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Editorial

Productivity in science: more more and more?

Tobias Opthof[a,*], Ruben Coronel[b,c]

[a]*Department of Medical Physiology, University Medical Center, P.O. Box 85060, 3508 AB Utrecht, The Netherlands*
[b]*Department of Cardiology, University Medical Center, Utrecht, The Netherlands*
[c]*Department of Experimental and Molecular Cardiology, Academic Medical Center, Amsterdam, The Netherlands*

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1. Introduction

During the first 60–70 years of the last century it was more or less possible to read everything that was published worldwide in whatever scientific speciality. This is no longer true. De Jong and Schaper [1] published a paper on the number of publications in clinical cardiovascular science including the citation of those papers over a 12-year period from 1981 to 1992. Of the 137 000 papers published during that period 46% remained uncited with a remarkable geographical variability from 31% for Norway to 69% for Japan. It should be realized that even a single citation by the authors themselves (self-citation) during such a long period would classify a paper in the cited category. Low citation is not synonymous with low scientific quality over brief periods (as used for popular bibliometric parameters as the 'impact factor') [2,3]. However, zero citation of about 62 000 papers over a 6-year period after publication [1], raises the question whether the scientific community should try to limit this flood of publications. This question becomes even more relevant when it is realized that electronic publishing will probably alleviate the burden of page limitations imposed on journal editors, and may lead to rejection rates that are more in agreement with reviewer's recommendations [4]. It has been pointed out previously that rejection rates are much higher than what is actually advised by reviewers [4].

2. More journals—more papers—more references

Fig. 1 shows the number of journals (left ordinate) and the number of papers published by these journals (right ordinate) in the Life Sciences as covered by the Journal of Citation Reports, a product of the Institute for Scientific Information (ISI, Philadelphia, USA). The number of journals covered by the ISI grew by 27% from 4464 in 1990 to 5684 in 2000. It is possible that these numbers may point to a better coverage of what is published by the ISI and that it may overestimate the real growth in the number of scientific journals. The number of papers increased by 38% from about 507 000 in 1990 to 702 000 in 2000. Fig. 2 shows that the number of citations almost doubled (+96%). This increase is partly based on the increase in published papers (Fig. 1), but to a larger extent on an increase in the references per paper (16.5 in 1990 and 23.3 in 2000). It is important to note that the references per paper are relevant to the citing papers, not to the cited papers. It is, theoretically, possible that in 2000 the 16.4 million citations in 702 000 citing papers went to

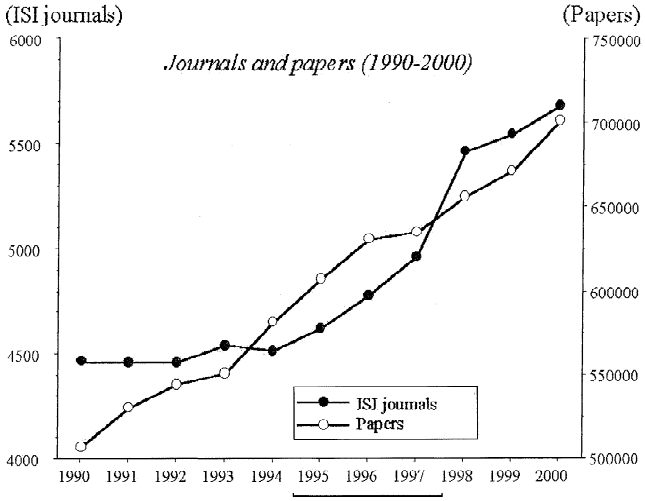

Fig. 1. Number of journals covered by the Institute for Scientific Information (Philadelphia, USA) in the yearly published Journal Citation Reports at the left ordinate and number of papers published by those journals at the right ordinate from 1990 till 2000.

*Corresponding author. Tel.: +31-30-253-8900; fax: +31-30-253-9036.
E-mail address: t.opthof@med.uu.nl (T. Opthof).

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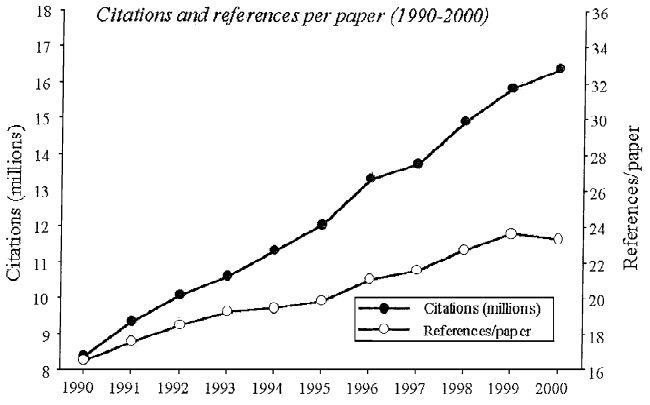

Fig. 2. Total number of citations in papers covered by the Institute for Scientific Information (Philadelphia, USA) in the yearly published Journal Citation Reports at the left ordinate and references per paper at the right ordinate from 1990 till 2000.

only 24 papers. This would be the case if the 702 000 citing papers with on average each 24 references would all have cited the same 24 papers.

Fig. 3 shows that the increase in references per paper coincided with a gradual decrease in the number of pages of scientific papers at least in Circulation which is the top journal in the category Cardiac and Cardiovascular System of the Journal Citation Reports. In 1970 the number of pages per paper was about 10 and it declined gradually to just over 6 in 2000. If this process continues at the same speed a paper published by Circulation will be no longer than one page in 2020! It is of interest to note that Seglen [5] found a strong correlation between the number of pages of an article and its citation 4 years after publication, i.e. well beyond the time window used for the calculation of the impact factor [2]. Of course, the decrease in the number of pages per paper may point to less verbosity, but it is also possible that it partly reflects a trend to less information per paper (minimal publishing unit).

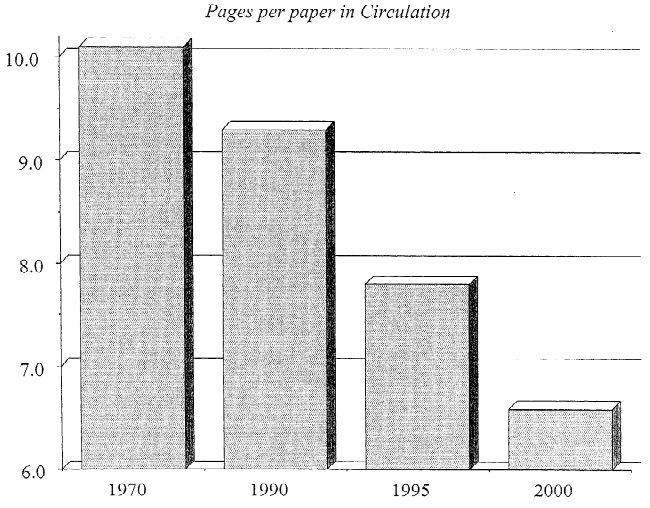

Fig. 3. Number of pages per original contribution in Circulation in 1970, 1990, 1995 and 2000.

3. Productivity of individual scientists

The increase in the numbers of published papers probably results from a larger number of scientists involved in research and from increased pressure to publish. Individual authors produce different numbers of papers during their career. Interestingly, Alfred J. Lotka scored the number of papers of authors with names beginning with A or B in a decennial index of Chemical Abstracts covering the years 1907–1916 and published his results in 1926 [6]. Fig. 4 shows that about 60% of the authors produced only one paper during that period. He formulated the 'inverse square law' which says that the fraction of scientists producing n papers equals $1/n^2$ of the fraction of scientists producing only one paper. In other words, about 7% of scientists produced three or more first author papers and about 1% of scientists produced 8 or more papers (Fig. 4).

As stated in the previous section there has been an enormous increase in the number of scientific journals and papers during the last decade. It is not known whether the increased urge to publish scientific papers ('publish or perish') has actually increased productivity per (first) author in a relevant way. Of course assessment of productivity of authors has both quantitative and qualitative aspects. Fig. 4 reproduces the original data from Lotka [6] on productivity per author together with the computed best fit (open circles). Fig. 4 further shows the fraction of scientists with one or more papers cited in the Science Citation Index of 1996. There was a technical reason to choose for the 1996 edition of the Science Citation Index, because it permits such an analysis by alphabet more easily than more recent products of the ISI. We simply scored the first 500 authors from the database (all with family names starting with AA). The cited papers could have been published in any year, but there were hardly papers older

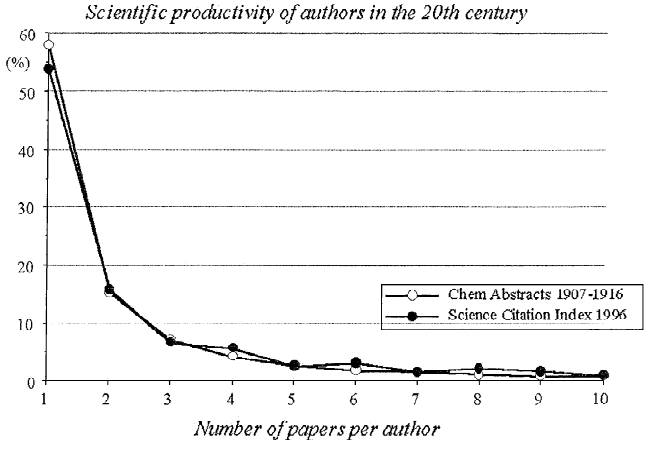

Fig. 4. Percentage of authors (with surname starting with A or B) who published one or more papers in Chemical Abstracts between 1907 and 1916 [6] and the percentage of authors that had one or more cited papers in the Science Citation Index of 1996. For the latter analysis the first 500 author surnames (all starting with Aa) were scored according to their number of cited papers.

than 10 years as was the case in the analysis of Lotka in 1926 [6]. The agreement between the data set of 1907–1916 (published, but not necessarily cited) and the data set of 70 years later (published and cited) is obvious. Thus, the large increase in scientific publications (Fig. 1) is based on the involvement of more scientists. It is suggested, however, that the productivity of relevant (cited) scientific information per author has not changed very much. Maybe this paper should not have been published, so please cite it.

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