VARIA – SCIENTOMETRICS

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The use of citation indicators to identify and support high-quality research in Poland

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Abstract

In large, mostly English-speaking countries, where the "critical mass" of scientists working in different subfields of science is achieved, the peer review system may be sufficient to assess the quality of scientific research. However, in smaller countries, outside the Anglo-American circle, it is important to introduce different systems to identify research of high quality. In Poland, a parametric system for assessing the quality of research has been introduced. It was largely based on the impact factor of scientific journals. While the use of this indicator to assess research quality is highly questionable, the implementation of the system in the Polish reality is even worse. Therefore it is important to change and improve the system currently used by the Ministry of Science and Higher Education to both evaluate and, more importantly, finance science in Poland. Here, a system based on three factors, i.e. the impact factor, the institutional h-index, and the institutional number of citations, is proposed. The scientific quality of institutions in Division VI: Medical Sciences of the Polish Academy of Sciences were evaluated and the results were compared with the existing system. Moreover, a method to identify high-quality researchers and institutions at the national level based on the quantity of highly cited papers is shown. Additionally, an attempt to identify the highest quality Polish research on an international level is proposed. This is based on the number of individual citations, the individual h-index, the number of publications, and the priority of the discovery.

Key words: h-ndex, citation number, impact factor, research quality.

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INTRODUCTION

In the countries of the Anglo-American circle, where the critical mass of scientists working on specific fields is achieved in most of the disciplines of science, peer-review systems may be sufficient to assess the quality of research and to rank scientists and/or institutions. Furthermore, in these countries there is a long tradition of free scientific discussion. However, in smaller countries, especially those of the former Communist Block, the tradition of free discussion was suppressed during communist rule and, equally important, the number of scientists working in specific areas of science is sometimes quite small, not to mention the related publications in local languages. In these countries it is be important to introduce a system of evaluation of the quality of science to promote high-quality research and, perhaps, to finance it properly. Poland is definitely such a place.

THE PARAMETRIC EVALUATION OF POLISH SCIENTIFIC INSTITUTIONS APPLIED BY THE MINISTRY OF SCIENCE AND HIGHER EDUCATION

The Ministry of Science and Higher Education introduced a system of so-called "parametric evaluation" a couple of years ago to evaluate the quality of the science. However, there are several obvious shortcomings to this system. First of all, when the ranking concerned the years 2002–2005, scientists learned about its parameters after the fact, at the end of 2005. The evaluation itself is based on the following three criteria: a) the scientific activity of an institution (e.g. the number of PhDs granted), b) the scientific quality, based on the impact factor of papers which the institution has published (e.g. an institution employing 100 scientists could present 200 high-quality publications), and c) the practical implementations of its scientific activity (e.g. the number of patents). The weight of each condition was not equal, and the heaviest in most of the fields of science was for the impact factor.

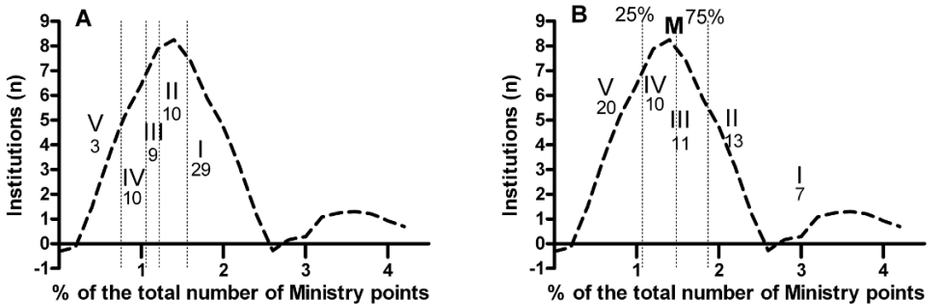

Fig. 1. A: Classification of medical institutions in Poland according to the Ministry. **B:** How the ranking should look in the group of medical science if the ranking were performed using statistical methods. The Y-axis presents the number of institutions receiving a similar number of points. On the X-axis is the percentage of the total number of Ministry points each institution obtained. The number of points was scaled to 100%. Distribution analysis shows a bimodal curve with a median (M) of 1.48%; 20 institution obtained less than 1.07% of the points (group 5), 20 obtained more than 1.87% of the points. The Roman numbers represent the actual (**A**) or the proposed (**B**) groups of ranking, the Arabic numbers show the number of the institution in each group (taken from Pilc [5]).

It was decided to analyze the results of this ranking using statistical methods and to focus on 61 institutions conducting medical research (http://www.nauka.gov.pl/mn/_gAllery/19/06/19063/Nauki_medyczne.pdf) which were categorized by the Ministry into five groups, with group 1 having the highest and group 5 the lowest quality. The data show (Fig. 1B) a clearly bimodal distribution of institutions, with a median of about 1.5%. The actual results of the ranking are shown in Fig. 1A, which clearly represents the virtual reality of Polish science. Of the 61 institutions ranked in the group of medical science, almost half (29) were assigned to the category of the highest quality. Only 3 of them were placed in the category 5. The scores for the first and the last institutions in category 1 of the ranking differed by a factor of 3, greater than the difference between the institutions ranked in groups 2–5 (with a factor of approx. 2). As financing was connected with the ranking group, the high-quality institution in the first group and the lower-quality institutions in the same group obtained identical financing. A similar situation also involved other fields of science in this country, and these results were perhaps due to the fact that the ranking was performed by scientists who actually work in the ranked institutions; therefore a profound conflict of interest must have existed and caused this distortion of the results. According to the statistics (Fig. 1B), if the Ministry had to divide institutions into five groups, 20 of them should have been placed in the fifth category (lowest quality), 10 in the fourth category, 11 in the third, 13 in the second, and 7 in the first category (highest quality). The data show that if the evaluation had been carried out properly, even using the existing system of evaluation, it would have produced meaningful results.

HOW THE PARAMETRIC EVALUATION OF POLISH SCIENTIFIC INSTITUTION SHOULD BE CONDUCTED IN THE FUTURE

Obviously, such mistakes should be avoided in the future. The world of science in this country has to be brought back to reality. First of all, the ranking conditions should be known before everything commences. The second point, i.e. not to take into account the results of such factors as the number of PhDs (this is not accounted for in the proposal for the newest ranking). Thirdly, while impact factors may be a proper measure of the quality of scientific journals, they cannot be used to evaluate the scientific quality of any single paper, individual scientist, or institution [3, 6]. Furthermore, such quantification is not only time consuming, but the data provided by institutions have to be thoroughly verified. However, the total impact factor can be regarded as a measure of the quality of the methodology used to publish a paper (it is impossible to publish in a high-impact journal using outdated methodology) and therefore can perhaps still be used as one of the factors of a parametric evaluation. The fourth and last point is that a better measure of scientific quality of institutions should be adopted, such as the institutional citation number or h-index [2]. Such data are easily obtainable from ISI or Elsevier databases and can be calculated in seconds by an independent evaluator.

AN EXAMPLE OF ASSESSMENT OF THE SCIENTIFIC QUALITY OF SCIENTIFIC INSTITUTIONS

Here are the calculations of the scientific quality of five leading Polish scientific institutions in the Division of Medical Sciences of the Polish Academy of Sciences which, according to the Ministry classification, occupied 5 of the 7 places at the top of the classification (Table 1, column 3). When the number of publications per person (column 4), the institutional h-index (column 4), and the number of citations per person (column 6) are compared and the overall number of points in each category is calculated (column 7), the institutions are ranked accordingly (column 8). A clear difference is observed.

Table 1. Column 3 shows the classification of the institutions from the Division of Medical Sciences of Polish Academy of Sciences according to the Ministry and column 8 illustrates them according to the proposed method.

Institution	Number of points in the Ministry's ranking	Position in the Ministry's ranking	Number of publications per person employed	h-index	Number of citations per person employed	Overall number of points	Position according to the proposed ranking
1	2	3	4	5	6	7	8
A	6.4	1	3.92/**5**	11/**5**	3.77/**5**	15	5
B	5.84	2	10.6/**2**	27/**1**	6.97/**1**	4	1
C	5.15	3	13.95/**1**	18/**4**	4.42/**2**	7	2
D	5.14	4	7.75/**4**	19/**3**	3.84/**3**	10	4
E	4.92	5	8.93/**3**	22/**2**	3.83/**4**	9	3

The bold numbers represent the number of points an institution obtained in each classification. In column 7 the total number of points is shown (the lower the number, the higher the place of an institution in the ranking). Column 8 shows the ranking proposal.

Institution no. 1 according to the Ministry is now no. 5, institution no. 2 is now no. 1, etc. The advantage of this proposal lies in the fact that the evaluation can be performed rapidly and efficiently by an independent reviewer and indicators which are better measures of scientific quality than the impact factor are taken into account.

DATABASES AS A SOURCE OF VALUABLE DATA TO IDENTIFY THE QUALITY OF RESEARCH AT THE NATIONAL AND INTERNATIONAL LEVEL

There are now a number of databases, such as ISI (Thomson) Web of Science and Elsevier's Scopus, which can help in identifying high-quality research [1]. As an example of this effort, the most frequently cited publications in different fields of science were identified. Such data for the field of ecology and the environment are presented here [4]. In this field, the mean number of citations of a Polish publication is 3.76, (see: http://in-cites.com/countries/poland.html). Thus, in the present evaluation, publications which received 10 times that number of citations (approx. 40) published between 1996 and 2005 with a Polish affiliation were searched for and 21 of these papers were identified, 7 of which were published by a single scientist at the University of Gdańsk and 8 were affiliated with the National Institute of Hygiene in Warsaw (5 of them were published by one scientist). Therefore, 71% of such high-quality publications in this field comes from two institutions and two scientists. It is evident from this short and simple search that in this particular field of science in this country, two institutions work at the highest national level. Such an approach to identifying high-quality research may have more sense than the creation of "flagships" of science among the best Polish universities because high-quality research is very often performed by a single individual or a group of people outside the largest universities.

IDENTIFICATION OF SOME FIELDS OF RESEARCH IN WHICH POLISH SCIENTISTS PLAY A LEADING ROLE AT AN INTERNATIONAL LEVEL

A couple of biomedical institutions in Kraków were analyzed. The study was based on the h-index of individual scientists and their numbers of publications and citations. It was assumed that the scientists with the highest scores could be regarded as being among the top at the international level. The number of papers published on each topic had to be around 1000 or more to allow meaningful comparisons. When the key words "asthma and aspirin" were searched for on the ISI Web of Knowledge, 980 records were found after the year 1996. A professor at the Clinic of Allergy and Immunology of the Collegium Medicum of Jagiellonian University had the highest number of publications (59), which also had the highest number of citations (2119) and the highest h-index (24). Moreover, two of his Polish coworkers were among the ten most frequently published in that specific field of scientists.

When the key words "gastric mucosa" were searched for on the ISI Web of Knowledge, 9486 records were found after the year 1996. A professor at the Institute of Physiology of the Collegium Medicum of Jagiellonian University was the most frequently published author, with 136 publications, and these publications had the highest h-index (29) and the highest number of citations (2602). Furthermore, in the top ten of the most frequently published authors were two of his coworkers.When the key words glutamate and anxiolytic or antidepressant [glutam* and (anxi* or antidep*)] were searched for via the ISI Web of Knowledge, 1147 records were found after the year 1996. A professor at the Institute of Pharmacology, Polish Academy of Sciences, was the most frequently published author, with 53 publications, and these publications had the highest h-index (19) and the second highest number of citations (929). Then, in the top ten of the most frequently published authors, five of his coworkers were found.

Very similar results were obtained using the Scopus database. When the quantity of publications was estimated, the GoPubMed database (http://www.gopubmed.org/) also gave similar results, as well as interesting geographical data. The results show that when databases are used, high-quality research can be identified at the national and international level.

CONCLUSION

The results show that applying scientometric indicators which, more so than the "impact factor", evaluate the quality of research, a reliable, fast and independent results can be obtained. The existing databases also allow for a simple and fast way to identify high-quality research at the national and international level.

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