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LETTER

Determinants of downloads and citations for articles published in *Intensive Care Medicine*

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Dear Editor,

Three themes are key to a journal's mission and vision statements: framing the contemporary and key issues of our time, showcasing the best science, and educating the targeted readership [1]. Manuscript citations and downloads are considered to represent the first and second themes. A careful understanding of the determinants of citations and downloads is therefore important to facilitate improvement in all the metrics that support the success of any journal. This study is part of a global quality improvement process for articles published in *Intensive Care Medicine* (ICM) [2–4].

All papers accepted in 2012 and 2013 were tracked through the Web-of-Science database for referencing and the Springer Link statistics report for downloads from 01 Jan 2013 to 31 Dec 2014. Spearman correlation coefficient was used to assess the relationship between manuscript citations and downloads. The relative risk of being downloaded or cited a single time was modeled using a negative binomial regression.

The variables introduced into the model were selected from available data based on potential importance by five of the authors (JFT, GC, SR, ML, EA). These included the country of the submitting author, manuscript type (ICM categories), keywords, topics, number of authors, H-index of the first and last authors, and whether it had been published with open access or not. The time since manuscript publication was added as a fixed covariate with eight categories because the linearity of the logit of this variable was uncertain. Statistical analysis was performed using SAS 9.4 software, and a p value of 0.05 or less was considered significant.

Overall 404 articles were studied: 304 (61%) original articles (59 pediatric), 46 (11.5%) reviews (including 10 conference reports and expert panel papers), 32 (8%) experimental studies, and 22 "what's new" reports. Major topics were sepsis (21%), ventilation (20%), and hemodynamics (16%). Only 6% of the papers were open access. The median (IQR) number of authors per articles was 7 (5–9). The H-index of first and last authors were 9 (4–16) and 23 (15–37), respectively. The median total number of 2013–2014 downloads was 696 (IQR 467–1083), and the median total number of 2013–2014 citations was 6 (4–11) per article. The correlation between citations and downloads was significant but relatively weak, indicating that only 28% of the variability of downloads was explained by the variability of citations ($R^2 = 0.28$, $p < 0.0001$).

Downloads and citations were significantly related to the time since publication.

Among the variables studied, those independently predicting download were manuscript type (more downloads for conference reports and expert panels, reviews, and the "what's new" series), higher last author H-index, inclusion of "septic shock" as a keyword. Those independently predicting citation were manuscript type (more citations for conference reports and expert panels, review articles, and original manuscripts); more authors; higher first author H-index. Open access and more time since manuscript publication were associated with more both more downloads and more citations (Table 1).

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Table 1 Determinants of citations and downloads (multivariate analyses)

Variables	Items	Relative risk (95% CI)	*p* value*
Determinants of downloads[b]			
Time since publication (months)	22–24	1.14 (0.93; 1.41)	0.2018
	19–21	1.31 (1.06; 1.63)	0.0118
	16–18	1.1 (0.9; 1.36)	0.3498
	13–15	1.08 (0.88; 1.32)	0.4848
	10–12	1.21 (0.98; 1.5)	0.0693
	6–9	1.29 (1.07; 1.57)	0.0088
	3–5	0.98 (0.8; 1.2)	0.8365
	Less than 3	Ref.	**0.0408***
Keyword	Septic shock	1.57 (1.22; 2.02)	0.0005
Type of article	Experimental	Ref.	**< 0.0001***
	Conference reports and expert panel	20.41 (13.79; 30.2)	< 0.0001
	Original	1.97 (1.61; 2.41)	< 0.0001
	Pediatric original	1.24 (0.99; 1.55)	0.062
	Review	4.28 (3.31; 5.52)	< 0.0001
	What's new in intensive care	3.18 (2.35; 4.31)	< 0.0001
H-index of the last author[c]	< 15	Ref.	**0.021***
	15–23	0.99 (0.85; 1.14)	0.85
	24–37	0.99 (0.85; 1.15)	0.93
	> 37	1.2 (1.04; 1.4)	0.016
Open access article	Yes	1.49 (1.18; 1.87)	0.0007
Determinants of citations[a]			
Time since publication (months)	22–24	1.68 (1.29; 2.2)	0.0001
	19–21	1.48 (1.13; 1.95)	0.0045
	16–18	1.38 (1.05; 1.82)	0.0198
	13–15	1.21 (0.92; 1.58)	0.1715
	10–12	1.19 (0.91; 1.56)	0.2117
	6–9	1.32 (1.02; 1.69)	0.0316
	3–5	0.75 (0.57; 0.98)	0.0363
	Less than 3	Ref.	**< 0.0001***
Type of article	What's new in intensive care	Ref.	**< 0.0001***
	Conference reports and expert panel	4.6 (2.52; 8.41)	< 0.0001
	Experimental	1.07 (0.68; 1.69)	0.77
	Original	1.8 (1.23; 2.63)	0.0025
	Pediatric original	1.1 (0.72; 1.67)	0.66
	Review	3.55 (2.39; 5.28)	< 0.0001
Number of authors[c]	< 5	Ref.	**0.0003***
	5–6	1.03 (0.84; 1.28)	0.76
	7–9	1.24 (1.01; 1.52)	0.042
	> 9	1.5 (1.21; 1.87)	0.0003
H-index of the first author[c]	< 4	Ref.	**0.01***
	4–9	1.21 (1.01; 1.45)	0.037
	10–16	1.35 (1.1; 1.65)	0.0036
	> 16	1.36 (1.12; 1.66)	0.0023
Open access article	Yes	1.31 (1.01; 1.7)	0.044

NB1: The relative risk of the binomial regression indicates the relative risk of being cited (downloaded) one-fold more

NB2: 5 International consensus conferences were excluded from the analysis: "Consensus statement of the ESICM task force on colloid volume therapy in critically ill patients"; "International evidence-based recommendations for point-of-care lung ultrasound"; "The Berlin definition of ARDS: an expanded rationale, justification, and supplementary material"; "Contemporary extracorporeal membrane oxygenation for adult respiratory failure: life support in the new era"; "Surviving Sepsis Campaign: international guidelines for management of severe sepsis and septic shock, 2012"

**p* value in bold indicate the overall statistical significance within one variable with more than two items

Table 1 (continued)

[a] Parameters significantly associated with citations in the univariate analysis adjusted on the time of exposure were country of the submitting author, multinational origin, keywords (RR > 1 septic shock, RR < 1 pediatrics), type of article, topic (RR < 1 for pediatrics and ethics), open access, number of authors, H-index of the first and of the last authors

[b] Parameters significantly associated with downloads in the univariate analysis adjusted on the time of exposure were country of the submitting author, multinational, keywords (RR > 1 septic shock, RR < 1 pediatrics), type of article, topic (RR < 1 for pediatrics and ethics), open access, number of authors, H-index of the first and of the last authors

[c] The quantitative variables were categorized according to quartiles of distribution

This study provides some important information on what leads to manuscript downloads or citations. Although the findings argue for publishing articles from established and renowned researchers, one of the goals of the journal's editorial board is to spot new talent, and this is reflected in the finding that 50% of first authors had an H-index of less than 10.

Optimizing manuscript keywords may improve ICM article downloads. Collaborative authorship should also be encouraged. Although ICM is not an open access journal, our findings suggest that authors agreeing to open access in our journal could potentially benefit from this concession.

Interestingly, article type was associated differently with downloads and citations. The "what's new" series provides rapid up-to-date information immediately accessible for a large cohort of readers and likely explains the high downloads. On the other hand, original articles were the key driver of citations.

The analysis of altmetrics [5], considered to frame the contemporary and key issues of our time, remains to be evaluated. Given the marked rise in citations and downloads over the past 6 years, a repeat analysis of the determinants of ICM paper's citations and downloads in 2018 in association with a qualitative assessment of the articles published will also be helpful [6, 7].

Unfortunately, we were not able to assess the impact of the quality of the article using the available metrics. To the best of our knowledge there are no existing tools able to assess manuscript quality across a broad spectrum of article types. A separate quality assessment of randomized controlled trials or review articles might be one way to refine our results.

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Compliance with ethical standards

Conflicts of interest
The authors report no conflicts of interest for this letter.

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