Jointly published by Akadémiai Kiadó, Budapest and Springer, Dordrecht

Scientometrics, Vol. 80, No. 3 (2009) 747–760
DOI: 10.1007/s11192-008-2108-6

Measuring the influence of clinical trials citations on several bibliometric indicators

ANTONIO GARCÍA ROMERO,[a] JOSÉ NAVARRETE CORTÉS,[b] CRISTINA ESCUDERO,[c] JUAN ANTONIO FERNÁNDEZ LÓPEZ,[b] JUAN ANTONIO CHAICHÍO MORENO[d]

[a] *Agencia Laín Entralgo, Consejería de Sanidad (Comunidad de Madrid), C/Gran Vía, 27 28013 Madrid, Spain*
[b] *Universidad de Jaén, Jaén, Spain*
[c] *Hospital Puerta de Hierro, Madrid, Spain*
[d] *Universidad de Almería, Almería, Spain*

The practice of publishing clinical trials in scientific journals is common, although not without its critics. This study aims to measure the effect of clinical trials citations on several bibliometric indicators: citations per document (CD); journal impact factor (JIF); relative h-index (RhI) and strike rate index (SRI). We select all the citable documents published in the *NEJM*, *Lancet*, *JAMA*, *AIM* and *BMJ*, for the period 2000-2004, and record the citations received by those papers from 2000 to 2005. Our results show that clinical trials have a CD significantly higher than those for conventional papers; JIF is lower when clinical trials are excluded, especially for *NEJM*, *Lancet* and *JAMA*. Finally, both RhI and SRI seem to be unaffected by clinical trials citations.

Introduction

Clinical trials are essential for the development of new drugs. Pharmaceutical firms invest huge amounts of money on R&D in order to bring new products to the marketplace. Clinical trials are usually published in scientific journals and these papers exert a strong influence on doctors and practitioners. Two main objections to this practice have arisen from the scientific community. On the one hand, the companies themselves select the clinical trials that are going to be published and, in general, these tend to demonstrate conclusions favorable to the companies' interests [ROCHON & AL., 1994]. On the other hand, clinical trials should not be considered as research [OECD, 2002] because, in fact, the doctors who participate merely have to follow a list of written instructions.

In this paper, we measure the contribution of clinical trials' citations to indicators commonly used in research evaluation, such as the average of citations per document (CD) or the Journal Impact Factors (JIF). In addition, we consider two other indicators derived from the h-index. These are: the relative h-index (RhI), proposed by ROUSSEAU [2006]; and the strike rate index (SRI), defined by BARENDSE [2007]. We propose the

Received July 21, 2008; Published online April 16, 2009

Address for correspondence:
ANTONIO GARCÍA ROMERO
E-mail: agr33@salud.madrid.org

0138–9130/US $ 20.00

use of these indexes, instead of the h-index, because they allow us to compare values when they are computed for two sets using different numbers of papers.

We studied five leading medical journals: *New England Journal of Medicine (NEMJ)*, *Lancet*, *Journal of the American Medical Association (JAMA)*, *Annals of Internal Medicine (AIM)* and *British Medical Journal (BMJ)*. Using data from Thomson-ISI Web of Knowledge (WoK) and Medline, we explore the effect that clinical trials' citations have on the above mentioned bibliometric indicators (CD, JIF, RhI and SRI).

Our results support the hypotheses that clinical trials receive a significantly higher number of citations than other medical papers. Regarding the effect on JIF, we observe a clear effect for three of the five journals analyzed (*NEJM*, *Lancet* and *JAMA*). As regards RhI and SRI, we do not find any significant reductions in their values when clinical trials and corresponding citations are excluded.

We believe that this procedure could be helpful when evaluating research, thereby contributing to the efficient allocation of research funds.

Background

The pharmaceutical industry makes a relevant contribution to the well-being of citizens. Proof of this fact is that almost all of the drugs that have contributed to an improvement in health, over the past century, have been developed by this industry [HOUSE OF COMMONS HEALTH COMMITTEE, 2005]. The socioeconomic benefits of pharmaceutical innovation are also measured, both in terms of mortality reduction and subsequent economic growth [LICHTENBERG, 2003].

Launching a new drug on the market is a difficult challenge. Companies have to invest huge amounts of money in R&D. In fact, the innovation process for a new medicine can take around 15 years. This process starts with the discovery or development of new molecules, by companies using their own labs or by universities and research centers.[1] As a second stage, these companies have to demonstrate the potential effects of the new drugs on humans, through clinical trials. A detailed description of the clinical trial process is shown in Appendix 1.

When a new drug is authorized, these companies would have to promote their products around the world. There are several ways to promote a new medicine. One of the most effective is to publish the results of a clinical trial in a medical/scientific journal. Pharmaceutical companies usually send reprints of these articles to doctors and practitioners and, thereby, influence their prescription habits.

[1] The role of universities and research centers as sources of fundamental knowledge is especially important in this sector [COHEN & AL., 2002].

The main problem with this practice is that there is evidence that published clinical trials are biased towards results in favor of new medicines [SMITH, 2006]. This fact is relevant because the results from published clinical trials are used as a basis for many important clinical decisions that affect patient health [SMITH, 2005B].

In recent years, some prominent members of the scientific community, together with important institutions (e.g.: the UK House) have argued that the clinical trials publication system must be modified. To overcome the problems described above, a proposal of publishing clinical trials was proposed [SMITH & AL., 2006]. One of the recommendations from this new system is that medical journals should not publish any clinical trials at all, but only commentaries and reports based on them. In order to enable this practice, the publication of all clinical trials, irrespective of whether or not results are favorable, should be compulsory in a publicly accessible database. This system ensures the full and unbiased reporting of clinical trials.

Nevertheless, an interesting initiative to improve the current publication system for clinical trials has emerged recently. It is the International Clinical Trials Registry Platform, based in the World Health Organization, and fostered by the main journals' editors thorough the International Committee of Medical Journal Editors. This committee stipulates that all clinical trials must be registered in order to be considered for publication.

There is another aspect of clinical trials that must be considered together with these important developments. This kind of study is generally conducted by physicians who usually follow a protocol or a list of instructions that has been designed by the pharmaceutical companies themselves. In addition, the OECD stipulates in the *Frascati* Manual [OECD, 2002] that phases I, II and III of clinical trials, must be considered as development and not as research (either as basic research as applied research).

Finally, as several studies have demonstrated, clinical trials tend to receive more citations than conventional articles. This phenomenon could be interpreted from contradictory points of view. On the one hand, as suggested by SMITH [2003], these citations do not take into account whether or not these papers constitute the best, or most original, pieces of research. He also suggests that it is very probable that the high number of citations is due to the dissemination practices followed by these companies. On the other hand, one cannot ignore that some studies reveal those companies with many citations are also those that are successful in discovering new drugs [KOENIG, 1997].

We believe that the foregoing arguments could have important implications for research evaluation procedures. Some of them can be formulated as research questions for this study.

1. Are clinical trials cited significantly more than other papers?
2. To what extent are JIF affected by the number of citations for clinical trials?
3. To what extent are RhI and SRI modified by the influence of clinical trials citations?

There is little quantitative evidence related to the above questions; especially concerning the latter two.

With regard to the first question, our sole aim is to confirm the results, obtained from previous studies that show that clinical trials are cited significantly more than other papers. For example, PATSOPOULOS & AL. [2005] find that randomized clinical trials received more citations than other study designs, such as epidemiological studies or non-systematic review articles, although these types of papers are cited less than meta-analyses. Further, large-scale clinical trials of drugs are identified as the most cited papers in *Lancet* by KOSTOFF [2007]. He also finds a higher citation rate when papers deal with specific medical themes such as breast cancer, diabetes, coronary diseases, and HIV. In addition, there are several studies that analyze the characteristics of clinical trials that result in higher citation rates. Among the most important factors are: the sample size [PERITZ, 1994] or the origin of funding [PATSOPOULOS & AL., 2006]. Similar results are obtained by KULKARNI & AL. [2007] for articles published in the *Lancet, JAMA* and *NEJM*. They find that larger trials, with group authorship, industry-funded and to end with results favoring industry receive more citations.

Second, with regard to the JIF, MOED & AL. [1994], found that for many journals, the values of the impact factors compiled by the ISI in JCR are inaccurate. They associate the problem with the inappropriate definitions of citable documents. When they recalculate the JIF taking into account only the citations for articles, notes and reviews, they find significant differences between the two figures. The most important effect is noted in a medical journal, *The Lancet,* that shows a difference of 40% when citations for non-citable documents are excluded. Less important but also significant are the differences observed for *New England Journal of Medicine* (19%) or *Annals of Internal Medicine* (15%). As a consequence, MOED & AL. [1994] suggest creating a JIF based only on articles. Nevertheless, there is a lack of information about the impact factor structure that suggests the need to explore this indicator in depth [CAMPANARIO & AL., 2006]. This implies the measurement of the contribution of several factors to JIF as self-citations [FASSOULAKI & AL., 2000] and [YU & AL., 2007], citations from the editorial boards [CAMPANARIO & AL., 2006] and, of course, the rest of variables that are determinants of JIF.[2]

We cannot find any studies that consider the effect of citations given to clinical trials on JIF. However, we expect a significant effect if we take into account two main assumptions. First, due to the uneven contribution of individual papers to the JIF [SEGLEN, 1997]; if we exclude papers with numerous citations, the new JIF should be significantly lower. Second, as we have seen in the previous paragraph, there is evidence that clinical trials are cited significantly more than other papers.

[2] The accuracy of Impact Factor depends on multiple variables. For a detailed list we suggest reading SEGLEN [1997].

Nevertheless, the alternative forms of JIF, proposed in this paper, have limitations that are similar to those for *classical* JIF. We should not forget that the JIF should not be considered as a *panacea* for research evaluation [CAMI, 1997]. In fact, we consider our alternative versions of JIF purely as complements to other bibliometric indicators, due to its important caveats.

As regards the use of both relative h-index (RhI) and strike rate index (SRI) instead of h-index, this procedure can be justified as follows. Although the h-index has been defined and applied successfully to journals [BRAUN & AL., 2006],[3] it is not an appropriate indicator for this study. The reason is that the h-index depends on both the number of papers and citations. This aspect implies that, if we use raw h-indexes, we can expect a lower value when papers related to clinical trials are excluded. On this basis, we are unable to discriminate if differences between these two figures are caused by the effect of clinical trials, or simply the lower number of articles.

In order to overcome this limitation, we use two alternative indicators derived from the h-index. They are the relative h-index [ROUSSEAU, 2006] and the strike rate index defined by BARENDSE [2007].[4] Due to the novelty of these indicators there are no previous studies on how they are affected by clinical trials citations.

Finally, we should not forget that there is an increasing need to develop new indicators that are capable of measuring the utility of research in educational, clinical or scientific applications [LEWISON, 2002] and [JELLINEK & AL., 2004]. In that sense, it could be interesting to investigate bibliometric indicators based on clinical trials. We would then be able to measure the contribution made by hospitals to the development of new drugs, through their participation in clinical trials.

Data and methods

Data

We analyze the data corresponding to all the citable documents[5] that were published in *The Lancet*, *New England Journal of Medicine*, *British Medical Journal*, and *Journal of the American Medical Association* and *Annals of Internal Medicine*, for the period 2000–2004. We classify the selected citable documents into two subsets: (i) papers related to randomized clinical trials and (ii) other papers.

In order to create a valid dataset, we use PubMed and WoK as follows. On the one hand, we use PubMed database to identify a valid set of clinical trials; and on the other, we retrieve the citations received by clinical trials from WoK. Both procedures are described in detail in the following paragraphs.

[3] In particular, its application to journals is recommended as a complement to the journal impact factor.
[4] In Data and Methods section we define both indicators.
[5] Following the recommendations from MOED & AL. [1997], we disregard documents such as editorial material, letters, proceedings or book reviews.

The right selection of clinical trials is a cornerstone of the study and is not a trivial task. In fact, previous studies have shown the impossibility to identify clinical trials when a simple query is used [SUAREZ-ALMANZOR & AL., 2000].[6] In order to select clinical trials from Pubmed we applied the specific search strategy for clinical trials (i.e.: Clinical Queries) provided by Pubmed. This search tool enables the retrieval of those documents whose methodological design is a clinical trial or a systematic review. We utilize the filter corresponding to clinical trials by selecting the search option called "broad, sensitive search". This query allows us to retrieve the maximum number of papers corresponding to the profile "clinical trials". In addition, in order to refine the search, we also include several restrictions associated with document type. (i.e.: Clinical Trial Phase I, II, III and IV). This search strategy gave us a dataset of 1830 documents. However, several errors were identified and we decided to carry out a revision using experts in order to select clinical trials correctly. The revision was made paper-by-paper, reading through their methodology sections. Those papers not identified as clinical trials (10.7%) were deleted from the original database, thereby giving us a final dataset with 1634 papers (see Table 1).

Table 1. Clinical trials by journal

	PubMed	Final	Difference (%)
NEJM	450	429	21 (5%)
Lancet	502	440	62 (12%)
JAMA	364	344	20 (6%)
AIM	203	137	66 (32%)
BMJ	311	284	27 (9%)
Total	1830	1634	196 (11%)

Although the search procedure described above is quite precise when it comes to recognizing those papers related to doubled-blinded randomized trials, it could fail to identify other types of trials. This is true for those clinical trials, without randomization, that are carried out in exceptional situations, especially for certain serious diseases. Fortunately, these types of clinical trials are not the subject of this study. However, in further studies, it could be interesting to improve procedures by including a check for false negatives.

The column 'PubMed' represents the number of papers related to clinical trials that were selected automatically from the database, the column 'Final' gives the number of valid clinical trials after the revision by experts. Finally the column 'Difference' represents the percentage difference between them, both in relative as well as absolute terms. The data reveal that the PubMed is more accurate in identifying clinical trials published in *NEJM*, *JAMA* or *BMJ* than those published in *Lancet* or *AIM*.

[6] A less sophisticated procedure was used in our early studies. It was based on the thesaurus MesH of PubMed. The results obtained by this procedure were significantly poorer (around 27% of invalid papers were included in the dataset).

Another important issue is the time distribution of the trial-related papers. Table 2 shows these data for each journal. For instance, if the clinical trials are published mainly at the beginning of the studied period, they could cause a bias due to the different lengths of the citation windows. We carry out two different tests in order to check the relationship between clinical trials and the year of publication. First, using the Kolmogorov-Smirnov test, we conclude that clinical trials are not distributed uniformly. However, given the small number of observations, only five for each journal, it would not be appropriate to use this statistic. Second, in order to overcome such a limitation, we estimate a linear regression for each journal, based on the expression $CT_i = a+b–YEAR$, where CT_i is the number of clinical trials published in the year, *i,* and *YEAR* is the publication year. Results show that for any journal, all the *b* parameters are not significantly different from 0. This result allows us to assume that there is no significant relationship between clinical trials and the year of publication.

The second step in data gathering is the assignation of citations to each paper (whether clinical trials or not) published by the five journals considered in our study for the period 2000-2004.[7]

To do so, we downloaded from Thomson-ISI Web of Knowledge (WoK) all the documents published in the journals *NEJM*, *Lancet*, *JAMA, AIM* and *BMJ* during the period 2000–2004. Besides, for each document we gathered the received citations by year along the period 2000–2005. Finally, we set up a working file through a match between the datasets containing the clinical trials, obtained from WoK and PubMed respectively.

Table 2. Distribution of clinical trials by year

	Year							
	2000	2001	2002	2003	2004	Total	Mean	Std. Dev
NEJM	79	90	78	91	91	429	85.8	2.95
Lancet	117	85	98	67	73	440	88	12.94
JAMA	62	56	68	87	71	344	68.8	8.29
AIM	31	28	23	24	31	137	27.4	3.29
BMJ	50	56	58	51	69	284	56.8	6.38
Total	339	315	325	320	335	1634	326.8	10.06

Methods

Our analysis is based on four bibliometric indicators: (i) citations per document (CD) (ii) journal impact factor (JIF) by year; (iii) relative h-index (RhI) and (iv) strike rate index (SRI). Although JIF is computed by year, we present the average values for the whole period, in order to facilitate the interpretation of results. As regards the other three indicators, CD, RhI and SRI, they are computed for the whole period.

[7] We need this information to elaborate the four indicators for each journal and year (see methods section).

In order to observe the effect of clinical trials on bibliometric indicators, all of these were computed for three sets of papers and citations: (i) all published papers; (ii) only those papers unrelated to clinical trials and, (iii) only clinical trials.

We use the definition of the relative h-index (RhI) given by ROUSSEAU [2006] as follows:

$$RhI_i = \frac{h_i}{\sum_{j=2000}^{2005} DOC_{ij}}$$

where h_i is the h-index[8] for the journal, *i,* and DOC_{ij} is the number of articles published by journal *i* in the year, *j*. As regards the *Strike Rate Index* (SRI) we use the definition proposed by BARENDSE [2007] as follows:

$$SRI_i = 10 \times \frac{\log h_i}{\log\left(\sum_{j=2000}^{2005} DOC_{ij}\right)}$$

where SRI_i is the Strike Rate Index for the journal, *i*.

Results

In this section we present the values for each indicator and journal organized into three groups: (i) All papers, (ii) Excluding clinical trials and, (iii) Clinical trials.

Citations per document

Table 3 shows the information related to the number of documents published during the period 2000–2004, and the citations they receive, from 2000 to 2005, for each of the five journals.

Table 3. Citations per Document

	All papers			Without Clinical Trials			Clinical Trials			Difference (%)	
	DOC_1	CIT_1	CD_1	DOC_2	CIT_2	CD_2	DOC_3	CIT_3	CD_3	DIF_{12}	DIF_{13}
NEJM	1803	187104	103,8	1374	110562	80,5	429	76542	178,4	**22***	**–72**†
Lancet	3173	167226	52,7	2733	120488	44,1	440	46738	106,2	**16***	**–102**†
JAMA	1862	126479	67,9	1518	94816	62,5	344	31663	92,0	**8**	**–36**†
AIM	996	40319	40,5	859	32461	37,8	137	7858	57,4	**7**	**–42**†
BMJ	3033	76193	25,1	2749	67361	24,5	284	8832	31,1	**2**	**–24**†

* Indicates significance level $p<0.005$; † Indicates significance level $p<0.001$.

[8] We use the following definition for h-index: a journal J has an h-index equal to h if there are h papers published by journal J during the period 2000-2005, each of which has at least h citations.

where DOC_i is the number of citable documents published for the period 2000–2004, CIT_i is the number of citations received by these documents from 2000 to 2005 and CD_i is the average number of citations by document for the journal, ***i***. It is computed by using the following expression:

$$CD_i = \frac{DOC_i}{CIT_i} \frac{\sum_{j=2000}^{2005} CIT_{ij}}{\sum_{k=2000}^{2004} DOC_{ik}}$$

Finally, in order to illustrate the effect of clinical trials, we calculate for each journal, two relative differences for the CD_i indicators as follows

$$DIF_{1i} = \frac{CD_1 - CD_i}{CD_1} \times 100 \quad i = 2,3$$

We use the ANOVA test to check if the differences between CDi and CDj, for each journal, are significant. As regards, the differences between CD_1 and CD_2 (DIF_{12}) we find that they are significant ($p<0,005$) for both *NEJM* (22%) and *Lancet* (16%), but the difference is not significant for the other three journals. Regarding the differences between CD_1 and CD_3 (DIF_{13}), we use the U–Mann–Withney[9] non parametric test, concluding that all of them are significantly different from 0 ($p<0.001$). The latter result corroborates the finding that clinical trials are cited significantly more than conventional papers. A possible explanation for the above results could be due to the fact that *NEJM* and *Lancet* are the journals where most clinical trials are published.

Journal Impact Factor

Table 4 shows the results obtained for the average of JIF for all the five journals considered in the study in the period 2002–2005.

Table 4. Average journal impact factors (2002–2005)

	All papers	Wihout clinical trials	Clinical trials	Difference (%)	
	JIF_1	JIF_2	JIF_3	DIF_{12}	DIF_{13}
NEJM	37.289	32.342	52.906	**13**	**–26**
Lancet	19.826	18.737	25.476	**6**	**–19**
JAMA	21.592	19.089	31.833	**12**	**–33**
AIM	12.567	12.453	13.069	**1**	**–3**
BMJ	7.721	7.720	7.906	**0**	**–4**

[9] We use this test instead of ANOVA due to the presence of heterokedasticity.

We observe that *NEJM* (13%) shows, on average, the highest difference in impact factor; followed by *JAMA* (12%) and *Lancet* (6%) respectively. Nevertheless, the other two journals, *AIM* and *BMJ* show differences that are substantially lower. This pattern is quite similar to that observed in the previous section. As regards the column DIF_{13}, we observe a similar pattern to $DIF_{12,}$ with higher differences for *NEJM*, *Lancet* and *JAMA* than for the other two journals considered in the study.

The previous results suggest that the effect of clinical trials depends on the journal in question. This is similar to results obtained by MOED & AL. [1997] regarding the effect of citations of the editorial material on JIF. The main implication of this result is that this characteristic of JIF, should be taken into account for research evaluation processes, especially in those countries where these indicators are used to establish comparisons between institutions and researchers.[10]

Relative h-index and Strike Rate Index

Finally, our analysis concludes by measuring the contribution of clinical trials on both the relative h-index (RhI) and the strike rate index (SRI), for each journal. We use a five year time window (2000–2005). These indicators have an interesting characteristic; their utility when comparing different journals, because they are corrected by the different number of papers published by each journal. Consequently, we can use these indicators to compare the results obtained for a journal with or without clinical trials. Tables 5 and 6 show respectively the RhI and SRI for the five journals.

Table 5. Relative h-index (RhI)

	All papers	Without clinical trials	Clinical trials	Difference (%)	
	RhI_1	RhI_2	RhI_3	DIF_{12}	DIF_{13}
NEJM	0.139	0.146	0.438	**–4**	**–201**
Lancet	0.062	0.060	0.309	**2**	**–412**
JAMA	0.098	0.103	0.334	**–6**	**–223**
AIM	0.104	0.112	0.401	**–8**	**–389**
BMJ	0.034	0.036	0.176	**–6**	**–259**

We can conclude that the *NEJM* exhibits evidence of the highest impact, followed by *AIM* and *JAMA*. This pattern is the same when clinical trials are excluded. In fact, the values for this indicator are even higher when we do not take into account the clinical trials for all the journals except the *Lancet*. Accordingly, the column DIF_{12} shows low values that are quite similar for all journals. An important conclusion, from Table 5, is that this indicator seems to be invariant to the effect of clinical trials.

As regards SRI, Table 6 shows behavior similar to RhI. This indicator is almost invariant when clinical trials are excluded from the analysis.

[10] For example, this practice is widely extended in Spain.

Table 6. Strike Rate Index

	All papers	Without clinical trials	Clinical trials	Difference (%)	
	SRI_1	SRI_2	SRI_3	DIF_{12}	DIF_{13}
NEJM	7.38	7.33	8.64	**1**	**–18**
Lancet	6.55	6.45	8.07	**2**	**–25**
JAMA	6.92	6.90	8.12	**0**	**–18**
AIM	6.72	6.76	8.15	**–0**	**–19**
BMJ	5.78	5.80	6.93	**–1**	**–21**

Finally, looking at columns RhI_3 and SRI_3, we find additional evidence of the clear difference among clinical trials and conventional papers published by the journals considered in this study.

Conclusions

Scientific papers in biomedicine exhibit an important dichotomy. On the one hand, there are papers based on original research, usually funded by public institutions whereas, on the other, there are those based on clinical trials supported mainly by private firms. Recently, there has been much controversy concerning the practice of publishing clinical trials papers in scientific journals.

When formulating a research policy, many decisions such as funding, hiring or promotions are taken on the basis of bibliometric indicators related to scientific journals where scientists publish their papers. In order to provide additional information for policy makers, we propose the identification and measurement of the contribution of clinical trials to commonly used bibliometric indicators: citations per document and journal impact factors. In addition, we consider two indicators based on the h-index for journals corrected for the number of publications: relative h-index (RhI) and strike rate index (SRI).

Our findings reveal, on the one hand, that the effect of clinical trials on both CD and JIF can be important for two of the journals: *NEJM* and *Lancet*. Less important are the effects observed for *JAMA*, *AIM* and *BMJ*. On the other, we find that RhI and SRI are more robust to the contribution of clinical trials.

A complementary set of conclusions are identified by looking at indicators computed only for clinical trials. We obtain additional evidence that clinical trials constitute a different class of paper within each journal. In particular, these papers are significantly more cited than conventional papers.

In line with the above statements and results, we propose the use of indicators, computed by excluding clinical trials, and their corresponding citations. We believe that this information could serve as a valuable tool to aid the decision making process that

governs research policy. Besides, it seems that both RhI and SRI are more appropriate indicators of journal quality than journal impact factor. Unfortunately, these better indicators are relatively unknown to decision makers and funding bodies.

This paper opens several interesting paths for further research. First, the development and application of new methods to identify clinical trials within ISI databases is needed. Particularly, we are interested in differentiating between clinical trials, for each of the phases, and also whether or not clinical trials have been funded by private firms. Second, it could be interesting to know to what extent clinical trials citations can affect bibliometric indicators when taking into account countries, institutions (i.e: hospitals), or even individuals. Finally, this analysis should be extended to other medical journals.

*

We are extremely grateful to two anonymous referees and Professor Braun, Editor of Scientometrics for their valuable comments during the review process. We also wish to thank Michael Koenig, Luis Plaza, Jordi Camí, Emilio Muñoz and José Manuel Estrada for their comments on an earlier draft of this paper. The authors would also like to acknowledge financial support for the study from Agencia Lain Entralgo and University of Jaén.

References

BARENDSE, W. (2007), The strike rate index: a new index for journal quality based on journal size and the h-index of citations. *Biomedical Digital Libraries*, 4 (3). http://www.bio-diglib.com/content/4/1/3.

BRAUN,T., GLÄNZEL, W., SCHUBERT, A. (2006), A Hirsch-type index for journals, *Scientometrics*, 69 (1) : 169–173.

CAMI, J. (1997), Impactolatría: diagnóstico y tratamiento. *Medicina Clínica*, 109 : 515–524.

CAMPANARIO, J. M., GONZALEZ, L. (2006), Journal self-citations that contribute to the impact factor: Documents labeled "editorial material" in journals covered by the Science Citation Index. *Scientometrics*, 69 (2) : 365–386.

CAMPANARIO, J. M., GONZALEZ, L., RODRIGUEZ, C. (2006), Structure of the impact factor of academic journals in the field of Education and Educational Psychology: Citations from editorial board members. *Scientometrics*, 69 (1) : 37–56.

COHEN, W. M., NELSON, R., WALSH, J. P. (2002), Links and impacts: the influence of public research on industrial R&D. *Management Science*, 48 (1) : 1–23.

DTI, BIA & DEPARTMENT OF HEALTH (2003), *Bioscience 2015. Improving National Health, Increasing National Wealth*. Retrieved January 15, 2007 from: http://www.bioindustry.org/bigtreport/index2.html

FASSOULAKI, A., PARASKEVA, A., PAPILAS, K., KARABINIS, G. (2000), Self-citations in six anaesthesia journals and their significance in determining the impact factor. *British Journal of Anaesthesia*, 84 (2) : 266–269.

HIRSCH, J.E. (2005), An index to quantify an individual's scientific research output. *Proceedings' of the National Academy of Sciences of the United States of America,* 102 : 16569–72, http://arxiv.org /abs/physiscs/0508113.

HOUSE OF COMMONS HEALTH COMMITTEE, *The Influence of the Pharmaceutical industry*. Retrieved February 15, 2007 from: http://www.publications.parliament.uk/pa/cm200405/cmselect/cmhealth/42/4202.htm , 2005.

JELLINEK, N. J., DESOUSA, R. A., BERNHARD, J. D. (2004), The clinical influence of the JAAD. *Journal of the American Academy of Dermatology*, 50 : 470–474.

KOENIG, M. E. D. (1997), A bibliometric analysis of pharmaceutical research. *Research Policy*, 12 : 15–36.

KOSTOFF, R. N. (2007), The difference between highly and poorly cited medical articles in the journal Lancet. *Scientometrics*, 72 (3) : 513–520.

KULKARNI, A. V., BUSSE, J. V., SHAMS, I. (2007), Characteristics associated with citation rate of the medical literature. *PLoS ONE*, 2 (5) : e403.

LEWISON, G. (2002), From biomedical research to health improvement. *Scientometrics*, 54 (2) : 179–192.

LICHTENBERG, F. R., Pharmaceutical innovation, mortality reduction, and economic growth. In: K. M. MURPHY, R. H. TOPEL (Eds), *Measuring the Gains from Medical Research: an Economic Approach (pp. 74–109)*. Chicago: The University of Chicago Press, 2003.

MOED, H. F., VAN LEEUWEN, T. N. (1994), Improving the accuracy of Institute for Scientific Information's Journal Impact Factor. *Journal of the American Society for Information Science*, 46 (6) : 461–467.

OECD, The measurement of scientific and technological activities. *Proposed standard practice for surveys on research and experimental developmen*t. Paris: OECD, 2002.

ROCHON, P. A., GURWITZ, J. H., SIMMS, R. W., et al. (1994). A study of manufactured-supported trials of nonsteroidal anti-inflammatory drugs in the treatment of Arthritis. *Archives of Internal Medicine,* 154 : 157–163.

ROUSSEAU, R. (2006), A case study: evolution of JASIS' h-index (in Chinese). *Science Focus*, 1 (1) : 16–17. English version: E-LIS: ID-code 5430.

SEGLEN, P.O. (1997), Why the impact factor of journals should not be used for evaluating research. *British Medical Journal,* 314 : 497.

SMITH, R., ROBERTS, I. (2006), Patient safety requires a new way to publish clinical trials. *Public Library of Science Clinical Trials*, e6 : 1–3.

SMITH, R. (2003), Medical journals and pharmaceutical companies: uneasy bedfellows. *British Medical Journal*, 326 : 1202–5.

SMITH, R. (2005a), Medical journals are an extension of the marketing arm of pharmaceutical companies. *Public Library of Science Medicine*, 2 (5) : e138.

SMITH, R. (2005b), Curbing the influence of the drug industry: a British view. *Public Library of Science Medicine*, 2 (9) : e241.

SMITH, R. (2006), The trouble with medical journals. *Journal of the Royal Society of Medicine*, 99 : 115–119.

SUAREZ-ALMANZOR, M. E., BELSECK, E., HOMIK, J., DORGAN, M., RAMOS-REMUS, C. (2000), Identifying clinical trials in the medical literature with electronic databases: Medline alone is not enough. *Controlled Clinical Trials*, 21 : 476–487.

YU, G., WANG, L. (2007), The self-cited rate of scientific journals and the manipulation of their impact factors. *Scientometrics*, 73 (3) : 321–330.

Appendix
Description of clinical trial process

A clinical trial usually comprises four steps or phases. Each phase is designed to respond to separate research questions. In Phase I, the researchers test a new drug or treatment on a small group of people, initially, in order to evaluate safety, determine a safe dosage range, and identify any side effects. In Phase II, the drug or treatment is given to a larger group of people in order to see if it is effective and to further evaluate its safety. Phase III deals with larger groups of people in order to: confirm effectiveness; monitor side effects; compare with commonly used treatments; and collect information that will allow safe usage of the drug or treatment. Usually, after the completion of this phase, the companies apply for authorization to commercialize the new drugs, from regulatory authorities. Finally, Phase IV studies are done after the drug or treatment has been marketed in order to gather information about the drug's effect on various populations and on any side effects associated with its long-term use.