level. Research institutions (e.g., Universities) and governments have a financial interest in maximising the quality and quantity of research outputs. In the UK the assessment of research output from Universities currently takes the form of the Research Excellence Framework (REF)[1], previously the Research Assessment Exercise (RAE) and this currently provides a measure of organisational quality.

The majority of research output can be measured in terms of academic publications. It is important, therefore, that the quality as well as the quantity of published research is measured. There are several bibliometric methods that can be used to assess individual publication performance; however, all have some limitations. A simple summation of peer-reviewed papers is a crude measure of output, which does not take into account the academic impact the research is having on the wider research community. Total number of citations may give some estimate of research impact; although this value is often skewed by a small number of very highly cited publications so does not give an indication of continuing or consistent high research output.

One measure of research output which is becoming more commonly used is Hirsch's (h) index[2], which attempts to combine the quality and quantity of an individual's publication output into one measure. The h-index tells us that the number *h* of an author's publications have at least *h* citations; essentially it is a measure of the author's median citation rate and is therefore robust to the influence of a few highly cited papers. For example, if a researcher with an h-index of 10 has published 50 papers and these are ranked by their number of citations, then the 10^{th} paper in the rank will have been cited at least 10 times. Since the h- index was described in 2005 it has been widely used; indeed, the original paper had been cited more than 3,000 times by April 2013. In the area of health care research the h – index has been shown to have high construct validity as a measure of researchers' academic rank.[3] To have a high h-index a researcher must publish a large volume of papers that are cited regularly. However, the index does have a drawback in that it favours older, more established researchers: it cannot go down. Consequently, its use could be combined with other measures of impact, such as the numbers of papers cited more than ten times (10-index) or the m-quotient, which divides the h-index by the number of years a researcher has been active. However, these additional measures may not add significantly to the use of the h-index.

Measures of research output vary between and within research areas. For instance, for researchers working in physics, an h-index that is equivalent to the number of years in research is good, but this is low for those working in biomedical sciences[2]. We currently know little about patterns within health services research (HSR) and how they might differ between core disciplines. We have deliberately chosen to keep the definition of health research broad to reflect the varied nature of the population of researchers who work in the field of HSR. In this paper, we have undertaken a survey of researchers in the field of health care to collate data on their research output in order to gain insight into what constitutes a "good" measure of output.

Methods

We conducted an online survey using Survey Monkey (www.surveymonkey.com). We developed and piloted a questionnaire among staff in the Department of Health Sciences, University of York. After feedback and minor modifications to the wording and order of questions we circulated the link to the online survey, with an accompanying cover email, to the following groups: The Directors of the UK Clinical Research Collaboration registered clinical trials units; the statistical email list ALLSTAT; the Medical Research Council Methods Hubs mailing list; and the directors of the National Institutes of Health Research Research Design Services, as well as researchers known personally to the authors. We also asked recipients to disseminate the link to colleagues and collaborators (a form of snowball sampling). The survey opened on 17th January 2013 and closed on 2nd April 2013.

Recipients were asked for brief demographic data and to use Google Scholar to compute their total number of citations, their h-index and other bibliometric measures (see Appendix 1 for copy of questionnaire). We chose to use Google Scholar as opposed to other databases for a number of reasons. First, it is freely available and easy to use. Second, other sources such as Web of Science tend to under-estimate the number of citations that accrue when the subject area is not a natural science[4]. Third, it also includes books, reports and book chapters in the measures of output and research impact, which may contribute significantly despite not being formally 'peer reviewed' papers.

Analysis

The results of the survey were downloaded from Survey Monkey and imported into Stata v12 for analysis. Respondent characteristics were summarised. The distribution of the bibliometric data was observed to be significantly non-normal and thus the median was used to describe the central tendency of each measure since this is often more informative and appropriate for skewed data than the mean. The median, 90^{th} and 95^{th} quantiles for the bibliometric measures of respondents stratified by a range of demographic characteristics including sex, age group, current position, years in academic role and research discipline are reported. Quantile regression with bootstrapped standard errors was used to investigate differences in median between independent groups, adjusting for age, sex and research discipline unless otherwise stated. Significance was set at the 5% level and 95% confidence intervals are presented.

Validation

Hirsch's h – index is one of the most well-known methods of estimating publication output and impact and to assess its validity we compared its performance with the other measures. We did this by calculating pairwise Spearman's rank correlations for the number of publications, number of citations, h-index and 10-index, and the standardised mean difference of these measures[5] by whether the researcher was entered for the last UK research assessment exercise (UK respondents only) and seniority as a measure of their sensitivity. Our hypothesis was that the best measure would have the strongest associations with these factors.

Results

We received 763 responses to the survey, with a completion rate of 69% (n=524). The reduced completion rate was due to people who did not answer the questions asking for their Google Scholar citation figures. The mean age (SD) of the respondents was 45 (10.8) years and 57% (n = 438) were female (table 1). There was no difference in the age or proportion of females of the recipients that answered the Google Scholar questions compared to those that did not. The majority of respondents had a PhD (67%, n=514) and we received a greater number of responses from researchers who had been active for less than 15 years (60%, n=458), than those with more experience in an academic role. The single largest represented research discipline was health services research (23%, n=178) and the majority of respondents were UK based (65%, n=498). A fifth (n=156) of responders had worked half-time or less for a proportion of their career and just under a third (n=230), of which 81% (n=186) were women, had taken significant time off work due to, for instance, maternity leave. For 27% (n=63), this time off totalled more than 2 years.

Citation analysis

Figure 1 displays the distribution of the number of papers, citations, h-index and 10-index for the entire population of respondents; all of which were highly positively skewed. The median h-index was 12 (95% CI 10.0 to 14.0) with 90^{th} and 95^{th} quantiles of 40 (95% CI 32.3 to 47.7) and 52 (95% CI 46.5 to 57.5) respectively. Table 2 provides a summary (n, median, 90^{th} and 95^{th} quantiles) of the publication rates and measures of impact stratified by demographic criteria and shows that measures generally increase with age, experience and seniority. For example, statistically significantly higher values were reported for respondents holding a Chair position than for all other respondents in an adjusted analysis (e.g., difference in median h-index 16.2, 95% CI 13.5 to 18.8, p<0.001).

Our data showed a large difference between men and women across all measures (e.g., median h-index 19 vs 9). These differences decreased by around 50% after adjusting for age and research discipline but remained statistically significant (e.g., difference in median h-index 4.2, 95% CI 1.9 to 6.6, p<0.001). No difference in h-index was observed for those who had worked part-time or had had time away from their careers in an adjusted analysis. There were marked differences in the raw measures for different academic qualifications with those holding an MD tending to have approximately double the impact measures of those holding a PhD. An MD is a qualification accessible only to medically qualified researchers, who tend to have a higher h-index than non-medically qualified researchers. Indeed, in an adjusted analysis doctors were seen to have a statistically significantly higher h-index than non-clinical researchers (difference in median 6.4, 95% CI 2.7 to 10.2, p=0.001). We also found that researchers who had published at least one paper from their highest qualification had larger measures of impact and productivity than those who had not, and the difference in h-index was statistically significant in an adjusted analysis (difference in median 3.3, 95% CI 0.8 to 5.7). We did not find a statistically significant difference in the median h-index of UK and non-UK researchers. For each outcome measure, the responses of those who were submitted to the last RAE were statistically significantly higher than those who were not (e.g., difference in median 14, 95% CI 11.9 to 16.1, p<0.001).

Table 3 presents the results of a quantile regression to predict the median, 90th and 95th quantiles for h-index, adjusting for age, sex, years in academia and research discipline. Coefficients are interpreted in a similar way to those produced by an ordinary least squares linear regression. That is, an estimate for the median h-index of a 39 year old male statistician with 15 years' experience is:

$$-2.2+(39x0.1)+3.1+2.2+16.5=23.5.$$

Similarly, the 95th quantile for a 30 year old female epidemiology researcher with 5 years' experience is estimated at:

$$-0.7+(30x0.4)-0.5+5.8=16.6.$$

At the right tail of the h-index distribution, differences become more pronounced. For instance, the difference in the median h-index of men and women is 3.1 (95% CI 1.57 to 4.57, $p<0.001$); however, the difference between the 95th quantiles is 13.0 (95% CI 6.28 to 19.81), reflecting the wider range of h-index scores for men. A noted limitation of this analysis is that it is not clear if respondents took account of significant periods away from work when reporting their total number of years in an academic role. We did not explicitly capture how respondents interpreted this question; therefore there could be bias in the reports of the number of years' service from those with any periods away from work.

Validity of impact measures

As the h-index is a measure of both output and impact, we would expect, if it has good construct validity, for it to correlate highly and positively with the number of publications, number of citations and 10-index; such correlations were observed in this survey (table 4). We considered the sensitivity of each measure to differentiate between different groups of researchers by computing the standardised mean difference[5] between those, UK based researchers, that were entered into the last RAE (n=209) and those that were not (n=209). The h-index was observed to be the measure most sensitive to the difference in impact and output between these two groups since it was the one with the greatest standardised mean difference (table 5). We did the same for respondents that hold a position as Chair and those that did not, this time adjusting for age as a confounder. In this situation, the standardised mean difference for h-index was only marginally succeeded by that for the number of papers, and so the h-index can be seen to be a responsive measure of output and impact.

Discussion

In this paper we have described a number of citation measures of impact and potential research quality in the general field of health services research generated from a large international sample. Our data can be used to estimate the output and impact of researchers from various health services research disciplines. We conclude that it is misleading to compare the h-index, for example, of a statistician or health economist, with a qualitative researcher. Similarly, it is important to consider the professional backgrounds of researchers; for instance, those from a medical as opposed to a nursing background have a higher h-index and allied health professionals will differ again. The notably higher impact measures for medically qualified respondents could be due to differences in authorship culture amongst different professions. For example, in the area of clinical trials, clinicial chief investigators are likely to have authorship on all trial publications; whereas other trial members may only be involved in papers relevant to their line of work (e.g., the statistician may only have their name on papers reporting clinical results, and not on the economic evaluation). While the higher impact measures for medical professionals was not unexpected we were more surprised by the relatively lower h-index of those citing systematic reviews as their primary discipline, although our sample of this group was small.

We found significant differences in values between men and women. A large part of this difference was explained when we adjusted for age and discipline as the women in our sample tended to be younger and more heavily represented in disciplines that have low citation rates (e.g., qualitative research). Nevertheless, differences remained, which were not explained when we adjusted for the presence of career breaks or working part-time. However, there is likely to be some residual confounding. For instance, many academics when they 'retire' retain a part-time research position consequently retired part-time academics will tend to have high bibliometric values, due to their age, and, in this sample, be more likely to be male, which would mask the downward effect on women's bibliometric scores by taking part-time positions.

This study is one of the largest bibliometric analyses in the field of healthcare to date. A recent analysis by Glanville and colleagues focused on outputs from primary care in the UK, USA, Canada, Australia, Germany and the Netherlands. The average h-index for that subset of health researchers for the UK was 13, somewhat lower than the value (18) that we found[6]. The difference, however, may have arisen as a consequence of our use of Google Scholar which tends to index greater numbers of publications than other databases. Another recent study has presented data from one research institute predominated by medicine[3]. Ours by comparison has a breadth of disciplines and professional backgrounds and recruited from an international field. In addition we have been able to address a number of the identified limitations of this previous paper by looking at age and scientific discipline. We have validated this against a number of similar benchmarks and described the patterns observed. The important variations between disciplines should be noted when assessing and benchmarking outputs for institutions and individuals.

We compared the h-index with other measures of impact such as volume of papers published and total citations. There were high correlations between the different measures. However, the h-index appears to discriminate more ably than other markers of quality and output, such as academic seniority and eligibility for the UK's research assessment exercise. Assessing the sensitivity of the h-index by comparing seniority as defined by holding a Chair position or not, may be a self-fulfilling prophecy, as some institutions consider the h-index as a criterion for promotion. In any expansion of this study the authors would consider asking respondents if this was a practice used in their institution.

There are a number of limitations to this study. We were unable to take account of co-authorship, language, and document type. Although we were able to generalise more widely than the previous work in one centre and the sample was relatively large, a more extensive survey would give these results more generalizability. Despite the overall relatively large sample size, the figures provided in table 2 should be interpreted cautiously, due to the limited sample size of some subgroups, for example, only 12 systematic reviewers provided their h-index. Reported sample subgroup quantiles are therefore a noisy representation of the likely population values, notwithstanding the selection bias our sample suffers from. We know little about those who chose to respond or not to respond to the survey or how individuals came to receive it due to the pragmatic sampling techniques employed. It is likely that those responding to our survey will tend to have a higher publication and citation rate compared with non-respondents. Consequently the values we present here are likely to be an overestimate of the average impact of researchers working in health care. Although we validated against inclusion in the last RAE (or REF14) we acknowledge that this is not an independent event and ultimately relies upon an institutional strategic decision. Furthermore, returnability is distinct from eligibility and therefore looking at this relationship may well be overly simplistic from a statistical and other perspectives.

While we acknowledge that this study is a ‘first look’ at citation rates amongst health service researchers and a larger, more strategic study would allow for more robust results and sophisticated analyses, this paper nevertheless contributes to the provision of a useful initial benchmark for judging research productivity in a variety of health related research disciplines. It demonstrates that the h-index may be used to compare between and within institutions, and for assessments relating to performance review and promotions in academic contexts.

Table 1. Characteristics of respondents

Characteristic	Total (n= 763)
Sex, n (%)	N=763
Male	325 (42.6)
Age, years	N=761
Mean (SD) (min, max)	45.0 (10.8) (20, 81)
Current position, n (%)	N=763
Chair	186 (24)
Reader	40 (5)
Senior Researcher	70 (9)
Senior Lecturer	84 (11)
Researcher	188 (25)
Lecturer	62 (8)
Other	133 (17)
Years in academia, n (%)	N=735
0-4	155 (21.1)
5-9	143 (19.5)
10-14	160 (21.8)
15-19	116 (15.8)
20-24	63 (8.6)
25-29	44 (6.0)
30+	54 (7.4)
Primary research discipline, n (%)	N=719
Health Services Research	178 (24.8)
Clinical Research	150 (20.9)
Statistics	97 (13.5)
Epidemiology	69 (9.6)
Psychology	53 (7.4)
Health Economics	47 (6.5)
Qualitative Research	31 (4.3)
Trial Methodology	21 (2.9)
Systematic Reviews	18 (2.5)
Other	55 (7.7)
Highest qualification, n (%)	N=763
PhD	514 (67.4)
MSc	112 (14.7)
MD	55 (7.2)
BSc	19 (2.5)
MPH	12 (1.6)
MPhil	11 (1.4)
Other	40 (5.2)
Country, n (%)	N=719
UK	498 (69.3)
Australia	110 (15.3)
Canada	31 (4.3)
USA	20 (2.8)
France	19 (2.6)
Ireland	10 (1.4)
Italy	5 (0.7)

New Zealand Netherlands Spain Norway Austria Other	5 (0.7) 4 (0.6) 4 (0.6) 3 (0.4) 2 (0.3) 8 (1.1)
GOOGLE SCHOLAR	
Number of papers	N=532
Median (IQR) (min, max)	49.5 (17, 126) (0, 904)
Number of citations	N=534
Median (IQR) (min, max)	681 (117, 2584) (0, 56 393)
H-index	N=544
Median (IQR) (min, max)	12 (5, 26) (0, 102)
10-index	N=533
Median (IQR) (min, max)	14 (3, 46) (0, 419)
Papers published in 2012	N=522
Median (IQR) (min, max)	5 (2, 10) (0, 66)

*Table 2. Citation summaries by respondent characteristics presented as **n** median (90th quantile, 95th quantile)*

Characteristic	Number of publications	Number of citations	H-index	10-index	Number of papers published in 2012
Sex					
Male	**241** 89 (367, 466)	**243** 1469 (11684, 16048)	**247** 19 (52, 62)	**243** 29 (141, 196)	**239** 8 (21, 34)
Female	**291** 29 (146, 186)	**291** 353 (3085, 6136)	**297** 9 (29, 38)	**290** 9 (51, 74)	**283** 3 (12, 20)
Age group, years					
<30	**36** 7.5 (43, 51)	**35** 36 (245, 443)	**38** 2.5 (8, 9)	**36** 1 (6, 8)	**34** 2 (7, 10)
30-39	**135** 20 (59, 111)	**135** 147 (1092, 2547)	**137** 6 (16, 26)	**135** 4 (24, 41)	**130** 3 (9, 12)
40-49	**180** 60 (183.5, 306)	**181** 867 (4887, 6635)	**186** 16 (32, 40)	**181** 19 (69, 94)	**179** 5 (20, 33)
50-59	**127** 105 (342, 416)	**129** 1647 (10693, 14072)	**128** 21 (50, 55)	**127** 33 (134, 169)	**125** 7 (20, 29)
60+	**52** 179 (479, 735)	**52** 4229.5 (17446, 23529)	**53** 34 (67, 76)	**52** 73.5 (216, 270)	**52** 8 (21, 20)
Current position					
Chair	**141** 175 (462, 488)	**142** 3568.5 (14417, 18445)	**142** 29 (58, 67)	**139** 70 (179, 216)	**137** 11 (28, 40)
Reader	**31** 103 (233, 261)	**32** 2140 (4687, 5302)	**32** 20.5 (34, 38)	**32** 33.5 (73, 101)	**31** 7 (18, 25)
Senior Researcher	**53** 47 (214, 265)	**54** 704.5 (4124, 4821)	**55** 13 (30, 35)	**54** 16 (58, 72)	**52** 4 (17, 27)
Senior Lecturer	**67** 53 (120, 180)	**67** 515 (3009, 3783)	**67** 12 (27, 30)	**65** 15 (50, 54)	**65** 5 (12, 16)
Researcher	**121** 16 (56, 77)	**120** 138.5 (1491.5, 2248)	**124** 4 (18, 20)	**121** 3 (22, 29)	**117** 2 (9, 12)
Lecturer	**47** 20 (55, 77)	**47** 78 (1491.5, 2248)	**50** 5 (15.5, 17)	**49** 4 (20, 24)	**47** 2 (8, 11)
Other	**72** 16 (114, 248)	**72** 136.5 (3406, 7208)	**74** 5 (29, 45)	**73** 4 (46, 113)	**73** 2 (10, 12)
Years in academia					
0-4	**107** 8 (39, 59)	**106** 40.5 (371, 522)	**109** 3 (9, 11)	**107** 1 (9, 11)	**103** 2 (7, 10)
5-9	**101** 22 (81, 124)	**101** 196 (1461, 3246)	**105** 7 (19, 24)	**104** 5.5 (28, 43)	**100** 3 (12, 15)
10-14	**117** 48 (151, 249)	**119** 739 (3507, 5302)	**121** 13 (28, 30)	**118** 17 (54, 73)	**116** 6 (20, 31)
15-19	**86** 100.5 (324, 402)	**87** 1993 (6724, 13658)	**89** 21 (46, 55)	**85** 36 (94, 161)	**85** 7 (21, 29)
20-24	**53** 146 (376, 416)	**53** 2367 (12759, 18848)	**53** 27 (55, 62)	**52** 51.5 (146, 175)	**529**.5 (19, 29)
25-29	**31** 172 (473, 489)	**31** 3859 (11455, 14072)	**31** 28 (56, 61)	**31** 70 (176, 212)	**31** 8 (22, 28)
30+	**37** 239 (479, 794)	**37** 7208 (18445, 49922)	**36** 45 (67, 81)	**36** 112 (250, 296)	**35** 8 (28, 40)
Primary research discipline					
Statistics	**78** 61 (264, 395)	**77** 873 (7936, 23529)	**79** 16 (49, 67)	**78** 20.5 (126, 141)	**76** 6.5 (18, 23)

Epidemiology	**52** 38.5 (308, 375)	**52** 917 (8235, 13658)	**52** 14 (48, 62)	**51** 19 (122, 198)	**51** 5 (18, 33)
Trial Methodology	**18** 100.5 (389, 481)	**19** 1532 (10184, 11684)	**20** 16 (43, 52.5)	**19** 30 (161, 175)	**18** 6.5 (18, 34)
Health Economics	**33** 55 (283, 462)	**33** 847 (9093, 16197)	**35** 15 (49, 55)	**33** 19 (127, 176)	**30** 5.5 (16.5, 28)
Health Services Research	**133** 53 (240, 320)	**133** 822 (6724, 10263)	**133** 14 (43, 50)	**131** 17 (94, 134)	**129** 5 (16, 20)
Clinical Research	**105** 57 (330, 418)	**106** 680.5 (7418, 12069)	**108** 12 (40, 56)	**106** 14.5 (98, 176)	**104** 6 (25, 36)
Psychology	**38** 40 (233, 319)	**38** 543 (7208, 7914)	**41** 11 (35, 47)	**40** 11 (72, 129.5)	**40** 5 (16.5, 22.5)
Systematic Reviews	**11** 26 (62, 261)	**12** 276 (2874, 33769)	**12** 7 (28, 58)	**12** 5.5 (63, 97)	**12** 3 (11, 12)
Qualitative Research	**20** 20 (76.5, 103)	**20** 269 (1065, 1123.5)	**20** 7 (17, 18)	**19** 4 (27, 29)	**19** 2 (7, 7)
Other	**44** 33 (207, 376)	**44** 207.5 (3406, 8117)	**44** 8 (29, 43)	**44** 7 (77, 105)	**43** 3 (17, 35)
Highest qualification					
PhD	**386** 58 (249, 376)	**388** 849 (6248, 10839)	**393** 15 (39, 51)	**385** 19 (94, 134)	**380** 5 (18, 25)
MD	**33** 182 (371, 664)	**33** 4598 (14640, 17239)	**33** 34 (62, 67)	**33** 73 (196, 216)	**32** 10.5 (45, 66)
MPhil	**8** 16.5 (122, 122)	**8** 331 (4124, 4124)	**8** 9 (25, 25)	**8** 9 (43, 43)	**8** 1 (11, 11)
MSc	**66** 13 (111, 212)	**66** 127.5 (3507, 4432)	**70** 4 (26, 29)	**68** 4 (46, 74)	**65** 2 (9, 11)
MPH	**8** 11 (165, 165)	**8** 41.5 (4440, 4440)	**8** 3 (37, 37)	**8** 1.5 (67, 67)	**8** 3 (11, 11)
BSc	**9** 16 (301, 301)	**9** 224 (8573, 8573)	**10** 4.5 (45, 50)	**9** 3 (129, 129)	**7** 2 (20, 20)
Other	**22** 30 (342, 466)	**22** 324.5 (6285, 12670)	**22** 9.5 (43, 58)	**22** 10 (125, 143)	**22** 4 (10, 13)
Published papers from highest qualification					
Yes	**437** 54 (273, 376)	**440** 757 (7252.5, 12369.5)	**445** 14 (45, 55)	**438** 17 (103, 146)	**430** 5 (18, 28)
No	**95** 25 (232, 310)	**94** 429 (5116, 8117)	**99** 9 (35, 47)	**95** 9 (79, 124)	**92** 4 (15, 20)
Clinical professional					
Doctor	**97** 124 (418, 489)	**98** 2157 (13314, 16048)	**97** 21 (57, 66)	**97** 35 (185, 212)	**95** 9 (35, 40)
Nurse/Midwife	**46** 65 (145, 166)	**46** 764.5 (2065, 2173)	**47** 14 (23, 24)	**46** 19.5 (42, 53)	**45** 5 (14, 14)
Other allied profession	**130** 43 (209.5, 275)	**130** 439 (4369.5, 7914)	**132** 10 (33, 49)	**130** 11 (72, 122)	**128** 5 (15, 21)
None of the above	**259** 33 (233, 310)	**260** 572.5 (6292, 10478.5)	**268** 11 (39, 50)	**260** 11 (92.5, 128)	**254** 3.5 (15, 20)
Country					
UK	**371** 43 (261, 371	**374** 606.5 (7936, 12670)	**377** 12 (47, 55)	**370** 13 (114, 169)	**362** 4 (15, 20)
Other	**161** 65 (249, 329)	**160** 753 (4584, 7435)	**167** 13 (35, 43)	**163** 17 (74, 113)	**160** 5 (24.5, 32.5)
Submitted to the last RAE					
Yes	**162** 127 (375, 473)	**164** 2775 (13314, 17446)	**165** 27 (56, 66)	**161** 50 (174, 198)	**159** 8 (21, 31)
No	**191** 20 (120, 180)	**192** 191.5 (2174, 4124)	**193** 7 (24, 29)	**190** 6 (36, 55)	**186** 2 (12, 20)

Worked part time (< 0.5 FTE)					
Yes	**116** 47.5 (256, 375)	**117** 528 (7936, 10839)	**117** 12 (45, 56)	**116** 13 (103, 174)	**113** 4 (17, 22)
No	**416** 50.5 (265, 366)	**417** 710 (6724, 11684)	**427** 12 (40, 51)	**417** 15 (97, 139)	**409** 5 (18, 28)
Significant time off from academic role					
Yes	**177** 48 (170, 246)	**177** 695 (4554, 7360)	**180** 12 (32, 45.5)	**174** 13 (70, 122)	**171** 4 (12, 21)
No	**355** 52 (320, 416)	**357** 676 (8352, 13658)	**364** 12 (47, 55)	**359** 15 (113, 175)	**351** 5 (20, 28)

Table 3.Quantile regression results for h-index metric

Quantile	Median	90th	95th
Variable **N=542**	**Coefficient (SE)***	**Coefficient (SE)**	**Coefficient (SE)**
Years in academia			
5-9	3.0 (1.00)	4 (2.52)	5.8 (3.44)
10-14	8.3 (0.88)	12 (3.12)	13.6 (3.59)
15-19	16.5 (1.79)	26 (5.50)	34.9 (5.65)
20-24	20.8 (2.77)	34 (6.50)	31.5 (7.80)
25-29	19.4 (4.08)	31.5 (9.29)	38.7 (8.00)
30+	35.9 (6.97)	38 (9.45)	48.5 (18.86)
Research discipline			
Statistics	2.2 (1.34)	-4.5 (3.72)	-4.2 (4.69)
Epidemiology	0.1 (2.10)	-1 (4.46)	-0.5 (8.88)
Trial Methodology	-2.3 (2.78)	-7 (3.78)	-8.8 (4.80)
Health Economics	0.1 (1.50)	-7 (3.35)	-6.9 (5.06)
Health Services Research	-0.5 (1.32)	-5 (3.34)	-1.5 (6.07)
Psychology	-0.1 (1.25)	-6 (2.68)	-6.6 (4.01)
Systematic Reviews	1.8 (1.80)	-7 (9.66)	-4.6 (7.04)
Qualitative Research	-5.5 (2.48)	-12 (3.03)	-10.8 (4.96)
Other	-3.4 (1.47)	-9.5 (2.93)	-9.6 (3.44)
Sex			
Male	3.1 (0.76)	7 (3.03)	13.0 (3.44)
Age	0.1 (0.06)	0.5 (0.23)	0.4 (0.30)
Constant	-2.2 (2.14)	-5 (8.18)	-0.7 (11.62)

Note. Reference categories: 0-4 (Years in academia); Clinical research (Research discipline); Female (Sex)
**Standard error (SE)*

Table 4. Pairwise Spearman's rank correlation coefficients between bibliometrics

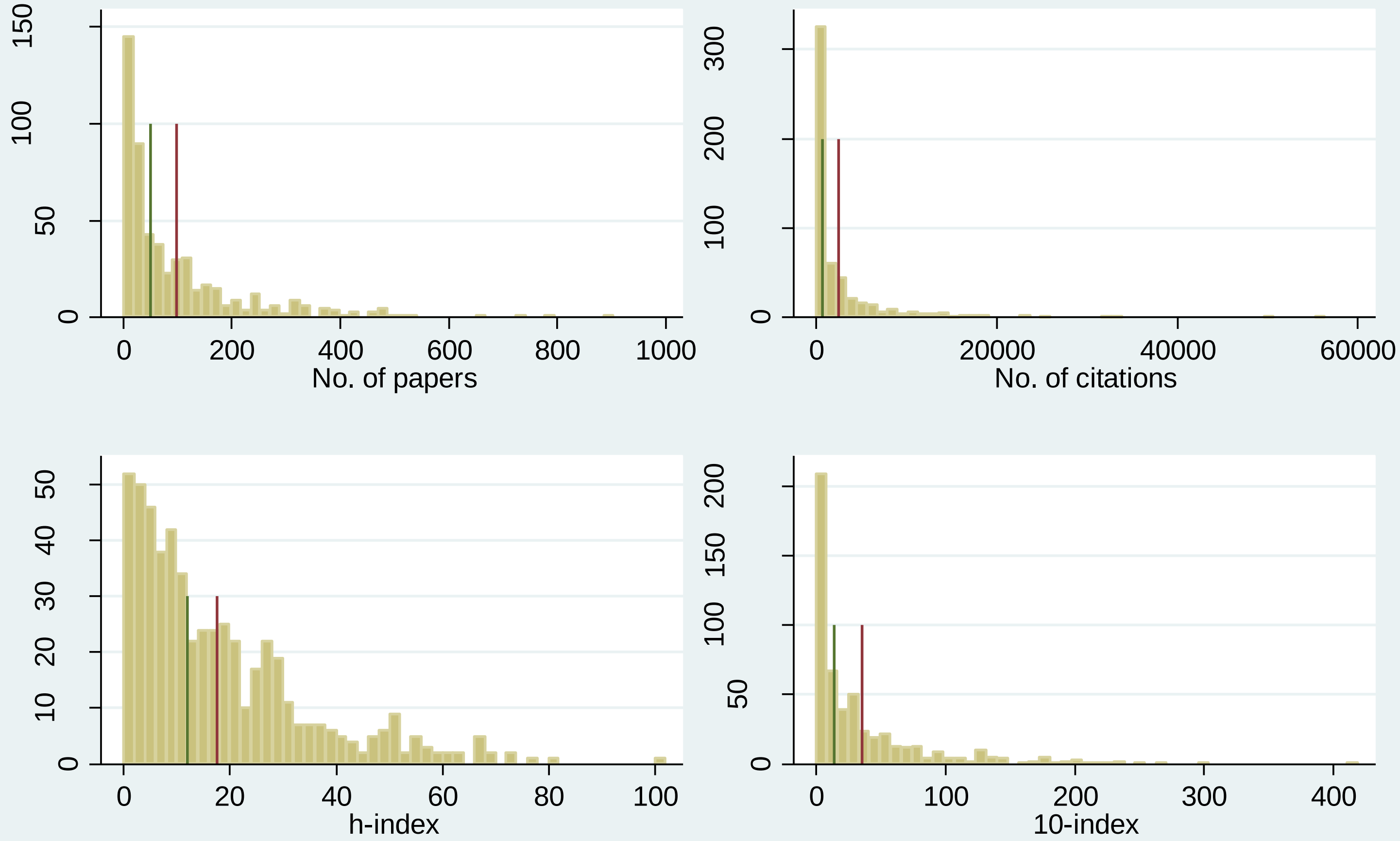
	H-index	Number of papers	Number of citations	10-index
H-index	1.00			
Number of papers	0.93	1.00		
Number of citations	0.98	0.92	1.00	
10-index	0.99	0.94	0.98	1.00

Table 5. Assessing the sensitivity of each measure

	Yes **Mean (SD)**	**No** **Mean (SD)**		
Impact measure	**Submitted to the last RAE**		**Mean difference (MD) (95% CI)**	**Standardised mean difference (MD/SD)**
H-index	31.0 (18.3)	9.8 (10.7)	21.2 (18.1, 24.2)	1.18
Number of papers	177.8 (149.5)	50.5 (91.6)	127.3 (101.7, 152.8)	0.93

Number of citations	5502.5 (7706.0)	877.5 (2099.5)	4625 (3484.9, 5765.0)	0.78
10-index	72.4 (66.5)	15.8 (32.2)	56.6 (45.9, 67.3)	0.97
	Chair		**MD adjusted for age (95% CI)**	
H-index	35.0 (17.4)	11.4 (11.0)	18.0 (15.4, 20.6)	1.08
Number of papers	230.9 (153.6)	49.7 (62.9)	149.5 (129.3, 169.6)	1.20
Number of citations	6331.0 (7199.1)	1094.9 (3273.4)	4053.4 (3065.3, 5041.6)	0.78
10-index	87.0 (67.2)	17.1 (27.0)	53.6 (45.0, 62.2)	1.04

Figure 1: Histograms showing the distribution of bibliometrics



The green vertical line indicates the median and the red indicates the mean of the data.
In each case, the distribution is highly positively skewed

Appendix 1: Survey

1. What is the job title for your current position? If you hold more than one position, please select which you would consider your main role.
    a. Chair
    b. Reader
    c. Senior Lecturer
    d. Lecturer
    e. Senior Researcher
    f. Researcher
    g. Other (please specify)…………………………………..
2. Are you male or female?
3. What is your age?
4. What is your highest qualification?
    a. BSc
    b. MSc
    c. MPH
    d. MD
    e. MPhil
    f. PhD
    g. Other (please specify)…………………………………..
5. Did you publish work from this qualification?
    a. Yes
    b. No
6. If yes, how many papers?
7. How many years have you worked in an academic role?
    a. 0-4
    b. 5-9
    c. 10-14
    d. 15-19
    e. 20-24
    f. 25-29
    g. 30+
8. Have you worked less than 0.5 FTE for a portion of the time you have been employed in an academic role?
    a. Yes
    b. No
9. If yes, what is the total amount in years this time amounts to?
10. Have you had any significant periods of time away from your academic role? (For example, through illness, maternity leave, secondment, etc)
    a. Yes
    b. No
11. If yes, what is the total this time amounts to?
    a. < 1 year
    b. 1-2 years
    c. 2-3 years
    d. > 3 years
12. Are you a

    a. Doctor
    b. Nurse/Midwife
    c. Other profession allied to medicine
    d. None of the above?
13. Please select your current PRIMARY research discipline
    a. Clinical Research
    b. Health Services Research
    c. Statistics
    d. Health Economics
    e. Epidemiology
    f. Trial Methodology
    g. Systematic Reviews
    h. Qualitative Research
    i. Psychology
    j. Other (please specify)…………………………………..
14. Which country are you currently based in?
    a. UK
    b. Other (please specify)…………………………………..
15. Were you submitted to the last RAE (Research Assessment Exercise – for UK based academics only)?
    a. Yes
    b. No
    c. Don't know
    d. Not applicable
16. How many peer-reviewed papers authored by you would you count on your CV? If you do not have any peer-reviewed papers, please enter 0 and go to Question 25.

> For the remaining questions, please use Google Scholar to obtain the figures. All the information we ask for can be quickly and easily found in My Citations in Google Scholar at www.scholar.google.co.uk.
>
> If you have published under a different surname, or a group authorship name, you will need to search under all these names and include these publications in your Google Scholar profile.
>
> You may spot some publications that are not yours. If you do, select all the papers you have not authored and select 'Delete' from the drop-down Action s menu at the top of the list of publications.
>
> The information is now simple to obtain from the table produced.

17. How many papers/abstracts etc authored by you does Google Scholar produce?
18. According to Google Scholar, what is the total number of citations your papers have had?
19. According to Google Scholar, how many citations have you had in the last 5 years (since 2008)?
20. According to Google Scholar, what is your total h-index?

21. According to Google Scholar, what is your h-index from the last five years (since 2008)?
22. According to Google Scholar, what is your total 10-index (i.e how many of your papers have been cited at least 10 times)?
23. According to Google Scholar, what is your 10-index from the last 5 years (since 2008)?
24. How many peer-reviewed papers did you first have published, in paper or online, in 2012?
25. If you would like to receive the results of this study, please supply your email address here. Thank you for your time and cooperation!

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