



Advancing bibliometric assessment of research productivity: an analysis of US Departments of Family Medicine

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ABSTRACT

INTRODUCTION: Measurement of family medicine research productivity has lacked the replicable methodology needed to document progress.

AIM: In this study, we compared three methods: (1) faculty-to-publications; (2) publications-to-faculty; and (3) department-reported publications.

METHODS: In this cross-sectional analysis, publications in peer-reviewed, indexed journals for faculty in 13 US family medicine departments in 2015 were assessed. In the faculty-to-publications method, department websites to identify faculty and Web of Science to identify publications were used. For the publications-to-faculty method, PubMed's author affiliation field were used to identify publications, which were linked to faculty members. In the department-reported method, chairs provided lists of faculty and their publications. For each method, descriptive statistics to compare faculty and publication counts were calculated.

RESULTS: Overall, 750 faculty members with 1052 unique publications, using all three methods combined as the reference standard, were identified. The department-reported method revealed 878 publications (84%), compared to 616 (59%) for the faculty-to-publications method and 412 (39%) for the publication-to-faculty method. Across all departments, 32% of faculty had any publications, and the mean number of publications per faculty was 1.4 (mean of 4.4 per faculty among those who had published). Assistant Professors, Associate Professors, Professors and Chairs accounted for 92% of all publications.

DISCUSSION: Online searches capture a fraction of publications, but also capture publications missed through self-report. The ideal methodology includes all three. Tracking publications is important for quantifying the return on our discipline's research investment.

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‘When you cannot measure it, when you cannot express it in numbers, your knowledge is of a meagre and unsatisfactory kind: it may be

the beginning of knowledge, but you have scarcely...advanced to the stage of science’
... Sir William Thomson¹

WHAT GAP THIS FILLS

What is already known: Using Web of Science, researchers found that US Departments of Family Medicine faculty published 3022 times in 2015.

What this study adds: It is unknown how a method that uses Web of Science compares to approaches that use PubMed or asking faculty to report their own publications. This comparison allows the area of family medicine to understand the accuracy of each approach.

Introduction

The lifeblood, legitimacy and future of a scientific discipline depends on continual growth of its unique features and body of knowledge through research.^{2,3} Family physicians (a synonym we use in this paper for ‘general practitioners’) and other primary care providers depend on a vibrant research enterprise to find answers to the questions relevant to the unique set of health services provided to most patients, most of the time, in all stages of wellness and illness.⁴

There is an expansive literature that captures research productivity across topics, countries and disciplines.^{5–11} Used in hiring, annual reviews, promotion and grants, publications are widely recognised as units of productivity. Given the differential impact of publications, researchers sometimes also incorporate into their curriculum vitae citations and the impact factors of journals where the works are published.^{12,13}

Measurement of publication productivity in family medicine has been reported only sporadically, using different methods and with different purposes in mind. Twenty-five years ago, a review of United States (US) primary care research conducted by family medicine investigators revealed that the majority of studies had been completed without external funding.¹⁴ Using PubMed and hardcopy searches, Pathman *et al.* identified family medicine authors of research articles published in a wide range of journals and concluded that productivity is growing and higher than previously recognised.¹⁵ Instead of capturing output, Merenstein *et al.* compared design quality for research papers that had at least one family

medicine author and were published in one of 20 journals in 2000 and in 2005. They found that research quality had not improved during this time.¹⁶ Like Pathman *et al.*, Post *et al.* used PubMed to assess the productivity of Society of Teachers of Family Medicine (STFM) members and found that a higher percentage of members published in 2009 than in 1999.¹⁷ In a 2015 study using Web of Science, another group updated these figures and concluded that US family medicine faculty published 3002 times that year.¹⁸ These studies demonstrate the heterogeneity of data sources, authors, journals and publication types of past reports, highlighting the need for a consistent methodology and population of study to provide a longitudinally coherent account of publication productivity in family medicine.

Family medicine in the US has dedicated significant resources towards building its research enterprise. Family Medicine for America’s Health was launched to explore the future and enhance the visibility of the discipline in six core areas, including research.¹⁹ The Association of Departments of Family Medicine and North American Primary Care Research Group have collaborated to create the Building Research Capacity initiative to support research development in the discipline.²⁰ Starfield Summits have used research to inform policy-makers and seeded investigators with new ideas, methods and collaborators.^{21,22} In some cases, external agencies have also enabled efforts to enhance scholarship; for example, the family medicine milestones created by the Accreditation Council for Graduate Medical Education established expectations for faculty research productivity.^{23,24}

In this study, we aimed to compare three methods of capturing productivity in an attempt to identify the advantages and disadvantages of these methods alone or for all possible combinations. This work provides the empirical assessment needed to develop a meaningful and practical methodology for measuring research productivity that could be replicated periodically across all US family medicine departments in academic medical schools in a longitudinal manner, and is likely to be transferable to other countries, allowing for international comparisons.

Methods

In this cross-sectional analysis, we compared three methods for capturing the research publication productivity of US departments of family medicine: faculty-to-publications, publications-to-faculty, and department-reported publications. We included 13 family medicine departments with active research programmes (Table 1) for this developmental study. The results of this work informed a broader effort to capture the publications across all US family medicine departments.¹⁸ Ten of these department chairs were members of the Research Development Committee of the Association of Departments of Family Medicine. This Committee comprises 12 members who develop and implement strategic goals and programmes designed to strengthen the research and scholarship capacity of US Departments of Family Medicine. Three additional chairs were recruited to enhance geographic and departmental structure diversity, particularly to include departments with divisions representing other disciplines in addition to family medicine. In 2015, there were 134 family medicine departments in US medical schools, a majority of which were members of the Association of Departments of Family Medicine in 2015.

Faculty-to-publications overview and data sources

We first used department websites to identify faculty (as of December 2016) and their research publications using Web of Science, a subscription-based bibliometric database that contains journals covering a wide range of disciplines (including medicine, social sciences and humanities).

Publications-to-faculty overview and data sources

Using the author affiliation field in PubMed, we identified publications linked to family medicine departments and then connected these products to commensurate faculty members. In this field, we searched for the institution's name, the name of the department as listed on the department's website and 'Department of Family Medicine'. PubMed is a free database that includes biomedical and health-related life science journals. Because of its more

Table 1. Participating Department characteristics

Department by US Region	n (%)
Northeast	1 (7.7)
Midwest	6 (46.2)
South	5 (38.5)
West	1 (7.7)
Department Divisional Structure	
Departments with Disciplinary Divisions*	3 (23.1)
No Disciplinary Divisions	10 (76.9)
Faculty Per Department	
>76–100	3 (23.1)
51–75	3 (23.1)
<51	7 (53.9)
NIH Award Amount (\$ million) Over 5 Years**	
5–11	4 (30.8)
1–4.999	1 (7.7)
<1	8 (61.5)

* Divisions included family medicine, epidemiology, physician assistants, occupational medicine, community medicine, etc.

** Total National Institutes of Health (NIH) direct award amounts over 5 years per department (2012–17). Source: NIH RePORTER (Research Portfolio Online Reporting Tools).

limited scope, it also indexes fewer journals than Web of Science.²⁵

Because this list of publications includes individuals affiliated with each department but not in the core faculty (eg residents, visiting professors), we included only articles from employed faculty listed on the department website or the department-provided list (see below).

Department-reported publications overview and data sources

In this method, we asked the 13 department chairs to provide a list of their employed faculty (including faculty who did not publish) and their publications.

Variables

Through a consensus-driven, iterative process, we collaborated with the Research Development Committee to identify faculty, divisions and publications to include in this analysis. We defined core academic faculty as faculty who have primary

Table 2. Academic appointment inclusion and exclusion criteria

Variable	Inclusion list	Exclusion list
Academic appointment	Assistant Professor, Clinical Assistant Professor, Research Assistant Professor or equivalent rank. Associate Professor, Clinical Associate Professor, Research Associate Professor or equivalent rank. Professor, Clinical Professor, Research Professor or equivalent rank. Chairs, Vice Chairs or equivalent rank.	Adjunct faculty Clinician educator Instructor Visiting Professor Other titles that reflect exclusively clinical responsibilities, part-time status or affiliated faculty.

Note: These titles refer to US faculty appointments and may have different meanings in non-US settings.

employment in the department (excluding faculty contracted with the department, visiting faculty, etc), have primary academic appointment with the department as of 1 January 2015 and whose academic appointment was included in the approved list (Table 2). If a faculty member had conflicting titles (one in the inclusion list and one in the exclusion list), we included the individual in the analysis. We incorporated all divisions within the departments, which included family medicine, community health, occupational medicine, physician assistant, public health and epidemiology. In the US, a subset of family medicine departments consists of multiple divisions. These divisions can emerge organically due to a critical mass of faculty expertise or result from the merger of departments as devised by institutional leadership. Understanding the contribution of these divisions to productivity informs the interpretation of data describing the output of family medicine scholars. In addition, many US family medicine departments employ investigators from disciplines such as psychology, epidemiology, anthropology and biostatistics on their faculty, and are not organised into distinct disciplinary divisions. To be included, publications had to be published in a peer-reviewed, indexed journal. We defined peer-reviewed as an editorial process where manuscripts were reviewed by reviewers, editorial referees or editors, and the journal had to be retrievable through a bibliometric index. We included original research (both primary and secondary data analyses) and narrative publications. We included articles with publication dates between 1 January 2015 and 31 December 2015.

Data analysis

We calculated counts and proportions of the number of faculty members and the number of

unique publications by department and by faculty academic rank titles identified through department-reported publications, faculty-to-publications, publications-to-faculty processes separately; department-reported publications and faculty-to-publications combined; department-reported publications and publications-to-faculty combined; faculty-to-publications and publications-to-faculty combined; and all three processes combined. We repeated these processes for the three departments with divisions, merging family medicine, physician assistant and occupation health divisions. We reported these measures individually for the community health, public health and epidemiology divisions.

The American Academy of Family Physicians Institutional Review Board approved this protocol.

Results

We identified 750 faculty members, a mean of 58 per department (Table 3). Eighty-seven percent were found on websites, whereas 89% were reported by the department. The percentage of faculty identified on websites varied across departments, ranging from 53.6% to 98.3%.

We identified 1052 unique publications by combining the three processes to identify publications. Departments reported 878 publications in 2015, while the faculty-to-publications process identified 616 and the publications-to-faculty process identified 412 (Table 4). The percentage of total publications identified through the faculty-to-publications process ranged from 27% to 89% per department, whereas these figures were 9% to 100% for the publications-to-faculty process.

Table 3. Counts and proportions of Department Faculty identified by method or a combination of methods

Department Code	Faculty total on department Website	% of Total	Faculty total reported by department	% of Total	Total faculty identified by both the department website and reported by the department	% of Total	Total faculty only identified on the department website	% of Total	Total faculty only identified through department report	% of Total	Total unique names either listed on the department website or reported by the department
A	21	72.4	20	69.0	12	41.4	9	31.0	8	27.6	29
B	58	98.3	55	93.2	54	91.5	4	6.8	1	1.7	59
C	50	94.3	49	92.5	46	86.8	4	7.5	3	5.7	53
D	15	53.6	28	100.0	15	53.6	0	0.0	13	46.4	28
E	113	90.4	92	73.6	80	64.0	33	26.4	12	9.6	125
F	68	81.0	75	89.3	59	70.2	9	10.7	16	19.0	84
G	23	82.1	26	92.9	21	75.0	2	7.1	5	17.9	28
H	12	46.2	23	88.5	9	34.6	3	11.5	14	53.8	26
I	57	87.7	64	98.5	56	86.2	1	1.5	8	12.3	65
J	29	90.6	25	78.1	22	68.8	7	21.9	3	9.4	32
K	19	82.6	23	100.0	19	82.6	0	0.0	4	17.4	23
L	167	94.9	166	94.3	157	89.2	10	5.6	9	5.1	176
M	20	90.9	21	95.5	19	86.4	1	4.5	2	9.1	22
Total	652	86.9	667	88.9	569	75.9	83	11.1	98	13.0	750
Mean	50		51		44		6		8		58

Table 4. Publication counts and proportions by individual methods and combinations of methods

Department Code	Department reported publications (DRP)	% of Total	Faculty-to-publications (FTP)	% of Total	Publications-to-faculty (PTF)	% of Total	DRP + FTP	% of Total	DRP + PTF	% of Total	PTF + FTP	% of Total	Total (DRP + FTP + PTF) (reference standard)
Department													
A	42	93.3	12	26.7	4	8.9	44	97.8	44	97.8	14	31.1	45
B	81	63.3	96	75.0	48	37.5	123	96.1	107	83.6	106	82.8	128
C	41	62.1	54	81.8	30	45.5	66	100.0	48	72.7	57	86.4	66
D	17	77.3	12	54.5	10	45.5	20	90.9	20	90.9	16	72.7	22
E	59	92.2	31	48.4	13	20.3	62	96.9	62	96.9	37	57.8	64
F	83	80.6	48	46.6	53	51.5	95	92.2	93	90.3	78	75.7	103
G	98	86.7	66	58.4	53	46.9	113	100.0	100	88.5	83	73.5	113
H	33	97.1	17	50.0	14	41.2	33	97.1	34	100.0	21	61.8	34
I	198	97.1	135	66.2	63	30.9	198	97.1	204	100.0	151	74.0	204
J	17	70.8	18	75.0	8	33.3	23	95.8	19	79.2	19	79.2	24
K	67	66.3	53	52.5	52	51.5	89	88.1	93	92.1	79	78.2	101
L	134	96.4	66	47.5	55	39.6	137	98.6	137	98.6	79	56.8	139
M	8	88.9	8	88.9	9	100.0	8	88.9	9	100.0	9	100.0	9
Total	878	83.5	616	58.6	412	39.2	1011	96.1	970	92.2	749	71.2	1052
Mean per department	68		47		32		78		75		58		81

Across all departments and combining the three methods, we found that 32.0% of faculty had any publications in 2015 and that the mean number of publications per faculty was 1.4 (Table 5). Including only faculty who published, the mean number of publications was 4.4. The percentage of faculty publishing in 2015 ranged from 16.0% to 82.6%. Two departments averaged over four publications per faculty member. Over 90% of Chairs published in 2015, whereas this figure was 66% for Professors. Assistant Professors (often called 'senior lecturers' in other countries), Associate Professors, Professors and Chairs accounted for 92% of all publications. Among the three departments with divisions, faculty in the family medicine divisions accounted for one-third of all publications and averaged nearly two publications per faculty.

Discussion

This project represents a major step forward in bibliometric measurement of family medicine research productivity. Through this effort, we have brought together expert informants from multiple, leading family medicine departments, the support of a major scholarly organisation, and explored traditional and novel methods for tracking family medicine research productivity. This study advances medical bibliographic research by comparing multiple bibliometric research methods for estimating proportional capture (relative to total publication denominator) identified by the three methods of department-reported publications (84%), faculty-to-publications (59%) and publications-to-faculty (40%). Optimal measurement may require combining all three methods. However, making the assumption that the systematic error leading to missed publications using PubMed (the publications-to-faculty method) is relatively consistent over time, a trend could be established over the 50 years since family medicine became a recognised medical speciality in the US. The more recent development of department websites and Web of Science would not allow the faculty-to-publications method to be useful retrospectively, but may provide an alternative method for prospective monitoring of publications.

Faculty generated a mean of 1.4 publications (4.4 for faculty who have published) and 32% of faculty had at least one publication in 2015. These

Table 5. Publications, by Faculty title, Department and Division

Department Code	Total faculty	% of Total	No. with any publications	% of Total	% within row	Total Publications	% of Total	Total Publications/ Total Faculty
Department								
A	29	3.9	16	6.7	55.2	45	4.3	1.55
B	59	7.9	29	12.1	49.2	128	12.2	2.17
C	53	7.1	14	5.9	26.4	66	6.3	1.25
D	28	3.7	6	2.5	21.4	22	2.1	0.79
E	125	16.6	20	8.4	16.0	64	6.1	0.51
F	84	11.2	18	7.5	21.4	103	9.8	1.23
G	28	3.7	12	5.0	42.9	113	10.7	4.04
H	26	3.5	13	5.4	50.0	34	3.2	1.31
I	65	8.7	35	14.6	53.8	204	19.4	3.14
J	32	4.3%	10	4.2%	31.3%	24	2.3	0.75
K	23	3.1	19	7.9	82.6	101	9.6	4.39
L	176	23.5	42	17.6	23.7	139	13.2	0.79
M	22	2.9	5	2.1%	22.7	9	0.9	0.41
Total	750		239		31.8	1052		1.40
Mean	57.8		18.4					
Faculty Title								
Assistant Professor	227	30.0	70	29.2	30.8	240	22.8	1.06
Associate Professor	138	18.4	66	27.5	47.8	301	28.6	2.18
Professor	96	12.8	63	26.3	65.6	359	34.1	3.74
Chair	13	1.7	12	5.0	92.3	65	6.2	5.00
Clinical Assistant Professor	209	27.9	15	6.3	7.2	41	3.9	0.20
Clinical Associate Professor	30	4.0	3	1.3	10.0	11	1.0	0.37
Clinical Professor	13	1.7	7	2.9	53.8	23	2.2	1.77
Assistant Clinical Professor	18	2.4	1	0.4	5.6	4	0.4	0.22
Associate Clinical Professor	6	0.8	3	1.3	50.0	8	0.8	1.33
Total	750		240		32.0	1052		1.40
Mean	83.3		26.7					
Division*								
Family Medicine	72	49.0	32	39.5	44.4	142	32.9	1.97
Physician Assistants	26	17.7	14	17.3	53.8	24	5.6	0.92
Occupational Medicine	15	10.2	10	12.3	66.7	61	14.2	4.07
Epidemiology	8	5.4	8	9.9	100.0	61	14.2	7.63
Community Health	6	4.1	3	3.7	50.0	10	2.3	1.67
Public Health	20	13.6	14	17.3	70.0	133	30.9	6.65
Total	147		81		55.1	431		2.93
Mean	24.5		13.5					

*These only include the three departments that consist of divisions. In the US, a subset of Family Medicine Departments consists of multiple divisions.

figures are higher than those reported in the article by Post *et al.*, who found that 21% of STFM members had published in 2009, with a mean of 2.2 publications for members who published, although faculty with qualified academic titles may be over-represented because the STFM focuses on teaching more than research.¹⁷

The combination of all three methods led to the most comprehensive view of publication productivity, underscoring the errors inherent in each individual method. For instance, departments missed faculty and publications when submitting the departmental reports. Because publications are tracked for promotion and tenure, this method is dependent on the conscientiousness of the department or individual recording an individual's publications in a given year, and several of these faculty members had more than 20 publications. The faculty-to-publications method is limited by the accuracy of websites, which do not have standardized practices for titles to display, faculty to include and intervals for updating. Once identified, we found that using names to query bibliometric databases was also fraught with imprecision, as website and publication names differed due to the use of nicknames and middle names and the modification of names over time. The faculty-to-publications method was further limited by the universe of journals included in Web of Science, encompassing articles in journals found in PubMed through the publications-to-faculty process and missing articles reported by departments but in journals not indexed in Web of Science. Finally, the publications-to-faculty process was dependent on the accuracy and completeness of the author affiliation field in PubMed. The publications-to-faculty process missed articles where this field was blank, included the institution name only (e.g. the University of Virginia) rather than the institution and department names (e.g. the Department of Family Medicine, University of Virginia) or included a different institutional affiliation (e.g. a cancer centre within the institution or an affiliated hospital). This method also captured authors affiliated with the department but not core faculty, such as family medicine residents. Publishing articles online before print articles also explained discrepancies across the methods, with PubMed capturing both electronic publishing and print dates while Web of Science includes only print dates. Therefore, a

publication electronically published in 2015 but printed in 2016 was captured by PubMed but not Web of Science.

Using a robust method to track productivity over time is critical to academic family medicine's future, and we have established a set of methods that can be used in isolation or combination to yield an approximation of family medicine research productivity. Our discipline should invest resources in improving our research enterprise and assessing the impact by repeating this process across all departments at predictable intervals. Without such data, the discipline generally, and departments specifically, will be unable to track performance against benchmarks, calculate returns on investments in research, and identify positive outliers with effective strategies for success.

One incremental step towards realising this goal would be to create and maintain a database of family medicine faculty members, each with a unique identifier. Because similar unique identifiers exist, they have their own shortcomings; for example, ORCID uniquely identifies researchers, but adoption is not comprehensive for family medicine.²⁶ In contrast, the Association of American Medical Colleges' Faculty Roster is more comprehensive but not publicly available.²⁷ Combining the faculty-to-publications or publications-to-faculty methods with department reporting is associated with marginal benefits and costs. As we have demonstrated, the inclusion of departmental data will increase the number of publications identified, yet the inclusion of departmental input naturally requires additional resources. Furthermore, the degree to which departments participate may be variable across departments and over time, introducing additional error.

Similar to other bibliometric approaches to measuring research productivity and performance at the department level, several limitations need to be kept in mind. The most frequent criticism of bibliometric analysis is its inability to measure quality accurately. Readers should have reservations about using bibliometrics to rate an individual researcher's intellectual performance, and whether such quantitative analyses appropriately account for qualitative evaluations. In this analysis, each publication is weighed equally, although publications

differ with respect to methodological rigour, journal quality and citations. Our methods do not allow us to measure the ability of the research to improve health or change policy. Second, our department sample was purposefully limited to 13 departments, most of whose Chairs were members of the standing research development committee of a national organisation. Our findings with respect to publication count are not likely to be representative of all family medicine departments. Similarly, the performance of the methods may be different when applied to all departments. Third, we limited our analysis to a specific subset of publications and faculty. As we were interested in the productivity of core faculty, we did not include instructors, adjunct professors and residents, although these faculty members contribute to scholarship within departments. Nor did we include community-based residency programmes where core faculty are not employed by academic departments. Furthermore, we restricted this analysis to research publications and excluded books, curricula and other scholarly works. Finally, because we captured faculty names from websites in December 2016, the website roster may not be an accurate representation of faculty present in 2015.

Conclusions

In summary, nearly 60% of total publications were identified through a method that uses websites and Web of Science alone, whereas only 40% were identified using PubMed alone. Combining these two methods identified 71% of all publications for this study. One of every three faculty in our sample had published one paper in 2015, which is higher than previous estimates, although the sample and methodology make direct comparisons difficult. In addition to future efforts to measure the quality of publications and impact, assess the products of scholarship more broadly defined among all family medicine organisations and compare these results across countries, these findings should be tracked at predictable intervals to determine the return on our discipline's investment in research and identify strategies for enhancement.

Competing interests

The authors declare that they have no competing interests.

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