

Bibliometrics: a Key Performance Indicator in Assessing the Influence of Biomedical Research

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Abstract

Bibliometrics, a quantitative evaluation of publication and citation data, is one type of indicator of productivity, influence, collaboration, and reach of scientific programs. Using research publications from programs funded by the National Institutes of Health (NIH) Common Fund, this presentation will focus on 1) the feasibility and utility of bibliometrics as a performance indicator for research programs, and 2) how bibliometrics integrate with other methods used to evaluate biomedical research programs. Challenges and lessons learned using bibliometrics as a performance indicator for NIH Common Fund programs will be discussed. Selected results including bibliometric data generated by Web of Science and a new measure – Relative Citation Ratio (RCR) – will be explored. The implications of these results related to science productivity and influence will also be discussed. Evaluators who assess research and technology programs will benefit from the experiences of the NIH Common Fund using bibliometrics as one of several program assessment tools.

Introduction

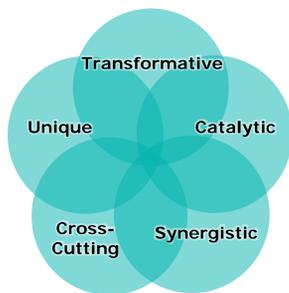
The National Institutes of Health (NIH)

The NIH is a Federal Agency within the Department of Health and Human Services, and the premier funder of biomedical research in the United States. The agency is subdivided into 27 Institutes and Centers, each with a unique mission to advance an area of biomedical research and human health.



The NIH Common Fund

The Office of Strategic Coordination manages the NIH Common Fund, a fund for the NIH Director to strategically invest in science that is potentially risky, but likely to have exceptional trans-NIH payoff if successful. Common Fund programs are short-term (5-10 years) and goal-driven, with deliverables intended to catalyze research across multiple biomedical disciplines. All Common Fund programs are required to meet the following five criteria: transformative, synergistic, catalytic, cross-cutting, and unique.



- Transformative:** Exceptionally high & broadly applicable impact
- Catalytic:** Achieve a set of high impact goals within a defined period of time
- Synergistic:** Value-added to the NIH Institutes and Centers
- Cross-Cutting:** Address complex issues requiring management by trans-NIH teams
- Unique:** Provide new solutions to specific challenges

Bibliometrics as a Performance Measure for NIH Common Fund Programs

Bibliometrics is a statistical assessment of the influence of written publications based on patterns and counts of citations.

Bibliometrics is used in the evaluation of scientific research based on the following assumptions:

- Publications of scientific findings are a key output of scientific research that reflect:
 - Productivity
 - Influence
 - Collaboration
 - Reach of scientific programs
- The more citations a publication receives, the more influence the publication likely has in its field



Bibliometrics is one of a suite of evaluation methods used to monitor and evaluate the performance of the research programs receiving Common Fund support.

Common Bibliometric Approaches

Some bibliometric measures apply to an individual researcher (e.g. h-index) or to a single scientific journal (e.g. impact factor). Other bibliometric measures can be scaled to assess the influence of a single publication or whole a portfolio of publications (e.g. Relative Citation Ratio).

Information Provided by Bibliometrics

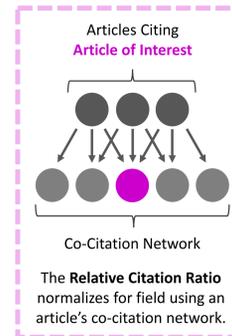


- Descriptive statistics** (counts, citations, etc.) of a research output (publications) that can be tracked over time
- A **quantitative measure of the influence** of research via citation frequency of publications
- Descriptions of citation patterns** that may provide insight into a field of research or the progress of a research program

Bibliometrics of NIH Common Fund-Supported Publications

Common Fund Bibliometric Measure Needs

- Scalable measures:** to look at the influence of a single publication, sub-groups of publications from individual Common Fund programs, or the entire portfolio of Common Fund-supported publications.
- Normalized measures:** the Common Fund supports programs in a variety of scientific disciplines. Each discipline has its own publication and citation practices, so scalable bibliometric approaches are needed that normalize their outputs against other publications from the same discipline.



Bibliometric Measures Used by the Common Fund

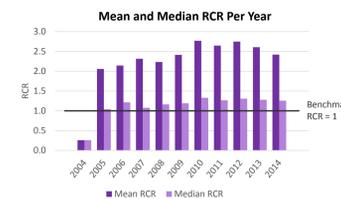
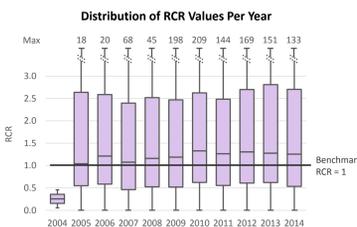
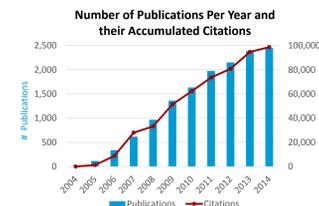
- Citation Percentile Ranking** based on Essential Science IndicatorsSM and Web of ScienceTM formerly of Thomson Reuters
- Relative Citation Ratio** developed by the NIH Office of Portfolio Analysis (Ref. 1)

These approaches provide complementary information on the influence of Common Fund-supported scientific research, and provide analytic rigor by using multiple measurement methods.

Relative Citation Ratio (RCR) of Common Fund-Supported Publications

RCR Summary Statistics

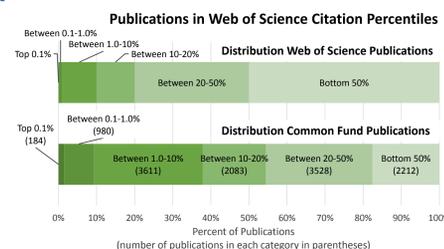
Years covered: 2004-2014
 Publications analyzed: 13,998
 Total Citations: 532,529
 Median RCR: 1.26
 Mean RCR: 2.55



Citation Percentile Ranking of Common Fund-Supported Publications

Citation Percentile Ranking Summary Statistics

Years covered: 2004-2014
 Publications analyzed: 12,598
 Publications in Top 10%: 38%



Bibliometrics Use Example: Health Care Systems (HCS) Research Collaboratory

HCS Collaboratory Goals and Outcomes

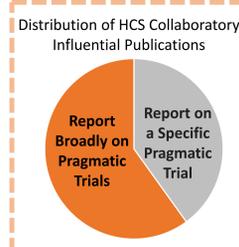
- The goal of the HCS Research Collaboratory program is to strengthen the national capacity to implement cost-effective, large-scale research studies called “pragmatic” clinical trials that engage health care delivery organizations as research partners.
- The primary expected outcome of pragmatic trials is to increase the utility of research results to clinical health practice.
- The program supports a series of pragmatic trial demonstration projects on a variety of pressing public health concerns.

Bibliometric Assessment

We combined a bibliometric assessment of publications from this program (covering 2013-2014) with a qualitative assessment of whether a publication reported on the design, implementation, or outcomes of a specific pragmatic trial demonstration project versus reporting on the conduct of pragmatic trials more broadly. The underlying assumption was that publications reporting broadly on issues related to pragmatic trials more directly support the overall goal of the program to enhance the capacity to conduct such trials.

Findings

- Six of the ten most influential HCS Collaboratory publications (as measured by RCR) reported broadly on the conduct of pragmatic trials.
- These publications support the program goal and show that the lessons learned by the program are being picked up by the research community.



Feasibility of Bibliometrics

Bibliometric approaches can provide useful information about the influence of research publications. However, the utility of the information should be judged against its limitations and the resources needed to carry out reliable and valid analyses.

Bibliometrics Requires Resources

Bibliometric Analyses Are Time and Labor Intensive

- Identifying and validating publications for analysis is an iterative process
- Expert input may be needed to determine whether the publications included in the analysis are relevant

Bibliometric Analyses Require Skilled Staff

- Staff skilled in data wrangling are needed to retrieve and analyze bibliometric data
- Staff with field-specific expertise are needed to interpret the results



Bibliometric Analyses May Require Financial Investment

- Not all bibliometric data sources are free
- Example: during our analyses, publication and citation data indexed by Web of Science over the past 10 years were free, but any historical search going back more than 10 years required paid data access

Limitations of Bibliometrics

- Bibliometrics only describes one type of output from a research program
- Bibliometrics uses only citation frequency to evaluate impact of research publications
- Citation does not always equal endorsement of scientific findings
- Bibliometrics is a lagging indicator as publications take time to accumulate citations
- Citation data depend on journal and publication indexing
- Linking publications to funding sources depends on accurate acknowledgement
- Each scientific discipline has its own publication and citation practices
- Assigning publications to a field can be difficult or even controversial
- Bibliometrics should always be used in conjunction with other evaluative measures!**



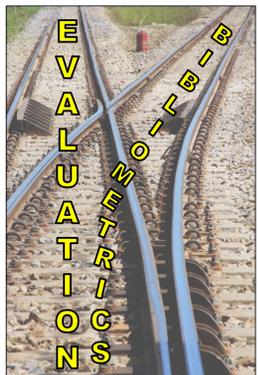
Integrating Bibliometrics with Other Evaluative Methods

- Bibliometrics should always be used in conjunction with other evaluative measures when judging the merit, worth, or significance of a scientific research program.
- Use of multiple evaluative methods is consistent with the Leiden Manifesto for research metrics (Ref. 2), which posits that a variety of indicators should be used in the evaluation of scientific research. Not only does this provide a more holistic assessment of the research, it also deters goal displacement.

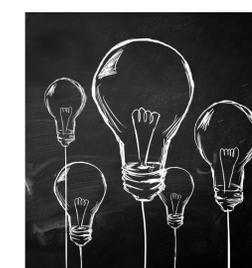
Evaluative Methods Used by the Common Fund

We use a variety of evaluative methods in program planning, management, & assessment

- Input from science experts & stakeholders via:
 - Interviews/focus groups
 - Meetings/workshops
 - Published Requests for Information
 - Informal discussions
- Portfolio analysis
- Landscape analysis
- Metrics of community uptake of research products
- Literature review
- Bibliometrics



Lessons Learned



- Bibliometric analyses can provide useful information for the evaluation of biomedical research programs
- Bibliometric analyses are resource intensive, especially with respect to staff time
- Inclusion/exclusion criteria for publications need to be established prior to analysis
- Bibliometric analyses, especially at the publication identification and validation stages, are iterative
- Bibliometric indicators do not mean much in isolation. These should always be used in conjunction with other indicators

References

- Hutchins BI, Yuan X, Anderson JM, Santangelo GM. Relative Citation Ratio (RCR): A New Metric That Uses Citation Rates to Measure Influence at the Article Level. *PLoS Biol* (2016) 14(9): e1002541. doi:10.1371/journal.pbio.1002541
- Hicks D, Wouters P, Waltman L, de Rijcke S, Rafols I. Bibliometrics: The Leiden Manifesto for research metrics. *Nature* (2015) Apr 23; 520(7548): 429-31. doi: 10.1038/520429a.

More information on the NIH Common Fund is available at: commonfund.nih.gov