Associations Between Academic Rank and Advanced Bibliometric Indices Among United States Academic Radiologists

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Rationale and Objectives: This study aimed to evaluate associations between traditional and advanced bibliometric indices with academic rank for radiologists in the United States.

Methods: Faculty web pages were searched to classify 538 members of the Association of University Radiologists as assistant ($n = 212$), associate ($n = 128$), or full ($n = 198$) professors. Radiologists' publication and citation records were extracted from Scopus to compute the following indices: publication count, citation count, h-index, i-10 index, h_c-index, m-quotient, e-index, and g-index. Analysis of variance, multivariable logistic regression, and receiver operating characteristic curve analysis were performed.

Results: All indices were significantly different among the three groups ($P \leq .001$), progressively increasing with increasing rank (eg, mean publication count of 17, 41, and 128 among assistant, associate, and full professors, respectively; mean citation count of 205, 687, and 3622, respectively; mean h-index of 5, 11, and 27, respectively). At multivariable analysis, the h-index (reflecting publications and citations) was a strong significant independent positive predictor of associate ($\beta=+0.32$, $P <.001$) or full professor ($\beta=+0.26$, $P <.001$) status, whereas the m-quotient (adjusted h-index that is greater for more rapid publication) was a strong significant independent negative predictor of associate ($\beta=-1.87$, $P = .009$) or full professor ($\beta =-4.97$, $P <.001$) status. The models exhibited moderate goodness-of-fit ($r^2 = 0.534–0.655$; $P <.001$). The model for predicting at least associate professor achieved area under the curve 0.876 (sensitivity 74.6%, specificity 88.8%). The model for predicting full professor achieved area under the curve 0.925 (sensitivity 85.5%, specificity 86.1%).

Conclusion: When controlling for the h-index, more rapid publication, as indicated by the m-quotient, was negatively associated with radiologists' academic rank, indicating the additional influence of career duration in promotions decisions.

Key Words: Academic radiology; bibliometrics; publication; citation; h-index.

INTRODUCTION

Decisions by academic faculty regarding when to seek promotion, as well as decisions by institutional committees concerning when to award such promotions, are challenging. Faculty's peer-reviewed publication record is widely applied for guiding such processes. However, efforts to objectively assess one's publication record can be difficult as well given a paucity of data indicating the expected publication performance associated with various academic ranks in a given discipline. Such data could be useful for suggesting approximate benchmarks that could be applied as a guide when evaluating this one component of an academic physician's portfolio. A prior investigation of research output among academic radiologists identified both the number of publications as well as the h-index to be significantly predictive of academic rank (1). The h-index, first described by Hirsch in 2005 (2), is intended to improve upon deficiencies of the simple publication count by also reflecting citations to one's publications as a measure of impact. Specifically, the h-index is defined as the maximal number of publications that each has at least h citations (2), such that an investigator with an h-index of 15 has 15 publications with at least 15 citations, in addition to any number of additional publications with 15 or fewer citations. The h-index has similarly been demonstrated as a useful measure of academic performance in other medical disciplines and indeed has become recognized as a metric considered by promotions committees (3–9).

Although the h-index has performed favorably as a measure of academic performance, the h-index also has a number of its own limitations. Of note, it does not reflect a number of aspects of the timing of one's publications, such as the duration over which one produced publications or the recency of such publications (10). Also, the h-index does not reflect the number of publications having fewer citations than the h-index for the given individual, or the number of citations

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occurring beyond the individual's h-index. To address such concerns, an array of advanced bibliometric indices has been introduced more recently, including the i-10 index, h_c-index, m-quotient, e-index, and g-index. These advanced indices have received far less formal investigation than traditional metrics such as the publication count or h-index. However, one study suggested added value of some of these indices for predicting National Institutes of Health funding among radiological investigators (11). It is possible that these advanced indices could also serve as better predictors of academic rank and complement the traditional metrics in providing benchmarks associated with various academic ranks. Thus, the purpose of this study was to evaluate associations among traditional and advanced bibliometric indices with academic rank for radiologists in the United States.

METHODS

Study Sample

This retrospective study was approved by our institutional review board with a waiver of written informed consent. A listing of 597 "full" members (requiring radiology faculty status at an accredited medical school or at an institution with an Accreditation Council for Graduate Medical Education (ACGME)-accredited radiology trainee program (12)) of the Association of University Radiologists (AUR) with an institutional affiliation in the United States, along with members' professional degree, was obtained with permission from the AUR in August 2015. Trainee members and international members were excluded from the provided list. Individuals in the list without an MD degree were excluded from the subsequently described data collection process.

Data Collection

Internet searches were then performed by a single medical student to identify each radiologist's faculty web page to determine academic rank. Academic rank was classified as assistant professor (including instructors), associate professor, or full professor. In addition, a listing of each radiologist's publications and the number of citations to each publication was retrieved from the Scopus database (13). Compared to other bibliometric databases, Scopus employs a unique algorithm to reliably associate individual investigators with their publications based on institution and coauthors, avoiding potential mismatches that may occur because of an investigator's name being listed in a different fashion across publications or multiple investigators having a similar name (14). All indices described in a recent review within the radiology literature of bibliometric indices were included in our analysis (14). Specifically, the following bibliometric indices were computed for each included radiologist using the publication and citation data retrieved from Scopus: publication count, citation count, h-index, i-10 index, h_c-index, m-quotient, e-index, and g-index (Table 1) (14).

Statistical Assessment

The mean and standard deviation for each of the bibliometric indices were computed for academic radiologists, stratified by academic rank. Analysis of variance was used to compare the bibliometric indices among the three academic ranks. Multivariable logistic regression was conducted for all of the bibliometric indices in combination to identify significant independent predictors of academic rank, performed separately for predicting reaching status of associate professor and of full

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TABLE 1. Summary of Bibliometric Indices*

Index	Definition
Direct indices	
Publication count	Total number of publications by investigator
Citation count	Total number of citations to investigator's publications
Composite indices	
h-index	The number of publications by an investigator having at least h citations, while all remaining publications have no more than h citations
i-10 index	The number of publications by an investigator that have been cited at least 10 times
Time-adjusted composite indices	
h_c-index	A "contemporary" version of the h-index in which each publication's citation count is multiplied by four and then divided by the number of years since publication, thereby giving greater weight to more recently published articles
m-quotient	h-index divided by the number of years since an investigator's first publication[†]
Composite indices adjusted for highly cited articles	
e-index	Average number of citations beyond the h-index for those articles included in the h-index; provides a measure of measure of excess citations not considered by the h-index[†]
g-index	Maximal number of publications that have received an average of g citations; accounts for all citations included in both the h-index and the e-index

* Taken from Reference 11.

[†] Has been applied to complement the h-index by providing an index for comparing investigators having the same h-index.