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ANALYSIS OF PUBLICATION QUALITY IN A CANCER RESEARCH INSTITUTE

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The paper presents an experimental method for the evaluation of scientific papers in the field of oncology and related disciplines developed at the National Institute for Cancer Research (IST), Genoa, Italy. The method is based on the partitioning of categories of the *Science Citation Index-Journal Citation Reports* (SCI–JCR) into deciles, thus normalizing Impact Factor (IF), in order to guage the quality of the productivity. A second parameter related to the number of staff of each department co-authoring a given paper has been introduced for the allocation of Institute funding. The following studies have been carried to compare the assigned score and the average number of citations of papers published by a research group. The identification of correctives is in progress. The method provides a basis for a possible method to judge the quality of publications from within a research organization, and should be reproducible independently of the disciplines considered.

Introduction

Economic difficulties are prompting many research organizations to reassess their approach to the evaluation of scientific productivity.[1] Studies carried out in the U. S. at the National Institutes of Health and the National Science Foundation reveal increased pressure to link science and technology programs more closely to organizational and broad societal goals.[2–4] As a consequence, focus of a great deal of attention on the assessment of research output has progressively and necessarily become a priority issue for the scientific research community.

Since the most important processes of science are the communication and exchange of research findings and results, one method of assessing the productivity of scientific research workers is to evaluate their output, i. e., their published papers. However,

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quantifying and weighting the results of research are most difficult, problematic and debated tasks. Peer review, the evaluation of research and its consequences by experts, is frequently the adopted method for such evaluation and is deemed essential for maintaining the high quality of published research.[5–7] Peer review, however, is a time-consuming and costly process. Bibliometric studies carried out in recent years have provided an accurate and presumably objective method, based largely on the number of citations as indicators to measure the contribution of a paper to the advancement of knowledge. While the method has been widely discussed and at times criticized, literature reveals a generally good consensus on an approach that, albeit imperfect, is simple and objective.[8,9]

Adopting and modifying this approach, the National Institute for Cancer Research of Genoa has developed an evaluation method to assess research output in order to quantify the productivity of the Institute and its departments.

Materials and methods

The environment

The analysis was carried out at the National Institute for Cancer Research (IST), Genoa, Italy, a public non-profit research organization founded in 1978. One of the leading centers in Italy, IST is a comprehensive health care organization that performs interdisciplinary activity in experimental and clinical research, focusing on prevention, diagnosis, treatment, rehabilitation and education and training in the field of oncology.

Data retrieval

The primary information resource utilized in the analysis was a computerized database implemented in 1986 by the Documentation Center of IST and providing information on staff publications.

The adopted Information Retrieval Software (IRS) is able to manage the database with great flexibility in the layout of records fields and with simple and rapid search methods.[10] The database includes bibliographic information (author, title, source, year, publisher, etc.) and additional fields in order to extract data according to the selected bibliometric indicators.

The database is updated periodically (three times/year) and a copy of each work is labeled with a record number assigned by the system and then stored. At the end of each year, an online search through the Scisearch database is performed to evince and

correct any possible oversights of Institute personnel in reporting their publications. Finally, departments are requested to review the update for completeness and accuracy.

In this analysis, collected data cover the period 1991–1993 and regard papers published in journals included in *Science Citation Index-Journal Citation Reports* (SCI–JCR, 1992 ed.).

Evaluation method

The products of research activity have been categorized into three main types and weighted as follows:

1. publications: 70%,
2. experimental and primary prevention activity: 20%,
3. promotional and educational activity: 10%.

The great importance assigned to publications (70%) is noteworthy.

The research products of activity types 2 and 3 include disease and mortality registries, projects and agreements with national or international organizations, patents, university teaching commitments, organization of international meetings and training courses. The data analysis of product types 2 and 3 are not included in this work.

Scores assigned on the basis of journal impact factor

The developed method is based on the impact factor (hereinafter IF) of journals in which the papers were published. IF is an indicator of journal quality based on the citation frequency of the journal in which the article is published (Table 1). Citation analysis is considered an important indicator since the listing of references in publications is traditionally used by researchers to acknowledge the value of previous work.[11–13]

Table 1
Impact Factor (IF) definition

The Impact Factor (IF) is a measure of the frequency with which the average article in a journal has been cited in a particular year.

The IF of a journal "x" (IF "x"), is calculated as follows:

$$\text{IF "x"} = A/B$$

where A = number of times a journal has been cited during the previous two years

and B = number of articles it has published in those two years.

Two problems arose at this stage of the analysis:

1. Could the citation performance of a paper, using the average citation frequency of the journal, be predicted accurately? and,
2. Since cancer research covers the gamut of basic and applied research, and results are published in many journals of varying disciplines, was it correct to compare citation counts generated in different fields?

To answer to the first question, we conducted the analysis using the IF of journals in which the paper was published, in spite of limitations of the method. Since some studies have demonstrated a good correlation between journal IF and average quality of published papers,[14–16] we opted to use this method in the first experimental step of our work for purposes of expediency. The relation should be analysed more thoroughly in order to eventually apply the appropriate corrective. For the second question we sought to develop a method in order to normalize IF. In fact, when we apply citation analysis to research evaluation, we are faced with difficulties due to the differences in citation levels in different branches of science.[17] In the multidisciplinary science of oncology, the differences in citation frequency are apparent when the IF of journals in different categories are compared: for example, the average IF value of the top ten journals in immunology is 12.888; in oncology: 6.369; in surgery 2.656.

It is immediately clear that values are particularly different and that these differences could play an important role in monitoring research performance in the field of cancer research. Starting from the Institute for Scientific Information (ISI) disciplinary category division (*JCR–Journal Rankings*, 1992 edition), we developed a method based on the partitioning of categories into deciles (i.e., a value that divides a total into ten equal parts).

Journals in the first decile of each category were assigned a score of 10, those in the second decile a score of 9, those in the third decile a score of 8 and so on (Table 2). A journal listed in more than one category was assigned the better score. This method allows for the comparison of papers published in journals listed in different category fields, since it places the IF of journals in all categories at the same level. The normalisation puts IF on a uniform scale ranging from one to ten, thereby describing the ranking of a journal according to a standard.

Table 2
Partition of categories into deciles

$$Dc = Nc/10$$

Dc = value for decile partition in the Category
Nc = number of journals listed in the Category

Example: Journal Rankings disciplinary Category listing 34 titles arranged in decreasing Impact Factor order

$$Dc = 34/10 = 3.4$$

According to the method the category is divided into deciles as follows: (with approximation)

Value of decile	Value for approximation	Article score
0 – 3.4	journals from 1 to 3	10
3.4– 6.8	journals from 4 to 7	9
6.8–10.2	journals from 8 to 10	8
10.2–13.6	journals from 11 to 14	7
13.6–17.0	journals from 15 to 17	6
17.0–20.4	journals from 18 to 20	5
20.4–23.8	journals from 21 to 24	4
23.8–27.2	journals from 25 to 27	3
27.2–30.6	journals from 28 to 30	2
30.6–34.0	journals from 31 to 34	1

Results

Evaluation of the Institute's research productivity

Data emerging from the evaluation of papers published in journals listed in *SCI–JCR–Journal Rankings* were elaborated in order to obtain a qualitative measurement of the Institute's research productivity. For the three-year period under consideration (1991–1993), scores from 1 to 10 (according to the method) were assigned. Data were elaborated by a Microsoft Excel worksheet and the results are shown in Fig. 1. The percentage of papers ranging from 8 to 10 (66%) attests to the high rate of publication in quality journals by Institute staff.

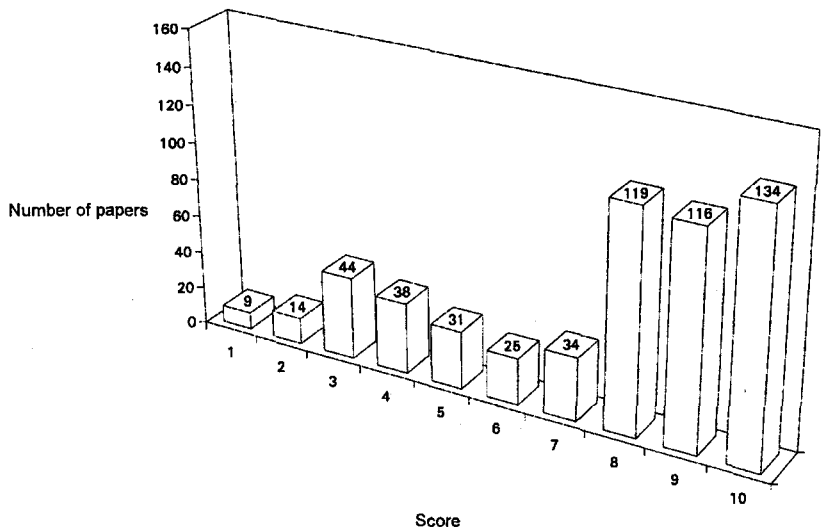

Fig. 1. Evaluation of publications, 1991–1993. The number of publications of IST during the three-year period 1991–1993 was 564. Each paper was evaluated with the normalized IF method. 66% of the papers belonged to scores ranging from 8 to 10. The 564 papers are only those published in journals covered by SCI–JCR

Evaluation of department productivity

Subsequently, data were elaborated in order to obtain a parameter for single department evaluation. To this end, each publication score (according to IF normalization) was recalculated on the basis of the number of authors working in each department:

Dpt. score = 50%a + b/c × 50%a

where a = score assigned by IF normalization (as described above);

b = number of authors working in the department;

c = total number of authors.

The introduced corrective is intended to better weight the involvement of the research groups in a work, even if the groups cooperation results somewhat penalized. Table 3 shows the changes ensuing from the recalculation of IF (column 2), where the corrective formula causes a clear difference, in department evaluation.

Table 3
Comparison of the evaluation analysis carried out at IST

		IF analysis		Authors analysis	
Departments	N. of pubbl	IF score	Average IF score	Adjusted score by authors	Average adjusted score
			1		2
1	40	351	8.78	261.75	6.54
2	14	119	8.50	76.32	5.45
3	43	355	8.26	275.19	6.40
4	52	420	8.08	197.29	3.79
5	19	153	8.05	118.38	6.23
6	15	120	8.00	86.42	5.76
7	43	344	8.00	231.72	5.39
8	17	131	7.71	107.10	6.30
9	11	83	7.55	68.45	6.22
10	28	206	7.36	140.65	5.02
11	15	110	7.33	76.13	5.08
12	34	247	7.26	144.18	4.24
13	4	25	6.25	21.05	5.26
14	15	88	5.87	58.68	3.91
15	5	26	5.20	18.00	3.60

		IF analysis		Citations analysis	
Departments	N. of pubbl	IF score	Average IF score	N. of citations	Average citation score
			1		3
1	40	351	8.78	673	17
2	14	119	8.50	560	13
3	43	355	8.26	378	22
4	52	420	8.08	175	9
5	19	153	8.05	101	9
6	15	120	8.00	149	10
7	43	344	8.00	172	12
8	17	131	7.71	619	14
9	11	83	7.55	18	5
10	28	206	7.36	182	12
11	15	110	7.33	305	11
12	34	247	7.26	231	7
13	4	25	6.25	55	4
14	15	88	5.87	475	9
15	5	26	5.20	20	4

Citation analysis

An analysis of citations of single papers was carried out after the experimental application of developed method. In order to obtain data, the specific option of the SciSearch data base hosted at DIMDI host computer was utilized.

The analysis conducted in July 1996 and aggregating publications of a research group and counting all citations credited to these publications, shows a different trend of some departments with respect to the normalized IF distribution. (Table 3 – column 3).

Nevertheless, the research groups evaluated still obtained close scores. As we can see in Table 3 – column 1, the difference of IF score from group 1 to 12 was only 1.52. Thus, the different distribution of the citation analysis does not seem that significant, since the different of funding allocation is very little, due to similar performance of the groups. To ensure a more careful evaluation a corrective should be added, and at present this is under consideration.

Conclusions

Over the past few years, research policy has been increasingly influenced by a wide range of management mechanisms and guidelines, including priority setting, accountability, selectivity, planning and evaluation. Research productivity has often been discussed in the literature over the last years, but evaluation of scientific quality has never been an easy matter. In lieu of satisfactory methods for quality measurement, many have attempted to elaborate fair and unbiased criteria, and all of these have inevitably been discussed and criticized. The method developed by our Institute provides a viable starting point for a more objective judgment of the quality of a given publication and should be reproducible independently of the disciplines considered.

Indeed, the model has introduced a normalization of IF that allows overcoming the problem of cross-discipline comparisons of output. Analysis following the experimental application of method, however, suggests that some further investigations and improvements are needed, for instance regarding:

- Number of authors – author position in the publication byline is not good weighted by the method. It would likely be more correct to use corrective formula only when authors are not in the first or last byline position;
- Number of citations – the basic assumption underlying this analysis states that the number of citations in a given field of science are reflected in the number of citations of journals covering that field. The average citation frequency of all

articles published by research groups shows a different trend of the assigned score as a consequence of this assumption. Research groups have obtained such similar scores that the difference does not seem significant (even if a corrective should be added on the basis of our results).

Finally, it is important to note that, in spite of the difficulties to define a sound approach to the evaluation of scientific productivity, the initiative to measure research output has made researchers more aware of the problem and has thus served as a stimulus to productivity itself.

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