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Counting and comparing publication output with and without equalizing and inflationary bias☆

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ABSTRACT

This paper examines the effects of inflationary and equalizing bias on publication output rankings. Any identifiable amount of bias in authorship accreditation was detrimental to accuracy when ranking a select group of leading Canadian aquaculture researchers. Bias arose when publication scores were calculated without taking into account information about multiple authorship and differential coauthor contributions. The ensuing biased equal credit scores, whether fractional or inflated, produced rankings that were fundamentally different from the ranking of harmonic estimates of actual credit calculated by using all relevant byline information in the source data. In conclusion, the results indicate that both fractional and inflated rankings are misleading, and suggest that accurate accreditation of coauthors is the key to reliable publication performance rankings.

1. Introduction

To count publications is the most basic task in evaluative bibliometrics and scientometrics (De Bellis, 2009). The outcome of any such task, usually a ranking or other comparative assessment, is determined by how the countable units of publication are selected and accredited. Hence, when two rankings based on the same set of publications produce fundamentally different results, at least one must be misleading as a consequence of inaccurate accreditation. Systematic inaccuracies in accreditation arise when authorship credit is not divided among coauthors, i.e. inflationary bias, or when credit is divided equally among coauthors who have not contributed equally, i.e. equalizing bias (Hagen, 2008). Here, the question of interest is: How serious is the effect of these biases?

It is known from several studies comparing inflated and fractional credit that inflationary bias alters publication performance rankings (Aksnes, Schneider, & Gunnarson, 2012; Gauffriau & Larsen, 2005; Gauffriau et al., 2008; Huang & Lin, 2011; Huang, Lin, & Chen, 2011; Piro, Aksnes, & Rørstad, 2013; Pravdic & Oluic-Vukovic, 1991). However, the possibility that both inflated and fractional rankings are misleading cannot be dismissed as long as neither ranking is corrected for equalizing bias.

Less is known about the effect of equalizing bias. One study found that rankings of *h*-index scores were gravely distorted by both biases (Hagen, 2008), and another study estimated that equalizing bias accounted for approximately 60% of the

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variation in a composite empirical dataset (Hagen, 2013). These results suggest that the distortional effect of equalizing bias may be comparable to the effect of inflationary bias. Furthermore, it is important to account for equalizing bias as it may affect a majority of contemporary publications (Waltman, 2012), and because it controverts the purpose of performance ranking by diverting credit from primary authors to secondary authors (Hagen, 2008).

In this study I compare the separate and combined effects of equalizing bias and inflationary bias on the ranking of leading Canadian aquaculture researchers, and show that both biases have a detrimental effect on accuracy. I conclude by discussing the need to move from proxies of authorship credit to more accurate estimates based on all available relevant information in order to construct reliable publication performance rankings.

2. Materials and methods

2.1. Empirical data

The empirical data were independently derived from a ranking of leading Canadian aquaculture researchers (Picard-Aitken & Coté, 2010, table XIX, p. 34). The number of publications for each researcher was matched using the same time frame (1996-2008) and publication types (journal articles, conference papers, notes, and reviews from peer-reviewed journals) to extract data for each researcher from the same commercial database vendor (Scopus). This task was nontrivial as the number of obvious aquaculture publications for each researcher rarely corresponded to their number in table XIX (Picard-Aitken & Coté, 2010), and publications of possible relevance for aquaculture had to be omitted or added in order to obtain a matching number. This approach worked for 35 of the 36 researchers in the original table. But for one researcher who was listed with 19 "aquaculture" publications, I found it impossible to make a meaningful selection of papers among the approximately 70 publications provided by the Scopus database. This researcher had conducted basic research using cell cultures derived from the tissue of aquaculture species, and it is easy to see how a keyword search in a library database could deliver an imprecise result.

The end result was a replicate dataset consisting of 699 authorship contributions from 35 researchers, to 531 research papers from 120 different journals (The replicate dataset is available on request). Only 10 publications were single-authored (1.9% of 531 papers), and I was unable to detect any unequivocal indication of equality among the coauthored contributions (98.6% of 689 contributions from 521 papers). However, 125 contributions came from coauthored papers where senior authorship was indicated by the presence of a corresponding last author.

2.2. Authorship quantification

Rankings were constructed by tallying inflated, fractional and harmonic credit scores for each of the 35 researchers in the replicate data set.

Inflated credit was calculated by using contribution count as a proxy for authorship credit (cf. Picard-Aitken & Coté, 2010), i.e. by assigning one full unit of authorship credit repeatedly to every coauthor:

$$\text{Inflated } i\text{th author credit} = 1 \tag{1}$$

Fractional credit was obtained by dividing one full unit of credit equally among all N coauthors of a multi-authored publication as follows:

$$\text{Fractional } i\text{th author credit} = \frac{1}{N} \tag{2}$$

Harmonic authorship credit for the ith author of a publication with N coauthors was calculated according to the following formula (Hagen, 2008, 2013; Hodge & Greenberg, 1981):

$$\text{Harmonic } i\text{th author credit} = \frac{1/i}{1 + (1/2) + \cdots + (1/N)} \tag{3}$$

I assumed that the presence of a corresponding last author indicated a senior author whose contribution was equivalent to the contribution of the first author (cf. Buehring, Buehring, & Gerard, 2007; Mattsson et al., 2011). In such cases, the first and the senior author share the credit for the 1st and 2nd position, and this reduces the credit of intermediate coauthors by one position as follows (cf. Hagen, 2008, Fig. 5):

$$\text{1st and senior } (N\text{th}) \text{ author credit} = \frac{1 + (1/2)}{2(1 + (1/2) + \cdots + (1/N))} \tag{4}$$

$$\text{Intermediate } (i = 2, \ldots, N-1) \text{ author credit} = \frac{1/(i+1)}{1 + (1/2) + \cdots + (1/N)} \tag{5}$$

The accuracy of the harmonic formula was unrivalled by other formulations from the bibliometric literature, when assessed against an empirical baseline (Hagen, 2010, 2013).