

What Can Be Learned from Impact Factor of *Croatian Medical Journal*, 1994-2003?

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We calculated the impact factor (IF) of the *Croatian Medical Journal (CMJ)* for the 1994-2003 period, ie, including the years before its inclusion into the Institute of Scientific Information (ISI) database in 1999. There was a latency period of several years from the inclusion of the Journal in indexing databases to the IF increase. According to the ISI Journal of Citation Report, IF of the *CMJ* in 2001 and 2002, was 0.43 and 0.71 and journal was ranked 70 and 56, respectively, out of 107 journals under the category "Medicine, general and internal". The analysis of distribution and type of citations that contributed to the IF of the *CMJ* revealed that its increase mainly resulted from the increase in the number of fully independent citations and author auto-citations in journals other than *CMJ*. The factors that probably accounted for the IF increase were better international visibility, full-text free-of-charge online availability, and large number of international contributions, especially in some thematic issues.

Key words: Croatia; impact factor; publications

Impact Factor (IF) is a measure of the frequency with which the "average article" in a journal has been cited in a particular year (<http://jcrweb.com/www/help/hjcrjls2.htm>). It is calculated by dividing the number of current citations to articles published in the two previous years with the total number of articles published in those two years. Ever since Garfield and Sher (1) introduced it in the early 1960s, it has been widely recognized as a quantitative measure of a journal's quality. Many criticize it for being a sort of Procrustean bed, treating alike journals from different research areas, and an unfair measure of the quality of small journals, journals outside mainstream science and medicine, and journals covering fields where research takes longer time and number of citations cannot be high (2,3). It is influenced by the proportion of article types published in a journal, e.g., reviews, case reports, letters, and original articles (3,4). Furthermore, as an average measure of article quality, IF is inadequate because citation counts are not normally distributed and show great variations even in high-impact journals (3,5). In short, IF is as ambiguous as any other attempt to quantify quality. However, the fact remains that there is no better way to assess and recognize the impact of a journal in its field (6).

The *Croatian Medical Journal (CMJ)* was launched in 1992 and included in the Index Medicus/MEDLINE in 1998 and in the Current Contents/Clinical Medicine and expanded Science Citation Index (SCI) under the category "Medicine, general and internal" in 1999 (7). Since 2001, it has been included in the Journal of Citation Reports, the official publication of the Institute of Scientific Information (ISI) bringing in-

formation on impact factor (IF) and other measures of quality of journals indexed in ISI databases, such as immediacy index, cited half-life, and citing half-life. We calculated the *CMJ*'s IF for the 1994-2003 period, ie, including years before the Journal was indexed in the ISI citation databases. We also analyzed the structure of IF of the *CMJ* to determine which type of articles (independent or auto-citations) contributed to the Journal's IF and in what extent. This analysis could provide a useful feedback for the improvement of editorial decisions and long-term policy of our journal.

Methods

To identify citations to the *CMJ*, we performed electronic search of the ISI databases, SCI-Expanded, Social SCI (SSCI), and Arts & Humanities Citation Index (A&HCI) available at ISI Web of Science website (<http://wos.isitrial.com/CIW.cgi>) for each year in the 1994-2003 period. We searched all three available databases because *CMJ* publishes articles covering wide range of topics that may be cited in journals under different ISI categories. We manually searched for the journal auto-citations before 2001, when the *CMJ* had not been included in the ISI databases as a source journal, and added these citations to those found by electronic search of the ISI databases.

To be able to calculate the *CMJ*'s IF, we first counted potentially citable articles published in each volume of the *CMJ*, ie, original scientific articles, review articles, and case reports but not letters, meeting reports, news and comments, and regular columns. Then we searched ISI databases for citations from the previous two years to *CMJ* articles published in the current year (numerator), and divided them with the number of citable articles published in the same period. Each cited reference was matched with its citing reference(s).

The structure of citing references was further analyzed to estimate the proportion of auto-citations and independent citations. We distinguished two types of auto-citations, journal auto-

citations and author auto-citations. Journal auto-citations were considered citations in the *CMJ* to the articles published in the *CMJ*, and author auto-citations were considered citations where one of the authors appeared as the author at both citing and cited articles, regardless of his or her rank on the author byline. Since these two types of auto-citations sometimes combine, we established four categories of citations to distinguish which of these categories had a major share in the *CMJ*'s IF, and how their number changed over time. These categories were as follows: (a) fully independent citations – citations to articles published in the journal by articles published in other journals and by independent authors; (b) journal auto-citations by independent author; (c) author auto-citations in other journals; and (d) both author and journal auto-citations.

To establish the contribution of individual *CMJ* issues to the general IF, we counted the number of citations per issue for two subsequent years included in the IF calculation. We also searched ISI databases for the total number of citations to the *CMJ* for all available years to identify the most cited articles according to the names of the authors and the most cited issues.

Furthermore, among the cited articles, we analyzed the distribution of citations among different categories of articles. We divided articles in the four main categories (original articles, reviews, case-reports, and correspondence) and separately analyzed two additional categories, Editorial and Forum, contained within specific sections of the *CMJ*.

We also analyzed number of citations for each article, to separate articles with highest citation numbers in total number of citations (in all years of ISI's databases) and among citations that contributed to the IF.

Results

Since its beginning, the *CMJ* has published a total of 865 articles eligible for IF calculation. Between 1993 and 2001, the number of articles per volume varied between 46 and 72. When the Journal changed the frequency of publication from quarterly to bi-monthly in 2001, it reached a stable hundred (Fig. 1).

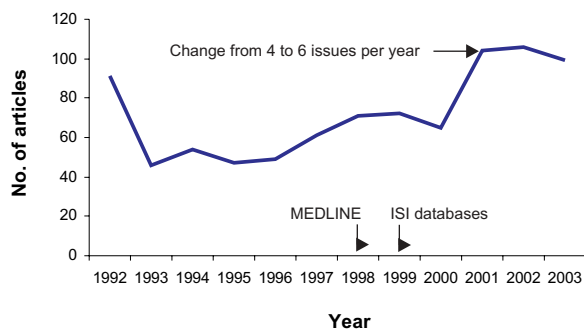


Figure 1. Absolute number of articles published in the *Croatian Medical Journal* in the 1994-2003 period.

According to our calculations, *CMJ*'s IF in 2002 has almost doubled in comparison with previous years (Fig. 2). Before 2002, it showed irregular ups and downs, oscillating between 0.16 and 0.36, which is more than 20% variation. In 2002, it reached the value 0.64, and our preliminary data for 2003 point to the IF value of 0.89. Furthermore, the pattern of the IF changes followed the increase in the absolute number of citations to the articles published in the *CMJ* in the previous two years (Fig. 3). Until the end of 2001, the absolute number of citations was below 50, in 2002 it more than doubled (to 109), and in 2003 it reached 187.

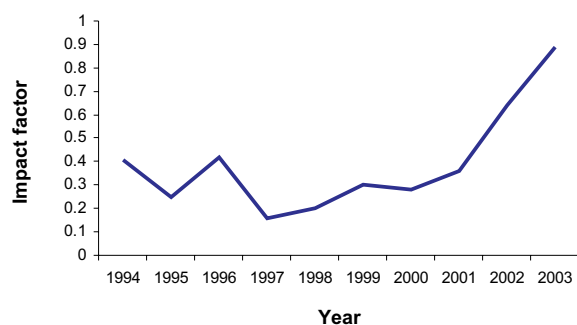


Figure 2. Impact factor of the *Croatian Medical Journal* in the 1994-2003 period.

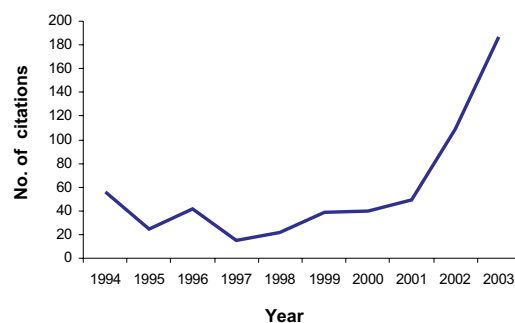


Figure 3. Absolute number of citations to articles published in the *Croatian Medical Journal* in the 1994-2003 period.

The official data from the ISI JCR on the *CMJ*'s IF were available for the last two years: 0.43 in 2001 and 0.71 in 2002. According to its IF in 2002, the *CMJ* was ranked 58 out of 107 journals categorized under "Medicine, general and internal" by ISI – almost middle position (Fig. 4). However, the differences between the IF of *CMJ* and "neighboring" journals on the 2002 list, as well as most other journals, are negligible in comparison with IF of the top four journals with IF above 10 – *New England Journal of Medicine*, *Journal of American Medical Association (JAMA)*, *The Lancet*, and *Annals of Internal Medicine*.

We also analyzed the structure of IF, ie, the citation distribution with respect to the proportion of auto-citations and independent citations to *CMJ* articles. We found an increasing trend in the absolute number of both journal- and author-independent citations to the *CMJ* since 1998. Total author auto-citations (for both other journals and *CMJ*) have accounted for a minor part of the total citation number in all years analyzed. However, in 2002 and 2003, we observed the increase in the number of author auto-citations in other journals, especially in comparison with the author and journal auto-citations (Fig. 5). The journal auto-citations (both author-independent and author auto-citations) accounted for quite a large part of total citation number, especially in the 1994-1995 period. However, their number decreased in the several subsequent years (1997-2000), and since 2001 it has been following the trend of independent citations. In 1994 and 1995, the proportion of journal auto-citations largely exceeded the proportion of journal-independent citations, making 62% and 80% of total citations, respectively (Fig. 6). In

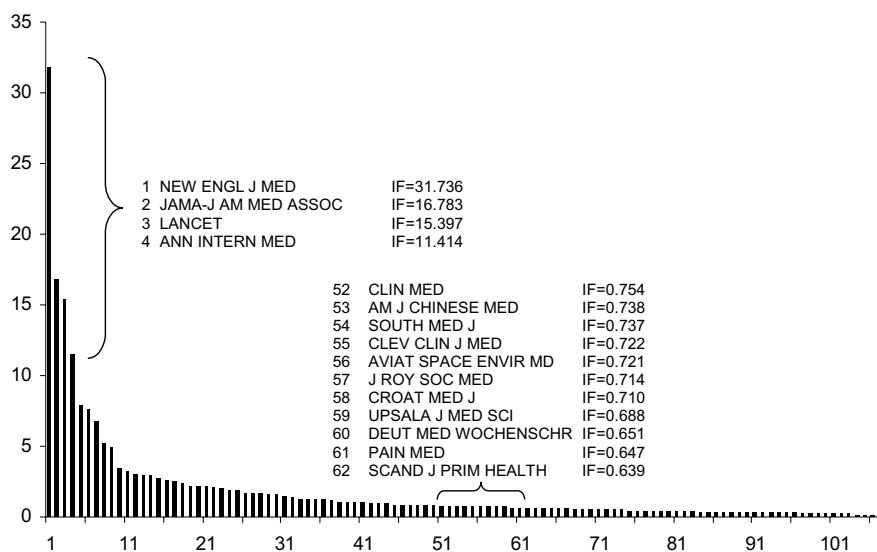


Figure 4. Rank of the *Croatian Medical Journal* (Croat Med J) in the group "Medicine, general and internal" in 2002, according to the Institute of Scientific Information (ISI) Journal of Citation Report (JCR). Journals are ranked according to their impact factors (IF).

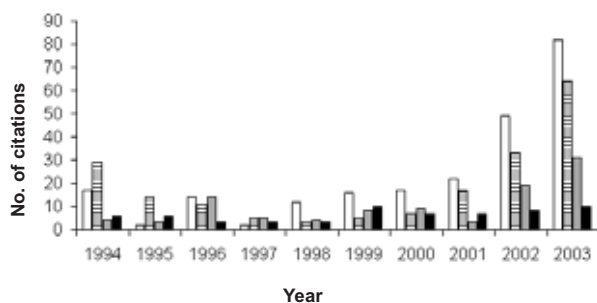


Figure 5. Distribution of independent citations and auto-citations to articles published in the *Croatian Medical Journal* in the 1994-2003 period. Citations are divided into four categories: fully independent citations (open bars) – citations to articles published in the journal by articles published in other journals, and by independent authors; journal auto-citations (striped bars) – citations by independent authors to articles published in the same journal as the cited article; author auto-citations in another journal (grey bars); and author and journal auto-citations (closed bars).

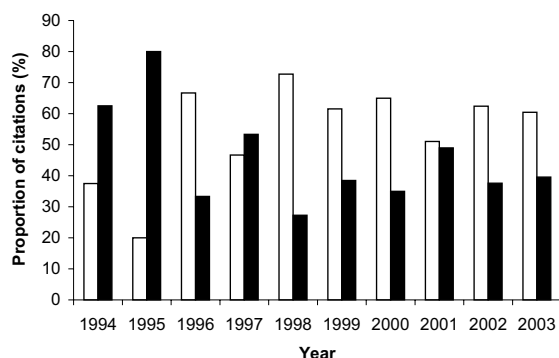


Figure 6. Proportions of journal-independent citations (open bars) vs journal auto-citations (closed bars) in the *Croatian Medical Journal*, 1994-2003.

1997, journal auto-citations were also more numerous than journal-independent citations, but afterwards their percentage dropped and kept oscillating around 37%.

As the *CMJ* occasionally publishes thematic issues, we wanted to establish in what manner such issues contribute to the journal's IF. We counted the number of citations per issue to see which issues contained the articles that brought the greatest number of citations. To determine the most cited issues that improve the Journal's IF, we took only cites to the articles that entered the IF calculation (Table 1). The issue that contributed the most to the IF was the thematic issue in Forensic Sciences published in 2001; the second in line was War Supplement 2 from 1992, followed closely by a non-thematic issue No. 2 from 2001, thematic issue on Molecular Medicine from 2001, and the two *StudentCMJ* issues (Table 1). According to the total number of citations, the most cited issues were two recent thematic issues: the Public Health issue from 2002 and the DNA Analysis in Forensic Sciences issue from 2001, followed closely by the Impact of New Technologies on Medicine issue from 1999 (Table 2). Other well-cited issues belonged to the earlier period (1999, 1998, 1995, and 1994); their citations exceeded the two-year time window and therefore did not contribute to the Journal's IF.

Analysis of contribution of different article types to the *CMJ*'s IF revealed that citations to original articles formed the major proportion of the IF, oscillating

Table 1. Issues of the *Croatian Medical Journal* with highest number of citations contributing to the Journal's impact factor

No. of citations	Volume (No.)	Publication year	Note
67	42 (3)	2001	Forensic Sciences (thematic issue)
32	33 (S2)	1992	War Supplement 2
31	42 (2)	2001	regular issue
26	42 (4)	2001	Molecular Medicine (thematic issue)
24	42 (1)	2001	StudentCMJ
23	43 (1)	2002	StudentCMJ
23	40 (3)	1999	regular issue

between 40-80% (Table 3). However, original scientific articles accounted for approximately 70% of articles published in the *CMJ* (data not shown). Review articles, which made approximately 4% of published articles, accounted for 0-8% of citations per year, and case reports that roughly made 8% or published articles accounted for less than 4% of citations per year, except for 2000 when they accounted for 4 out of a total of 40 (10%) citations. Editorial section – quite a heterogeneous group of articles (around 8% or published articles) – accounted for 10-28% of all citations. Forum section, making around 10% of published articles, has been steadily increasing its share in the total citation number since it was introduced in 1999 (Table 3).

We analyzed total number of citations per each published article and number of citations that contributed to the IF. Since it was first published, the *CMJ* has received a total of 1,196 citations, of which 584

(49%) contributed to the IF. The remaining citations required a longer time to be cited. We found only 12 articles that received more than 10 citations each (Table 4). However, these articles contributed to the Journal's IF only moderately, with two of them having no citations in the years relevant for IF calculation. The majority of cited articles have been cited only once or twice, and much smaller number received three or more citations. In 2002 and 2003, there were 11 and 15 articles cited three or more times, respectively, whereas in the former years, there were three or less articles with three or more citations (data not shown).

Discussion

The *CMJ* is an expanding journal that continuously increases the number of published articles. In 1992, the first year of publication, the number of published articles almost equaled the average number of articles published during the last three years. This initial high article number was a consequence of additional two War Supplements included in the volume 33 from 1992, which accounted for the IF "drop" in 1993. The Journal's IF followed the increase in the publication rate. In 2002, it increased about 80%, compared with the previous year, and our preliminary data for 2003 indicate the 40% increase compared with 2002.

In comparison with ISI JCR data, our IF estimates for 2001 and 2002 were slightly lower. Such discrepancies in IF calculations have already been reported and ascribed to the possible differences in counts of source articles and in availability of citations through different ISI search systems (8). The numerator of the IF contains all cited articles, whereas the denominator

Table 2. Issues of the *Croatian Medical Journal* with the highest total number of citations, 1992-2003

No. of citations	Most cited issue		
	volume (No.)	publication year	contents
73	43 (2)	2002	Public Health and Peace (thematic issue)
67	42 (3)	2001	Forensic Sciences (thematic issue)
66	40 (3)	1999	Impact of New Technologies on Medicine (thematic Issue)
55	40 (2)	1999	Financing Health Care (thematic issue)
47	34 (1)	1993	regular issue
46	39 (3)	1998	Priorities in Health Care (thematic issue)
46	36 (1)	1995	regular issue

Table 3. Proportions of citations to different types of articles published in the *Croatian Medical Journal* according to Institute of Scientific Information databases

Article type	Proportion of citations (%) in year									
	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Original article	80.4	40.0	64.3	66.7	68.2	69.2	72.5	53.1	52.3	67.4
Review article	0.0	8.0	2.4	0.0	4.5	2.6	0.0	4.1	7.3	6.4
Case report	0.0	0.0	0.0	0.0	0.0	0.0	10.0	2.0	3.7	1.6
Editorial	14.3	24.0	19.0	13.3	22.7	15.4	10.0	28.6	18.3	12.3
Correspondence	5.4	28.0	14.3	20.0	4.5	10.3	5.0	6.1	5.5	2.7
Forum	0.0	0.0	0.0	0.0	0.0	2.6	2.5	6.1	12.8	9.6

Table 4. Articles with the highest total number of citations and their contribution to the two-year impact factor (IF) of the *Croatian Medical Journal*

No. of citations	Most cited article	
	cumulative	contributing to the IF
26	4	Hebrang A. Reorganization of the Croatian health care system. 1994;35:130.
21	0	Lang S. The Third Balkan War: Red Cross bleeding. 1993;34:5.
14	2	Janošić K, Lovrić Z. War surgery in Osijek during 1991/92 war in Croatia. 1995;36:104.
14	8	Bagarić I. Medical services of Croat people in Bosnia and Herzegovina during 1992-1995 war: losses, adaptation, organization, and transformation. 2000;41:124.
12	0	Husar J, Eltz J. Mobile surgical teams in Croatian Special Forces Unit. 1993;34:276.
11	2	Lang S. Challenge of goodness II: new humanitarian technology, developed in Croatia and Bosnia and Herzegovina in 1991-1995, and applied and evaluated in Kosovo 1999. 1999;40:438.
11	3	Lang S, Javornik N, Bakalić K, Swedlund S, Ghidi V, Luetic V, Culo B. "Save Lives" Operation in liberated parts of Croatia in the 1995: an emergency public health action to assist abandoned elderly population. 1997;38:265.
11	5	Marušić A, Marušić M. Small scientific journals from small countries: breaking from a vicious circle of inadequacy. 1999;40:508.
10	7	Duraković A. On depleted uranium: Gulf War and Balkan Syndrome. 2001;42:130.
10	1	Kozarić-Kovačić D, Folnegović-Šmalc V, Marušić A, Arcel LT. International Rehabilitation Council for Torture Victims (IRCT): experiences after two years of providing psychosocial help to women-victims of war and their families from Bosnia and Herzegovina and Croatia. 1995;36:67.
10	2	Lang S. Human rights medicine and health: tragic symbols of Eastern Slavonia that became a reality. 1995;36:3.

contains all citable articles. Citable articles include only original articles, reviews and case reports, but not letters, essays or viewpoints. The discrepancy between our data and ISI data could also be a consequence of including the greater number of articles to the denominator in our calculations.

However, the increase in IF is obvious irrespective of the differences in absolute IF values calculated by ISI and ourselves. We can only speculate about the reasons for such increased visibility of the *CMJ*. It has been shown that free online availability of an article positively correlates with the number of citations it gets, which may contribute to the increase of the Journal's IF (9). Thus, IF increase could be ascribed to the availability of the full-text articles at the *CMJ's* website since 1996, but it may also be the result of now several years long inclusion in international indexing databases and therefore better visibility.

We further analyzed the number of auto-citations, since it is known that auto-citations can positively influence the IF (10). Interestingly, the number of independent citations has been climbing since 1998, which is the year when the Journal was included in Index Medicus/MEDLINE. This may be interpreted as a consequence of the increased visibility of the *CMJ*. Author auto-citations in other journals also increased, especially when compared to author auto-citations in the *CMJ*. Those citations may possibly contribute to the overall citation rate of the *CMJ* by referring the readers of these other journals to *CMJ* articles cited in their articles. Admittedly, journal auto-citations are still an important contributor to the Journal's IF. In the first years of the *CMJ*, journal auto-citations accounted for the major part of its IF, which is in accordance with the conclusion that journal auto-citations weakly contribute to the visibility of the small peripheral journal, especially if it is not indexed in major databases or available online (9).

Concerning the contribution of thematic issues to the *CMJ's* IF, our findings imply that such contribution actually depends on the general publishing dynamics in the area covered by that thematic issue, e.g., forensic sciences. On the other hand, the high citation number of the Forensic Sciences thematic issue may also be explained by a generally increased visibility of the journal.

Major contributors to the IF of the *CMJ* are original articles. Although correspondence and short articles may expand the IF by being cited, because they are not counted as citable articles, they account for a very small proportion of total yearly citations. Their proportion in total number of citations was especially low in 2002 and 2003. Review articles and case reports also contributed with small proportion to the total citation number. Such proportion corresponded to the overall frequency by which those article types were published in the *CMJ*. Editorial section often contains articles submitted by internationally recognized contributors, which may explain such a high citing rate for this type of article among cited references. We can conclude that the citing rate of a specific article type corresponds to its general frequency of publishing in the *CMJ*. This parallels the number of

citations per cited article that contribute to the IF. An article received one or two citations on average, whereas only a minority of articles received three or more citations.

In conclusion, we may say that the *CMJ* keeps climbing on the ISI JCR's rank list in the category "Medicine, general and internal". Even when its IF was the lowest, in 1997, its rank would have been 89 out of 100 had it been included in the ISI JCR. In 2002, the *CMJ* was ranked 58 out of 107 journals, and in the 2003 JCR edition, its rank may be expected to be even higher. The most positive finding was the increase in the number of independent citations, probably due to many international contributions, especially in the thematic issues. Hopefully, this trend will continue in the future. We should keep the present general quality of the journal, ie, regularity of publication, international pool of reviewers and contributors, high percentage of original scientific articles, high quality standards, and author-friendly policy (7). Furthermore, education of our authors through close cooperation with *CMJ* editors may enable them to publish more in other international journals, bringing the *CMJ* closer to the focus of international readership.

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Received: January 7, 2004

Accepted: January 21, 2004

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