

# Are we allowing impact factor to have too much impact: The need to reassess the process of academic advancement in pediatric cardiology?

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## Abstract

Impact factor has been used as a metric by which to gauge scientific journals for several years. A metric meant to describe the performance of a journal overall, impact factor has also become a metric used to gauge individual performance as well. This has held true in the field of pediatric cardiology where many divisions utilize impact factor of journals that an individual has published in to help determine the individual's academic achievement. This subsequently can impact the individual's promotion through the academic ranks. We review the purpose of impact factor, its strengths and weaknesses, discuss why impact factor is not a fair metric to apply to individuals, and offer alternative means by which to gauge individual performance for academic promotion.

## KEYWORDS

academic promotion, H-index, I-10 index, impact factor, pediatric cardiology

## 1 | INTRODUCTION

Considering its relative youth, the field of pediatric cardiology has undergone remarkable changes. The era spanning from the 1950s to the 1970s was unequivocally revolutionary, with paradigmatic changes in the treatment of most lesions. We have now entered a period of tamer evolution. Advancements in the field have become so great the specialty has spawned a number of more subspecialized disciplines, such as catheterization and intervention, intensive care, noninvasive imaging, heart failure, and transplant. All this new thought and advancement, however, has not been seen within the entirety of the specialty. Although the landscape of academic publishing is undergoing its own changes, it seems that older perceptions and thoughts continue to prevail. One such manifestation of this is the assessment of the quality of academic publications on the basis of the impact factor of the journal in which they are published. We discuss here the flaws in logic of such an approach. In particular, we stress why it becomes problematic to use such metrics to assess whether the academic accomplishments of a given individual merit academic promotion.

## 2 | WHAT IS IMPACT FACTOR?

If we are to discuss the so-called impact factor, it is important to establish what it is, and how it is calculated. The impact factor for a particular

journal is calculated by taking the number of manuscripts published in the journal over the past two years, and then dividing this number by the number of citations these specific manuscripts received over the same two-year period. The result is self-evidently a metric of the journal as a whole, a population metric so to speak. Now knowing what the impact factor is, nonetheless, and understanding how it is calculated, we can move to the next logical step, which is to examine its advantages and disadvantages.

## 3 | WHAT ARE THE STRENGTHS AND WEAKNESSES OF THE IMPACT FACTOR METRIC?

The impact factor is unequivocally a wonderful metric for journals to demonstrate their scope. It allows one to gauge how many manuscripts published in a particular journal may perform in regards to being cited by future investigators. This is valuable to journals themselves to attract future submissions, but is also important for the journals to attract advertisers. While journals are meant to share academic advancement, and distribute scientific knowledge, they function within a for-profit environment. Hence they require resources for their preparation, printing, and distribution. As such, the maintenance and publication of a journal require monetary funding, much of which can be in

the form of purchased digital or print advertisement. A metric such as impact factor, therefore, can be helpful for journals to attract advertisers. The impact factor can also be helpful when establishing distribution of a journal. Indeed, distribution was the historical nidus for the initial development of the concept of the impact factor. Libraries and vendors needed a metric to decide what journals they should loan or sell when only print journals were in circulation. It was this impetus that helped spur the development of impact factor.

There are, however, also disadvantages to the concept of the impact factor.<sup>1</sup> Publication of only a small number of manuscripts can greatly improve the impact factor. Hence, the metric may not correlate well with the performance of a majority of the manuscripts published. Additionally, calculation of the factor covers only a 2-year period, thus capturing no more than the early performance of the manuscripts in question. This means that the factor makes no allowance for “late-bloomers.” Impact factors, furthermore, are also specialty specific. Any gauge of a journal based on its impact factor, therefore, must be done in comparison to those gained by other journals catering for the same discipline. The impact factor can also be influenced by practices such as the promotion of citation of previous manuscripts from the journal, or by publication by the journal of large number of review articles.

#### 4 | SHOULD IMPACT FACTOR BE USED TO GAUGE INDIVIDUAL ACADEMIC PERFORMANCE?

Having established that the impact factor, in essence, is a population metric, we must question its value in assessing the performance of an individual. The answer is that it has minimal value. It is established that impact factor has progressively worsened in its correlation to the number of citations received by manuscripts published by the journal during the time-period of interest.<sup>2</sup> This is of particular importance in the modern era, as journals are now increasingly taking their enterprises into the digital world. Whereas manuscripts were previously bound in a physical journal, along with the other manuscripts contained in that issue, manuscripts can now be identified and accessed individually.

Lozano et al. were able elegantly to demonstrate the decreasing correlation between impact factor and individual manuscript citations. They established a dataset of just under 30 000 000 manuscripts published from 1900 through 2011 in the fields of natural sciences, medical sciences, physics, and social sciences. Included in this dataset were a total of just under 820 000 000 cited references. Impact factors for included journals were recalculated for the study, and then compared with the number of citations of individual manuscripts from the journal. The endpoint of interest was the  $r^2$  value of the chosen correlation. Between 1900 and 1999, the  $r^2$  for the medical sciences increased, indicating that the relationship between impact factor and individual manuscript citation was strengthening. From 2000 onward, however, the  $r^2$  continuously decreased. As well as simply observing the trend in the  $r^2$  over the years, the investigators also calculated the absolute value of the  $r^2$ . In the early 1900s, the  $r^2$  was approximately 0.1. It peaked in the late 1990s at a little under 0.35, but since then has decreased to a value of approximately 0.2 after 2010. This shows that

the correlation was never truly strong, even at its peak. The rate of change in the  $r^2$ , furthermore, is greatest in the current era, concomitant with its decrease.<sup>2</sup> Why, therefore, should we be using a population metric to gauge individual performance when its correlation with individual performance is worsening, and was never good to begin with?

We can explore further the notion of using population metrics to gauge individual performance by leaving the realm of medical sciences for a moment, and entering the world of sports. As fantasy sports have become increasingly popular over the years, there is a greater desire for metrics relating to individual performance as fans put together their own team of individual athletes from various teams in the league of their choice. If someone wanted to gauge, for example, the performance of a player they were considering to draft on their basketball fantasy team, they would require data relating to points, rebounds, steals, or blocks per game for that individual player. Perhaps a composite metric, such as an efficiency rating, would be preferred? Irrespective of such niceties, it is the statistics relating to the individual that are desired. In this regard, the points, rebounds, steals or blocks per game amassed by the team are not particularly helpful. In fact, some athletes will have decreased individual metrics in the setting of improved team metrics. And other athletes will have exceedingly stellar performance while being on an overall underwhelming team. It follows, based on our example, that individual metrics are the only means of gauging individual performance.

#### 5 | WHAT METRICS ARE BETTER SUITED FOR GAUGING INDIVIDUAL ACADEMIC PERFORMANCE?

Why should it be any different for individual scientists and their publications? Why should we use a population-based metric to gauge individual performance in the academic setting? Clearly, Lozano et al. demonstrated the lack of value of this approach using a rigorous, mathematical method. We must explore, therefore, what individual metrics might be used? Some may decide that the overall number of publications is the paramount metric of importance. This approach, however, is a crude, since it fails to consider the scope or reach of the work itself. One could, alternatively, take the mean number of citations an individual receives per published manuscript. This is a relatively simple calculation to make. It becomes problematic since it can be influenced by several constraining factors.

Another individual metric that can be used is the H-index. This is the value at which  $x$  number of manuscripts received  $x$  number of citations, with  $x$  being used here twice to denote equivalence. Thus, an H-index of 5 would mean that an individual has 5 publications that have been cited at least 5 times. As this number increases, this implies that the individual is amassing more publications with increasing number of citations. Thus, the H-index allows for taking into account the number of citations, as well as the number of publications in a single metric. But amassing citations for a publication, and publishing new manuscripts, takes time. The H-index, therefore, self-evidently increases with years of experience. More experienced individuals may have

higher H-indices simply as a function of their experience. This means there is a limitation in using the H-index to compare investigators. As a means to permit the H-index to become comparative, some have proposed a new metric. This is achieved by dividing the H-index by the number of years over which an investigator has been publishing. Yet another metric is the I-10 number. This is simple to calculate, and represents no more than the number of publications produced by an individual has have received 10 or more citations. It becomes clear, therefore, that individual metrics do exist. But let us assume that the practice of gauging academic performance by using the population metric of impact factor is here to stay. What special considerations must then be kept in mind? First and foremost is that impact factor is highly variable between specialties. This was shown by Epstein et al., who demonstrated the skewedness of its distribution, and significant differences between specialties.<sup>3</sup>

## 6 | WHAT IS A REASONABLE IMPACT FACTOR FOR PEDIATRIC CARDIOLOGY JOURNALS, ANYWAYS?

So, what does this mean for those working in pediatric cardiology, for whom it has very important consequences? As far as we are aware, several academic divisions still gauge academic performance, at least in part, on the basis of the impact factor of the journals in which the individual has published. But there are relatively few pediatric cardiologists, and few journals devoted specifically to pediatric cardiology. These journals have a maximum impact factor of 1.6, considered to be low by most gauging the academic performance of their junior colleagues. This is the more significant, when we recognize that the highest performing cardiology journals, which are primarily adult-oriented, have impact factors in the range of 15–17.

It is also acknowledged that, in the current era, it is particularly difficult to have high-quality investigations related to pediatric cardiology published in these adult-orientated journals. It follows, therefore, that

those working in divisions of pediatric cardiology are likely to be assessing the performance of their junior colleagues not only by using a population metric, but by using a population metric unsuitable for their subspecialty. There are approximately 2600 pediatric cardiologists in the United States, compared with approximately 26 000 adult cardiologists. The 10-fold greater number of adult compared with pediatric cardiologists means that the academic output of adult cardiologists, in terms of number of publications, would be expected to be greater. This means that, while the number of overall publications will increase, so will the number of publications that may cite other publications in the specialty. It is this fact that makes it more likely that journals devoted to adult cardiology will achieve greater impact factors just by sheer volume.

Let us now consider some specifics. Consider *Congenital Heart Disease* and *Pediatric Cardiology*, the two highest performing pediatric cardiology journals. By using PubMed data, we can establish that, in the two-year period encompassing 2015 and 2016, the two journals published 232 and 552 manuscripts, respectively (using PubMed data). This equates to 392 manuscripts per year, or about 0.15 manuscripts a year for each pediatric cardiologist. If we now consider *Circulation*, and *Journal of the American College of Cardiology*, the two highest performing adult cardiology journals, over the same 2-year period these two journals published 1790 and 2143 manuscripts, respectively. Thus, the total number of manuscripts published by these two journals during the same 2-year period was 3933. This equates to 1966 manuscripts per year between the two journals during the time period. This then translates into 0.07 manuscripts per year per adult cardiologist. The journals devoted to pediatric cardiology, therefore, demonstrate a greater percentage of the total output per individual than do the two adult cardiology journals. It is true, nonetheless, that *Circulation* and *Journal of the American College of Cardiology* published some manuscripts relating to pediatric cardiology. In fact, of the 3933 manuscripts published over the 2-year period, 97 (2.4%) were related to pediatric cardiology. And over half of these were guidelines or reviews. This

TABLE 1 Overview of journal characteristics

Specialty	Number of adult doctors in specialty	Highest impact factor for adult journal <sup>a</sup>	Highest impact factor pediatric journal	Ratio of impact factor for pediatrics to adult
Orthopedics	26 000.00	6.00	1.40	0.23
Neurology	17 000.00	6.00	1.90	0.32
Dermatology	9600.00	5.00	1.00	0.20
Nephrology	11 000.00	6.00	2.20	0.37
Endocrinology	7200.00	8.00	3.80	0.48
Psychology	51 000.00	9.00	3.30	0.37
Oncology	18 000.00	12.00	2.30	0.19
Radiology	44 000.00	7.00	1.50	0.21
Emergency medicine	48 000.00	4.00	2.00	0.50
Cardiology	25 000.00	16.00	1.60	0.10

<sup>a</sup>Average of two highest performing.

does no more than strengthen our comment relating to the difficulty encountered by pediatric cardiologists seeking to publish in adult-orientated journals.

We can now establish that the hard-working academic pediatric cardiologist seeking promotion is being gauged using a population metric that fails to correlate well with individual performance, and is being judged on the basis of population metrics that are not even specialty-specific. There is no logic in using metrics based on adult cardiology to judge the achievements of pediatric cardiologists. This can be further demonstrated by looking at the highest performing journals devoted to adult medicine, namely *New England Journal of Medicine* and *Lancet*. These journals have impact factors of approximately 33 and 26, respectively. It follows that the highest performing journals devoted to adult cardiology are functioning with impact factors of approximately half of the parent specialties. We will call this the relative performance index. Now consider the highest performing journal devoted to child health, namely *Pediatrics*. This journal has an impact factor of approximately 5.5. If we were to apply the relative performance index of *Circulation* and *Journal of the American College of Cardiology*, we can estimate that a "high-performing" pediatric cardiology journal may have an impact factor of 2.7. Trends in recent years have shown an increase in the impact factor of pediatric cardiology journals. It seems realistic, therefore, that over time a relative performance index will be achieved equivalent to that of the adult cardiology journals.

Let us, however, briefly explore the performance of other pediatric specialty journals when compared with their adult counterparts. In orthopedics, with approximately 26 000 adult orthopedic surgeons in the United States, the two highest performing journals have an impact factor of approximately 6. The highest performing pediatric orthopedics journal has an impact factor of 1.5 (23% of its adult counterpart). In endocrinology, with approximately 7200 adult endocrinologists in the United States, the two highest performing journals have an impact factor of approximately 8. The highest performing pediatric endocrinology journal has an impact of 3.8 (47.5% of its adult counterpart). Table 1 demonstrates the relative number of adult providers in each subspecialty, the approximate impact factors of the two highest performing journals in that specialty, and the impact factor of the highest performing pediatric journal in that specialty. The ratio of pediatric to adult impact factor in a specialty is lowest with cardiology at 0.1, and greatest with emergency medicine at 0.5, with a mean of 0.3. If pediatric cardiology were to achieve a mean ratio of 0.3 with its adult counterparts that would result in an impact factor of 4.8, which would be very high in relation to *Pediatrics*, the highest performing journal in the discipline of pediatrics overall. It is unlikely to expect pediatric cardiology to accomplish the mean ratio, which is likely due to the over-performance of the two adult cardiology journals being used as a comparator when compared with other specialties. A reasonable impact factor for the highest rated pediatric cardiology journal can reasonably be expected to be somewhere between 2 and 3. These numbers should be kept in mind when "tiering" such journals.

## 7 | CONCLUSION

But what does this all mean? Our conclusions are few, but we suggest they should receive serious consideration: first, and foremost, impact factor, a population-metric, should not be utilized to gauge individual performance. Second, individual metrics should be used to gauge individual performance. Third, the impact factor shares similar shortcomings when being used to gauge the performance of journals as do individual metrics when being used to compare individual performance. Fourth, if it is insisted that impact factor should continue to be used incorrectly to gauge individual performance, then this must be done in a specialty-specific manner. Finally, insistence on publication in high impact factor, predominantly adult cardiology journals may not be the publication utopia many seem it to be. Publication of pediatric cardiology articles in pediatric journals still allow for manuscripts to receive attention and citations and such publication habits will help raise the impact factor journals to their full potential.

## CONFLICT OF INTEREST

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## AUTHOR CONTRIBUTIONS

*Conceptualization, preparation of manuscript draft:* Rohit S. Loomba

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