Comparison of the share of documents and citations from different quartile journals in 25 research areas

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Abstract
The total number of publications and/or the share of total publications in a given quartile, usually first quartile (Q1), is increasingly used in performance-based funding of public research. However, the quality significance of publishing in Q1 journals is very different depending on the research areas. Both the expected probability to publish in Q1 journals, given by the number of papers published in each quartile, as well as the average citations received by Q1 publications compared to other quartiles, is largely dependent on the research area. This study analyzes the share of articles published in each quartile in the 25 largest research areas indexed by Science Citation Index-Expanded (Web of Science) and their main citation characteristics aiming to enrich the discussion about journal-based evaluation systems and specifically the number and/or the share of publications in Q1. It was found that the average share of documents published in Q1 was 45.7% (38.4% for articles and reviews), varying from 25.4 to 85.6% (from 17.1 to 88.9% for articles and reviews) depending on the area. Q1 publications were cited, on average, 2.07 times more than Q2 publications (2.41 times for articles plus reviews), however, depending on the area, this ratio varied from 0.9 to 6.1 (from 1.7 to 5.4 times for articles plus reviews). Q1 (total publications or articles plus reviews), received, on average, 65% of total citations of the research area, but again this value varied from 46 to 98% depending on the area.

Keywords Journals quartiles · Impact factor · Citations · Uncitedness · Research areas

Introduction

Journal Impact Factor (JIF) from Journal Citation Reports (JCR) (Clarivate Analytics) is defined as the number of citations received in a year of the articles published in that journal during the two preceding years, divided by the total number of "citable items" published in that journal during the two preceding years. In other words, JIF is the average number of citations of the papers published in a journal, calculated according to a specific formula (Brito and Rodríguez-Navarro 2019).

Citation impact indicators nowadays play a prominent role in the evaluation of scientific research (Waltman 2016). Although several other types of citation-based measures of journal impact have been recently proposed, such as the SCImago Journal Rank, the Eigenfactor, and the source normalized impact per paper, JIF from JCR is still the most widely used (Lozano et al. 2012). Researchers now consider JIFs when choosing their publication outlets; journal editors formulate policies explicitly designed to improve their IFs; and publishers advertise their IFs on their websites (Lozano et al. 2012). Many bibliometricians reject the use of the impact factor and other journal-level indicators for evaluating individual publications as the citation impact of a journal offers only a weak predictor of the citation impact of individual publications because the distribution of citations over the publications is known to be highly skewed (Waltman 2016). However, JIF is one of the most frequently used scientometric indicators to evaluate the scientific merit of papers published in a journal

(Campanario and Cabos 2014) and thus for the evaluation of research and researchers (Brito and Rodríguez-Navarro 2019). It is often used as a basis for decision-making for research grants, hiring and even salaries (Campanario and Cabos 2014).

One of the key principles of citation analysis is that citation counts of publications from different fields should not be directly compared with each other, as there are large differences in the citation density, i.e. the average number of citations per publication, among fields (Waltman 2016). Due to incomparability across different research areas, fieldnormalized JIFs such as JIF quartiles have been introduced and increasingly adopted in research evaluation (Liu et al. 2016). Quartile rankings are calculated for each journal in each subject category according to which quartile of the journal occupies in the impact factor distribution of that subject category. Q1 denotes the top 25% of the impact factor distribution, Q2 the middle-high position (between top 25 and top 50%), Q3 the middle-low position (top 50 to top 75%) and Q4 the lowest position (bottom 25% of the impact factor distribution).

The total number of publications and/or the share of total publications in a given quartile, usually first quartile (Q1), can play and important role in performance-based funding of public research (García et al. 2012). Q1 indicator, for example, has been previously used to compare individual researchers (Bornmann and Marx 2014; Bornmann and Williams 2017), institutions (Bornmann et al. 2013; Chinchilla-Rodríguez et al. 2016), to evaluate the impact of university excellence initiatives (Matveeva et al. 2019), etc.

On first impression, one could expect that the number of documents published in each quartile would be around 25% of total publications. This would implicitly assume that all journals covered in the same JCR subject category publish similar number of documents, which is not the case (Liu et al. 2016). Even one could also expect Q1 journals had the lowest number of publications compared to other quartile journals due to high level of exigence of these journals, which is usually translated into low acceptance rates (Ibáñez et al. 2013). Gu and Blackmore (2017), for example, demonstrated the acceptance rates in Q1 journals are much lower than in other quartiles journals, the other quartile journals having similar acceptance rates. Other authors have also found there is a negative correlation between journal acceptance rates and its impact factor, however, these correlations are generally not very strong (Kurmis and Kurmis 2006; Sugimoto et al. 2013, Lamb and Adams 2015).

However, as demonstrated by Huang (2016) in a very comprehensive study analyzing 12 subject categories from SCI and other 12 from Social Science Citation Index (SSCI), JIF and articles number in scholarly journals are positively correlated, i.e. Q1 journals publish

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more issues and articles than other quartiles journals. This correlation was examined using a Lorenz curve $y(x)$ and its subsequent parametrization, where y_i represents the cumulative number of articles published in a journal and x_i denotes rank of the impact factor after normalization. Other studies focused only in specific areas have obtained the same results, i.e. in computer science (Ibáñez et al. 2013) or in gastroenterology and hepatology (Elizee et al. 2012). This is explained by the fact that authors are urged to publish in journals with the highest impact factor, these journals receiving more manuscripts and publishing more articles despite their lower acceptance rates (Ibáñez et al. 2013).

Two short communications recently published have shown that the share of papers published in Q1 journals is much higher than the 25% expected. On the contrary, the share of publications in Q3 and especially in Q4 were significantly lower than 25%. Liu et al. (2016) analyzed 8506 journals from the 2015 edition of JCR—Science Edition, considering only two document types (articles and reviews). The journals indexed in more than one research area were allocated to only one quartile to avoid double counting, using two

different modes: the "optimistic" mode (this journal is allocated to the higher quartile) and the "pessimistic" (this journal is allocated to the lower quartile). These authors obtained the following share of articles and reviews in each quartile journals: Q1 (36.4–45.9%), Q2 (24.6–27.0), Q3 (16.8–20.1) and Q4 (12.7–16.5%), these intervals being defined by the "optimistic" and "pessimistic" modes. It is important to notice that the share of journals in different quartiles is not the same, e.g. Q1 share of journals was 27.5% in the "optimistic" mode and only 20.3% in the "pessimistic mode", which have a clear influence on the obtained results.

Liu et al. (2018) again studied the journals from 2016 JCR-Science Edition but also extended the analysis to 2016 JCR-Social Sciences Edition. They again considered only articles and reviews document types, but only one mode of avoiding double counting of journals: the "optimistic" mode. They obtained similar results for sciences: 44, 27, 16 and 13% share of publications for Q1, Q2, Q3 and Q4, respectively. The values for Social Sciences, again under "optimistic" mode, were slightly lower but following the same trends than observed in Sciences, i.e. 36, 29, 20 and 15% share of publications for Q1, Q2, Q3 and Q4, respectively.

As the number of articles or the share of articles published in certain quartiles of the journals impact factor, usually in Q1, is increasingly used for evaluation purposes, it would be interesting to analyze both the share of articles published in each quartile and several citation indicators for these publications in different research areas. None of the previous studies analyzed the differences between research areas nor any citation parameters of the documents published in each quartile journals, but only the share of total documents published in each quartile. Furthermore, in these studies the share of journals in each quartile were not the same due to the "optimistic" and "pessimistic" modes used for avoiding the double counting, and only considered articles and reviews document types.

Thus, the main aim of this study is to analyze the share of articles published in each quartile in the 25 largest research areas indexed by the SCI-E from Web of Science, covering more than 50% of total publications in the database, and their main citation characteristics (share of total citations in the area, average citations per publication and uncitedness rates). This would allow comparing the level of exigence and/or quality differences among the publications of different quartiles in different research areas. Furthermore, as the citation characteristics are greatly dependent from the document types and the share of these document types varies greatly among research areas, the study will be carried out both in total publications and the main document types, i.e. articles plus reviews. Authors believe the findings of this study may be useful to enrich the discussion about journal-based evaluation systems and debate whether the use of JIF quartiles, especially the share of papers in Q1 journals, allows fair comparisons among researchers from different areas.

Methodology

The scientific production of different research areas has been analyzed through the Science Citation Index Expanded (SCI-E) database from Web of S cience® Core Collection database (Clarivate Analytics). The study has circumscribed to the 25 largest subject categories in terms of publications by year 2015. The journals of each subject category has been grouped in Q1, Q2, Q3 and Q4 according to their impact factor extracted from 2015 JCR. All the documents published by these journals were retrieved without any restrictions on the document types, and always using the International Standard Serial Number (ISSN) for the identification of the journals of each quartile. Along the study, the results considered both all document types and only articles plus reviews. In some cases, the observed trends are

similar with both document types, however, in some cases, it is preferred to consider only articles plus reviews.

To compare the share of documents and some of the most relevant citation indicators by different quartile journals in the 25 selected research areas, the following items were analyzed. First, the share of publications by quartiles and related to this, the average number of articles published by quartiles journals. Then, the average citations received by each publication by quartiles and the share of total citations received by quartiles, were analyzed. The number of citations of a publication and the total citations received by quartile journals were counted at September 2018 from SCI-E data (Web of Science).

Finally, the share of uncited publications by quartiles journals was evaluated. Studies related to citation of papers and authors, and especially highly cited ones, usually attract much attention, one reason being that citations act as indicators in individual and institutional evaluations (Liang et al. 2015). However, the opposite of cited papers, i.e. uncited papers, is a less frequent but valuable citation indicator. "Being cited" and "being uncited" are relative notions. Being cited is usually determined with respect to a given database (in the present study, SCI-E from Web of Science). If a publication is cited in this database, then certainly the publication is cited but if the publication is not cited in this database, this does not prove that it is totally uncited. "Being uncited" is also a temporal phenomenon, a publication may be uncited at the day when the evaluation is carried out, however it may be cited later (Liang et al. 2015). In fact, the share of uncited papers decreases rapidly with time since publication (Wallace et al. 2009). In the present study, the uncitedness of the 2015 publications has been evaluated at Sept. 2018, around 2.75 years since publication. Whatever the case, one should not interpret that uncited papers are not being read, or do not contribute to scientific progress (Garg and Kumar 2014).

Results

Research areas analyzed

The research areas selected for this analysis were the 25 subject categories from SCI-E having the greatest number of publications in 2015. Table 1 shows their main characteristics in 2015: number of publications, number of journals and average documents per journal. As

Table 1 Main characteristics of the largest 25 subject categories selected for the study (2015)

Rank	Subject category	TP	NJ	APJ
1	Materials Science Multidisciplinary	88,415	271	326.3
2	Oncology	83,347	213	391.3
3	Chemistry Multidisciplinary	72,251	171	422.5
4	Biochemistry Molecular Biology	68,826	289	238.2
5	Multidisciplinary Sciences	65,547	63	1040.4
6	Chemistry Physical	62,841	144	436.4
7	Neurosciences	58,407	256	228.2
8	Surgery	57,934	200	289.7
9	Physics Applied	57,043	145	393.4
10	Engineering Electrical Electronic	55,157	257	214.6
11	Pharmacology Pharmacy	52,095	255	204.3
12	Clinical Neurology	49,543	193	256.7
13	Medicine General Internal	46,291	155	298.7

14	Cell Biology	45,198	187	241.7
15	Environmental Sciences	44,683	225	198.6
16	Cardiac Cardiovascular Systems	44,294	124	357.2
17	Immunology	37,572	151	248.8
18	Medicine Research Experimental	36,492	124	294.3
19	Engineering Chemical	34,879	135	258.4
20	Nanoscience Nanotechnology	34,720	83	418.3
21	Gastroenterology Hepatology	34,192	79	432.8
22	Biotechnology Applied Microbiology	33,214	161	206.3
23	Hematology	32,217	70	460.2
24	Radiology Nuclear Medicine Medical Imaging	31,271	124	252.2
25	Public Environmental Occupational Health	29,849	173	172.5
	Sum	1,256,278	4248	–
	Average	50,251	169.9	

NJ number of journals, *TP* total publications, *APJ* average publications per journal

observed, the number of journals indexed in each subject category varied from 63 (Multidisciplinary Sciences) to 289 (Biochemistry Molecular Biology), the average being 169.9 and the median 161.0. Globally, these subject categories represented 1,024,051 documents from 1,879,609 documents indexed in SCI-E in 2015, i.e. 54.5% total publications. The number of total documents is smaller than the sum in Table 1 (1,256,278 publications) due to some documents were published in journals indexed in more than one subject category.

Share of publications by quartiles

Figure 1a shows the box-plot for the share of total documents published in each quartile for the selected subject categories. As commented before, the expected share of publications in each quartile would be roughly 25%. However, as Fig. 1a shows, this is only the case for publications in Q2 journals, where the average share of publications was 25.6%, although varying largely among the different areas (from 6.1 to 37.3%). Nevertheless, the average

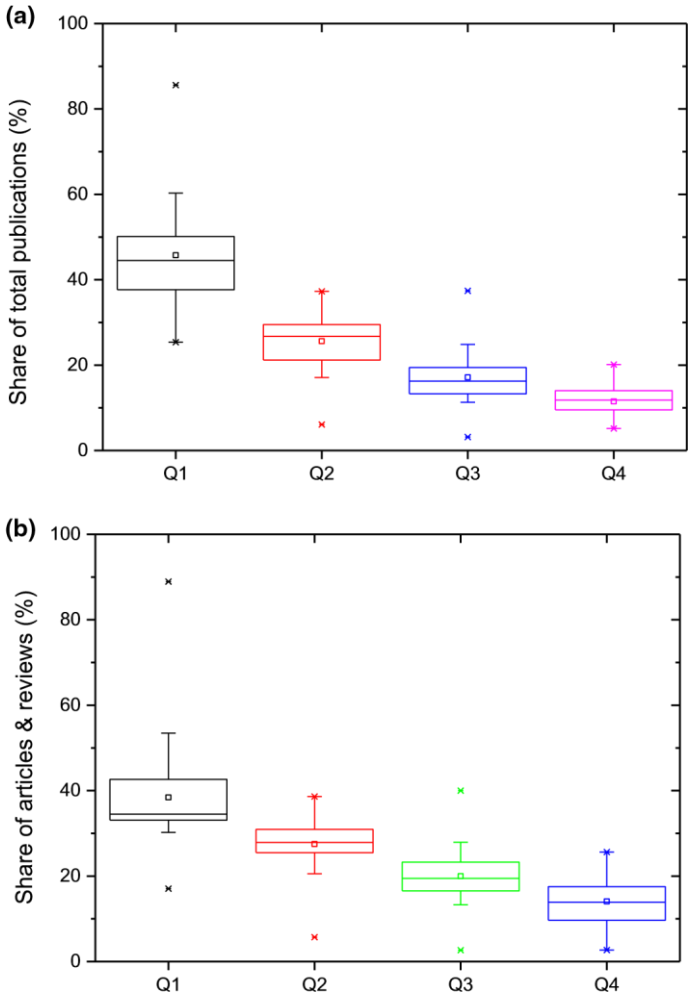

Fig. 1 Box plot for the share of **a** total publications and **b** articles plus reviews, in each quartile of the 25 largest subject categories in WoS (2015 publications). The box represents the 25th, 50th and 75th percentiles, "□" is the average, and "x" represent the minimum and maximum values

share of documents published in Q1 journals is almost double than expected (45.7%), varying from 25.4% (Medicine Research Experimental) to 85.6% (Multidisciplinary Sciences). On the contrary, the share of documents published in Q3 and Q4 journals is much lower than expected: 17.1% in Q3 (varying from 3.2 to 37.4%) and 11.5% in Q4 (varying from
5.1 to 20.1%). This means the number of documents published in Q1 journals were 1.78, 2.67 and 3.97 times as large as those published in Q2, Q3 and Q4 journals, respectively.

The same trends were also observed when only articles plus reviews were considered, however, the differences among quartiles were slightly lower (see Fig. 1b). In this case, the share of articles and reviews published in Q1 journals was around seven percentage units lower (38.4%) than for total publications, varying from 17.1% (Medicine Research Experimental) to 88.9% (Multidisciplinary Sciences). The average share of articles and reviews published in the other quartiles, however, increased 2–3 units: 27.5% in Q2, 20.0% in Q3 and 14.1% in Q4.

Therefore, Q1 journals published 1.40, 1.92 and 2.73 times more articles and reviews than Q2, Q3 and Q4 journals, respectively.

Table 2 compares the share of publications by quartiles obtained in the present study with the existing literature, basically Liu et al. (2016, 2018). As observed, there is a strong agreement with the previous literature, especially when the values from literature were recalculated to avoid the differences in the number of journals considered in each quartile.

Next, the main differences among different research areas were analyzed (Table 3), both for total publications and only articles plus reviews, which show very similar trends. Multidisciplinary Sciences is the area in which the share of documents published in Q1 journals is the greatest (85.6–88.9%). Other areas, in which the share of documents published in Q1 is especially high (> 40%), independently of the document types considered, are Engineering Chemical, Materials Science Multidisciplinary, Cell Biology, Nanoscience Nanotechnology, Chemistry Physical and Environmental Sciences. On the other side, the areas with the lowest share of documents published in Q1 journals were: Medicine Research Experimental, Public Environmental Occupational Health, Pharmacology Pharmacy, Immunology and Biochemistry and Molecular Biology.

It was identified a group of research areas, mostly related to Medicine, where the share of total documents published in Q1 is especially high but not the share of articles and reviews. This is the case for Gastroenterology Hepatology (60.3% of total documents, 30.2% articles and reviews), General Internal Medicine (58.9% of total publications, 33.5% articles and reviews), Oncology (50.1% of total publications, 33.4% articles and reviews), Radiology Nuclear Medicine Medical Imaging (46.7% of total publications, 33.8% articles and reviews) and Clinical Neurology (45.7% of total documents, 30.2% articles and reviews). This is explained by the large share of other documents different to articles and reviews in Q1 journals, mainly meeting abstracts.

These first results have two clear implications. First, around 40% of the documents were published in Q1 journals (45.7% for total publications and 38.4% for articles and reviews), compared to the 25% theoretically expected. Second, the expected probability to publish in Q1 journals is very different depending on the research areas. As commented before, there are research areas in which the expected probability to publish in Q1 journals is as high as 50%, while in other research areas, the probability is around two times lower (20–40%). The expected probability to publish in Q1 journals cannot be considered an indicator of the rejection rates in these journals (which were not considered in this study), however, it indicates the expected share of publications from a researcher published in Q1 journals. An author having a share of 50% publications in Q1 journals means different depending on the average share of publications in Q1 journals in this area. If the average share of publications in Q1 journals is 25% in this research area, an author having 50% publications in Q1 journals is an outstanding researcher, publishing almost double articles in Q1 journals than the average researchers of the area. However, if the average share of publications in Q1 journals is 50%, a researcher having a 50% publications in Q1 journal could be considered as a regular researcher. Consequently, although the percentage of Q1 publications is usually believed to be independent on the research area and allows comparison of individuals from different research areas, this is not the case, and this not allows fair comparisons among them.

Average documents published by journals by quartiles

The greatest share of documents published by Q1 journals is explained by the greatest average number of documents published per journal compared to Q2, and especially to Q3 and

Table 2 Comparisonoftheshareofpublicationsbyquartilesobtainedinthepresentstudywithexistingliterature

Reference	Areas	Documenttypes	Methodtoavoiddoublecountingof journals	Q1(%)	Q2(%)	Q3(%)	Q4(%)
Liuetal.(2016)	JCR-SCI(8659journals)	Articlesandreviews	“Optimisticmode”	45.9 (42.8[a])	24.6(25.4 [a])	16.8(18.3 [a])	12.7(13.6 [a])
			“Pessimisticmode”	36.4 (42.1[a])	27.0 (26.8[a])	20.1(18.2 [a])	16.5(12.9 [a])
Liuetal.(2018)	JCR-SCI(around9000journals	Articlesandreviews	“Optimisticmode”	44 (41.3[a])	(27.4% [a])	16% (17.6 [a])	13% (13.7 [a])
Liuetal.(2018)	JCR-SSCI(around3000journals	Articlesandreviews	“Optimisticmode”	36 (34.9[a])	29 (29.2[a])	20 (20.2[a])	15 (15.7[a])
Presentstudy 2016	JCR-ScienceEdition(25largest researchareas)	Totaldocuments	Notnecessary(eachjournalisconsidered separatelyineachsubjectcategory)	45.7	25.6	17.1	11.5
		Articlesandreviews		38.4	27.5	20.0	14.1

[a]Valuesrecalculatedforallthequartileshavingthesamenumberofjournals.InLiuetal.(2016 ,theshareofjournalsineachquartilewere27.5%inQ1,24.9%inQ2,23.6% and24.0%inQ4(intheoptimisticmode)and20.3%inQ1,23.6%inQ2,26.0%inQ3and30.0%inQ4(inthepessimisticmode).InLiuetal.(2018 ,theshareofjournalsin eachquartilewere:Q1:27%,Q2:25%,Q3:23%andQ4:24%forSCIjournalsandQ1:26%,Q2:25%,Q3:25%andQ4:24%,forSSCIjournals

Table 3 Percentage of total publications and articles plus reviews, by quartiles, in the 25 WoS largest research categories (2015 publications)

Rank	Research area	Total publications				Articles plus reviews			
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
3	Materials Science Multidisciplinary	49.3	27.5	14.5	8.7	49.3	27.7	14.6	8.5
12	Oncology	50.1	17.9	18.0	14.0	33.4	23.9	20.5	22.3
17	Chemistry Multidiscplinary	37.0	36.8	14.2	12.0	37.9	38.6	14.8	8.7
19	Biochemistry and Molecular Biology	40.8	27.7	17.1	14.4	32.3	30.2	19.4	18.2
1	Multidiscplinary Sciences	85.6	6.1	3.2	5.2	88.9	5.7	2.7	2.7
10	Chemistry Physical	44.1	36.2	13.3	6.5	44.0	36.3	13.3	6.4
18	Neurosciences	39.8	27.7	23.0	9.6	34.5	28.5	24.3	12.7
4	Surgery	56.2	18.7	13.2	11.8	37.8	25.2	19.5	17.5
16	Physics Applied	37.9	29.5	23.0	9.6	37.3	29.8	23.3	9.6
20	Electrical Electronic Engineering	35.4	29.8	21.1	13.8	35.6	30.1	20.9	13.3
23	Pharmacology Pharmacy	34.1	30.7	20.3	14.8	33.2	30.9	19.2	16.7
15	Clinical Neurology	45.7	23.6	19.2	11.5	30.2	27.9	23.7	18.2
14	Medicine General Internal	45.9	21.5	18.3	14.3	33.5	25.3	20.8	20.4
5	Cell Biology	50.3	28.1	12.5	9.1	43.6	29.2	14.8	12.4
11	Environmental Sciences	43.7	25.6	16.2	14.5	42.6	26.1	16.5	14.7
6	Cardiac Cardiovascular Systems	58.9	18.7	12.9	9.5	33.1	27.0	22.4	17.5
22	Immunology	37.7	35.9	14.3	12.2	31.5	33.5	18.8	16.2
25	Medicine Research Experimental	25.4	17.1	37.4	20.1	17.1	17.3	40.0	25.6
2	Engineering Chemical	48.6	18.8	15.0	17.5	53.5	20.6	16.3	9.7
9	Nanoscience Nanotechnology	44.5	26.5	19.4	9.5	44.3	26.7	19.5	9.6
8	Gastroenterology Hepatology	60.3	22.4	11.3	6.0	30.2	31.7	25.7	12.4
21	Biotechnology Applied Microbiology	36.6	26.8	24.9	11.8	34.1	26.7	27.9	11.3
7	Hematology	55.0	21.2	18.3	5.6	36.2	25.5	24.5	13.9
13	Radiology Nuclear Medicine Medical Imaging	46.7	28.5	13.0	11.8	33.8	30.9	18.6	16.7
24	Public Environmental Occupational Health	33.8	37.3	15.2	13.7	32.7	32.9	17.7	16.7
	Mean	45.7	25.6	17.1	11.5	38.4	27.5	20.0	14.1
	Standard deviation	11.9	7.3	6.2	3.7	12.7	6.4	6.6	5.2
	Median	44.5	26.8	16.2	11.8	34.5	27.9	19.5	13.9
	Minimum	25.4	6.1	3.2	5.2	17.1	5.7	2.7	2.7
	Maximum	85.6	37.3	37.4	20.1	88.9	38.6	40.0	25.6

Rank is based on the average between the percentage of total publications in Q1 journals and the percentage of articles plus reviews in Q1 journals

Q4 journals. The average number of documents published by Q1 journals in 2015 was 663, while this value was 313, 207 and 139 for Q2, Q3 and Q4 journals, respectively (Fig. 2a). The average number of articles plus reviews was 432 for Q1 journals, while this value was 245, 168 and 113 for Q2, Q3 and Q4 journals, respectively (Fig. 2b). This means Q1 journals

published in 2015, on average, 2.12, 3.19 and 4.78 times more documents than Q2, Q3 and Q4 journals, and 1.76, 2.58 and 3.83 more articles and reviews, respectively. As previously commented, JIF and article number in journals are positively correlated (Huang 2016). The explanation is that the highest impact factor journals are more successful in

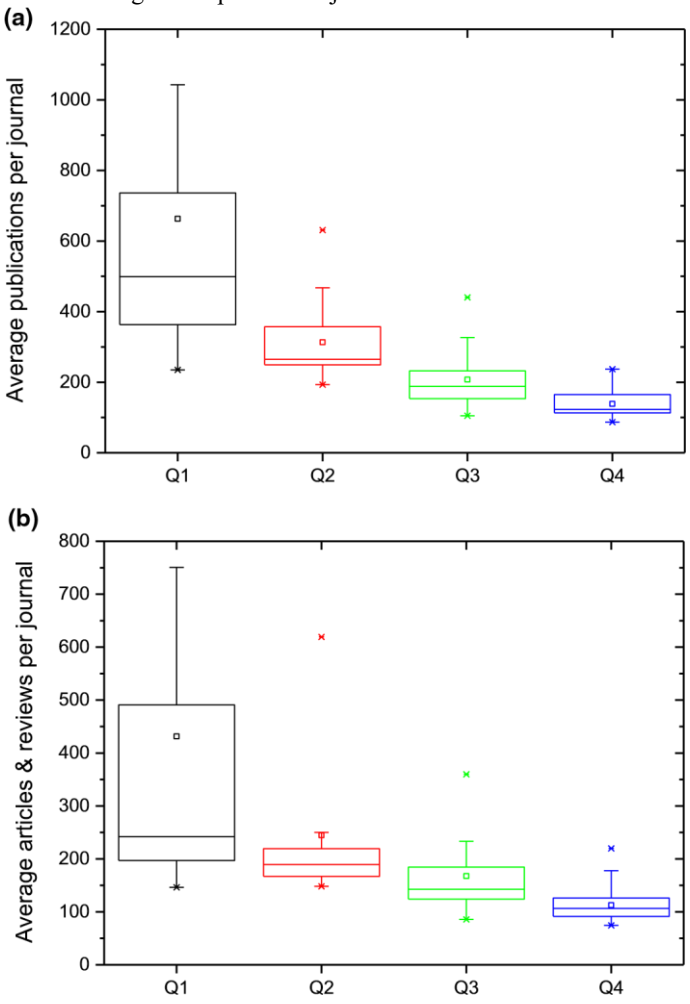

Fig. 2 Average number of **a** total publications and **b** articles plus reviews, by quartiles, in the 25 WoS largest research areas (2015 publications)

attracting more publications than the lowest impact factor journals as the researchers are increasingly urged to publish in the journals with the greatest impact factors, even taking into account that the acceptance rates in these journals is lower (Ibáñez et al. 2013).

It is well known that the number of publications is usually concentrated in a few journals, following the typical Bradford's law of scattering. These journals are usually some of those having the highest impact factors, usually Q1 journals. For example, the first journal in terms of published items in each research area published on average, 10.2% of total documents (varying from 2.4 to 44.5%) and 8.5% of the articles plus reviews (from 2.2 to

50.8%) (Table 4). These are very high values considering the average number of journals in the analyzed research areas is around 170. Furthermore, the top 5 and top 10 largest journals in each research area published, on average, 28.6 and 40.2% of total documents, and 22.6 and 32.7% of the articles and reviews of the area, respectively. The most extreme case was found in Multidisciplinary Sciences where two journals, PLOS ONE and Scientific Reports, published more than 60% total documents and 70% articles and reviews in the area. RSC Advances published 18.0% total documents and 19.0% articles and reviews in Chemistry Multidisciplinary area. Furthermore, Biomed Research International published 9.3% total documents and 12.0% total documents in Medicine Research Experimental area, and 10.3% of total documents and 11.2% articles and reviews in the research area of Biotechnology Applied Biotechnology.

The share of total documents and the share of articles plus reviews in the largest journals differs largely in the following areas. In Cardiac Cardiovascular Systems, the Journal

Table 4 Share of total publications and articles plus reviews, published in the top 1, top 5 and top 10 largest journals in the 25 WoS largest research areas (2015 publications)

Rank	Research areas	Total publications			Articles plus reviews		
		Top 1	Top 5	Top 10	Top 1	Top 5	Top 10
20	Materials Science Multidisciplinary	3.8	17.1	26.8	3.9	17.5	27.3
10	Oncology	10.1	29.5	42.3	7.5	21.9	31.5
2	Chemistry Multidisciplinary	18.0	34.4	47.6	19.0	35.4	48.0
17	Biochemistry and Molecular Biology	11.3	23.4	32.2	4.8	18.0	24.8
1	Multidiscplinary Sciences	45.5	78.0	88.9	50.8	83.4	90.3
11	Chemistry Physical	5.6	25.0	40.3	5.6	25.3	40.6
23	Neurosciences	3.6	14.8	24.8	3.6	11.8	19.9
22	Surgery	4.3	18.4	28.7	2.2	9.9	17.1
12	Physics Applied	6.2	24.1	36.2	6.2	24.1	36.2
25	Electrical Electronic Engineering	2.4	9.7	16.5	2.5	9.9	16.8
24	Pharmacology Pharmacy	2.5	11.9	20.1	2.8	10.7	17.6
21	Clinical Neurology	4.3	19.6	30.5	2.8	10.4	18.3
13	Medicine General Internal	7.2	23.1	38.1	8.5	22.9	29.5
7	Cell Biology	17.2	35.7	42.5	10.8	19.4	27.1
19	Environmental Sciences	4.2	16.9	26.9	4.4	17.4	27.8
9	Cardiac Cardiovascular Systems	12.3	40.6	52.0	3.8	14.2	23.9
16	Immunology	8.0	27.3	38.9	5.3	18.0	28.9
6	Medicine Research Experimental	9.3	32.3	45.4	12.0	36.9	47.6
14	Engineering Chemical	8.0	23.9	36.6	4.9	21.5	34.0
5	Nanoscience Nanotechnology	9.7	34.1	49.7	9.9	34.5	50.2
4	Gastroenterology Hepatology	13.6	41.8	61.4	12.0	23.7	35.6
8	Biotechnology Applied Microbiology	10.3	24.5	36.3	11.2	27.5	38.8
3	Hematology	21.3	52.5	66.4	6.7	20.8	34.5
15	Radiology Nuclear Medicine Medical Imaging	8.9	33.2	42.4	3.9	14.8	25.5
18	Public Environmental Occupational Health	8.1	22.8	32.2	6.3	16.2	24.9

Mean	10.2	28.6	40.2	8.5	22.6	32.7
Standard deviation	8.8	14.3	15.5	9.7	14.8	15.4
Median	8.1	24.5	38.1	5.6	19.4	28.9
Minimum	2.4	9.7	16.5	2.2	9.9	16.8
Maximum	45.5	78.0	88.9	50.8	83.4	90.3

Rank is based on the average between top 1, top 5 and top 10 for total publications and articles plus reviews

of the American College of Cardiology and the European Heart Journal published 12.3% and 11.8% of total documents in the area, respectively. However, they published only 2.1 and 1.5% of total articles and reviews. Blood published 21.3% total documents but only 6.7% articles and reviews in Hematology area. Gastroenterology published 13.6% total documents and only 2.1% of articles and reviews in Gastroenterology Hepatology area, while the World Journal of Gastroenterology published 12.0% of articles and reviews but only 4.5% total documents. In Oncology, Cancer Research published 10.0% of total documents but only 1.2% articles and reviews, while Oncotarget published the largest share of articles and reviews (7.5%) but 4.2% total documents.

All the previously mentioned journals are Q1 Journals but RSC Advances (Q2), World Journal of Gastroenterology (Q2) and Biomed Research International (Q3).

Share of citations and average citation by quartiles

As expected, the share of citations received by the documents published in Q1 journals is larger than their share of total publications (Fig. 3a), as the impact factor essentially equals to the average number of citations of the publications of a journal. On average, Q1 publications received 65.3% of total citations of the research area, varying from 46.4% in Medicine Research Experimental to 98.1% in Multidisciplinary Sciences, which are also the areas having the lowest and the highest share of publications in Q1. The share of citations by Q2 publications was 20.6%, varying from 1.14% (Multidisciplinary Sciences) to 28.6% (Pharmacology Pharmacy). Finally, the share of citations received by Q3 and Q4 publications were, on average, 10.0% and 4.0%, respectively. These results are practically the same that obtained for articles plus reviews only (Fig. 3b). In this case, the following shares of citations in each quartile were obtained: 64.8% for Q1, 20.9% for Q2, 10.2% for Q3 and 4.1% for Q4. This is easily explained by the fact that articles and reviews are the document types receiving almost all the citations (96.4% of total citations): 95.6% in Q1, 97.8% in Q2, 98.0% in Q3 and 97.4% in Q4.

Table 5 shows the distribution of citations received by quartiles and research areas. Again the results were almost identical for total publications and articles plus reviews: the differences were always lower than 1.5% but in Medicine General Internal (3% difference). The areas in which the share of citations received by Q1 publications were the greatest are (> 70%): Multidisciplinary Sciences, Engineering Chemical, Materials Science Multidisciplinary, Medicine General Internal, Nanoscience Nanotechnology, Chemistry Multidisciplinary, Physics Applied and Chemistry Physical. On the opposite, the research areas in which the proportion of citations received by articles and reviews published in Q1 journals is the lowest are (< 60%): Medicine Research Experimental, Pharmacology

Pharmacy, Clinical Neurology, Public Environmental Occupational Health, Immunology, Neurosciences, Radiology Nuclear Medicine Medical Imaging, and Biochemistry and Molecular Biology.

Furthermore, the average citations received by document and quartile were analyzed. Q1 publications received 13.14 citations per publication, while this value decreased to 6.34, 4.28 and 2.56, for Q2, Q3 and Q4 publications, respectively (see Fig. 4a). When only articles and reviews were considered, the average citations increased due to these document types are the most cited (Miranda and Garcia-Carpintero 2018). On average, Q1 articles and reviews received 19.75 citations, while this value decreased to 8.18, 5.26 and 2.97, for Q2, Q3 and Q4 publications, respectively (see Fig. 4b).

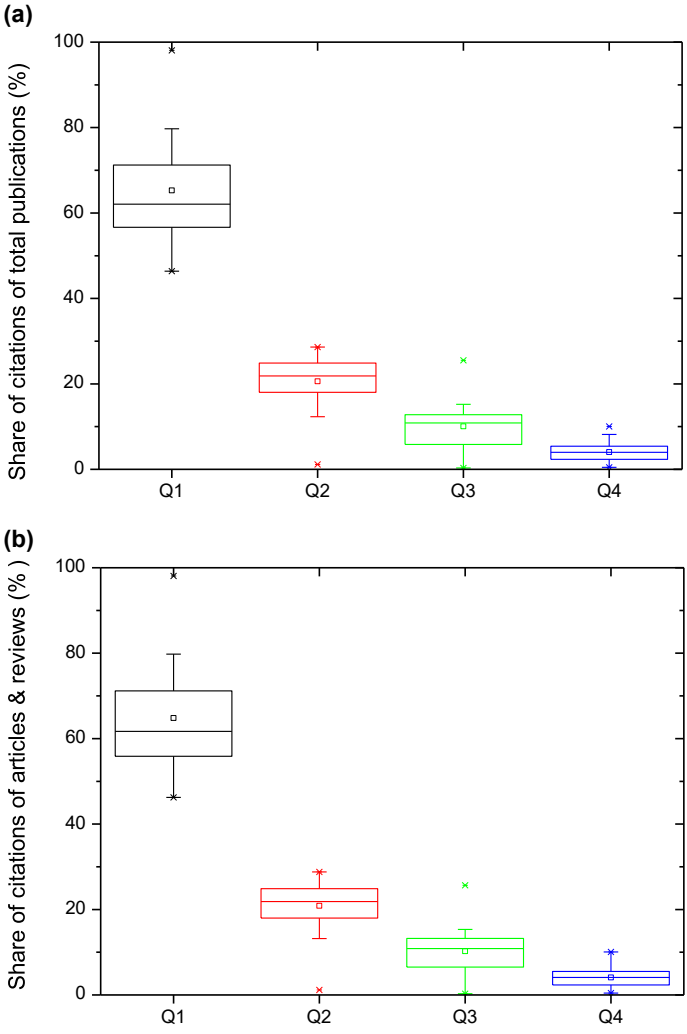

Fig. 3 Box plot for the share of citations received by **a** total publications and **b** articles plus reviews, by quartiles, of the 25 WoS largest categories (2015 publications)

These data indicated that the average citation of Q1 total documents was, on average, 2.07, 3.07 and 5.13 times as large as Q2, Q3 and Q4 publications. These differences are still slightly higher when only articles plus reviews were considered: Q1 articles and reviews were cited, on average, 2.41, 3.75 and 6.64 times more than Q2, Q3 and Q4 publications. This fact, together with the largest share of publications of Q1 compared to Q2, and especially Q3 and Q4, explained the large differences previously observed in the share of total citations received by Q1 compared to the other quartiles (Fig. 3).

The average citations per document by quartiles was also calculated by research areas (Table 6). As observed, there are large differences among areas, explained by the different practices in citations and the fact that some areas receive more citations than others (Waltman 2016). In the case of total publications, it is also affecting the important differences in

Table 5 Percentage of citations received by total publications and articles plus reviews, by each quartile of the 25 WoS largest categories (2015 publications)

Rank	Research areas	Total publications				Articles plus reviews			
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
3	Materials Science Multidisciplinary	79.1	14.8	4.8	1.4	79.1	14.8	4.8	1.4
14	Oncology	62.1	18.3	11.7	7.9	61.3	18.6	11.9	8.2
6	Chemistry Multidisciplinary	73.5	21.9	3.8	0.8	73.5	21.9	3.8	0.8
17	Biochemistry and Molecular Biology	58.6	24.7	11.6	5.2	58.2	24.9	11.7	5.3
1	Multidiscplinary Sciences	98.1	1.1	0.3	0.5	98.1	1.2	0.3	0.4
8	Chemistry Physical	70.3	23.7	4.8	1.2	70.3	23.7	4.8	1.2
20	Neurosciences	55.7	24.5	15.2	4.6	55.5	24.6	15.3	4.5
16	Surgery	61.1	22.6	10.9	5.4	60.2	23.0	11.2	5.6
7	Physics Applied	71.2	17.6	8.8	2.3	71.2	17.6	8.9	2.3
15	Electrical Electronic Engineering	60.9	24.9	10.9	3.2	60.9	24.9	10.9	3.2
24	Pharmacology Pharmacy	52.8	28.6	13.1	5.5	52.5	28.8	13.2	5.5
23	Clinical Neurology	53.5	24.9	15.0	6.5	53.2	25.0	15.3	6.6
4	Medicine General Internal	78.9	12.3	5.8	3.0	76.1	14.0	6.5	3.4
9	Cell Biology	69.8	19.5	7.3	3.3	69.6	19.7	7.4	3.3
10	Environmental Sciences	68.5	20.3	7.4	3.8	68.4	20.3	7.4	3.9
12	Cardiac Cardiovascular Systems	64.2	22.3	9.4	4.1	62.9	22.9	9.9	4.3
21	Immunology	55.7	26.8	11.8	5.6	55.0	27.3	12.1	5.6
25	Medicine Research Experimental	46.4	18.0	25.5	10.0	46.3	18.0	25.7	10.1
2	Engineering Chemical	79.7	13.2	5.7	1.3	79.8	13.2	5.7	1.3
5	Nanoscience Nanotechnology	75.8	17.2	4.9	2.1	75.8	17.3	4.9	2.1
18	Gastroenterology Hepatology	59.1	22.7	14.2	4.0	57.6	23.4	14.9	4.1
13	Biotechnology Applied Microbiology	62.1	20.9	13.6	3.5	61.7	21.1	13.7	3.5
11	Hematology	64.1	18.9	12.8	4.2	63.0	19.3	13.4	4.3
19	Radiology Nuclear Medicine Medical Imaging	56.7	27.0	11.1	5.3	55.9	27.4	11.4	5.4
22	Public Environmental Occupational Health	55.5	27.8	10.5	6.2	54.4	28.7	10.7	6.2
	Mean	65.3	20.6	10.0	4.0	64.8	20.9	10.2	4.1
	Standard deviation	11.3	6.0	5.1	2.3	11.4	6.0	5.1	2.3

Median	62.1	21.9	10.9	4.0	61.7	21.9	10.9	4.1
Minimum	46.4	1.1	0.3	0.5	46.3	1.2	0.3	0.4
Maximum	98.1	28.6	25.5	10.0	98.1	28.8	25.7	10.1

Rank is based on the average between the percentage of citations received by Q1 journals in total publications and articles plus reviews

the share of document types in different research areas, e.g. the average citation for areas with a large share of meeting abstracts or news items is much lower. This is the reason why a lower variance among research areas was found when only articles and reviews were considered compared to total publications.

For a better comparison among areas, the ratio between average citations received by Q1 publications and Q2, Q3 and Q4 publications was calculated (Table 7). As total publications are still affected by the different shares of other document types different to articles and reviews, the discussion of the results focused on articles plus reviews instead.

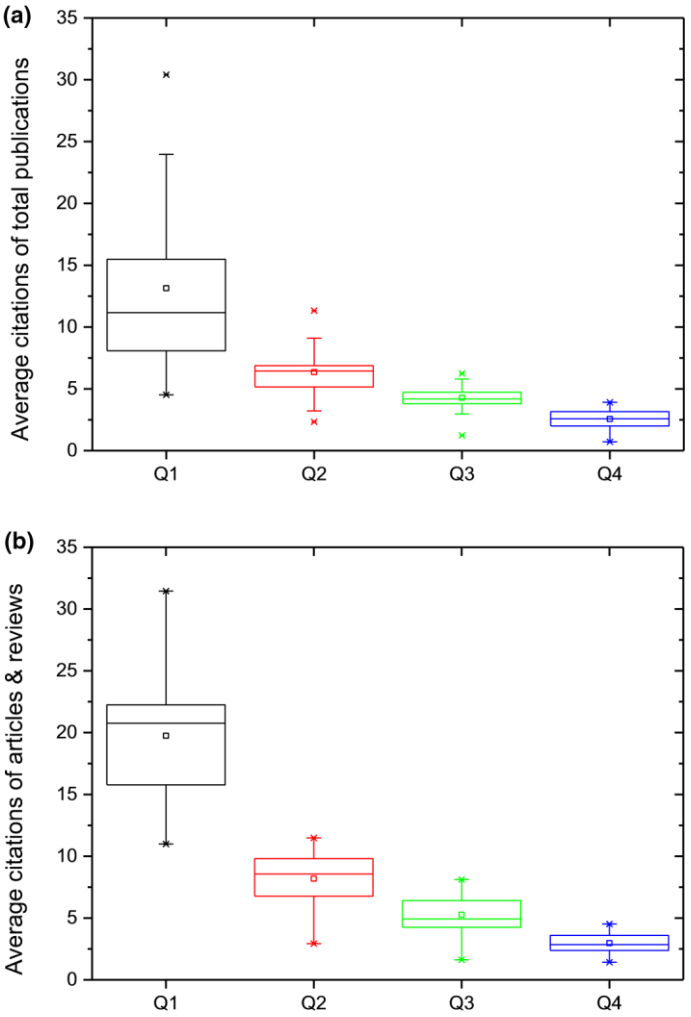

Fig. 4 Box plot for the average citations received by **a** total publications and **b** articles plus reviews, by each quartile in the 25 WoS largest subject categories (2015 publications)

The research areas where articles plus reviews in Q1 journals received more citations compared to other quartile journals were Materials Science Multidisciplinary, Chemistry Multidisciplinary, Multidisciplinary Sciences, Chemistry Physical, Physics Applied, Medicine General Internal, Cardiac Cardiovascular Systems, Engineering Chemical and Nanoscience Nanotechnology. In these areas, the average citations of Q1 articles plus reviews was 3.20, 6.01 and 10.4 times as large as Q2, Q3, and Q4 journals. On the contrary, the importance of publishing in Q1 journals compared to other quartiles journals was lower in Oncology, Biochemistry and Molecular Biology, Neurosciences, Surgery, Pharmacology Pharmacy, Clinical Neurology, Immunology, Radiology Nuclear Medicine Medical Imaging, Public Environmental Occupational Health. In these areas, the average citations of Q1 articles plus reviews was only 1.97, 2.74 and 5.0 times as large as Q2, Q3, and Q4

journals, which are almost half of the values obtained in the previous research areas. This means the

Table 6 Average citations received by total publications and articles plus reviews, by each quartile of the 25 WoS largest categories (2015 publications)

Rank	Research areas	ıtal publications				Articles plus reviews			
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
4	Materials Science Multidisciplinary	20.5	6.9	4.2	2.0	21.0	7.0	4.3	2.1
13	Oncology	8.1	6.7	4.2	3.7	22.7	9.6	7.2	4.5
1	Chemistry Multidisciplinary	30.4	9.1	4.1	1.1	31.5	9.2	4.2	1.5
7	Biochemistry and Molecular Biology	13.2	8.2	6.2	3.3	21.4	9.8	7.2	3.5
15	Multidiscplinary Sciences	14.2	2.3	1.2	1.2	15.8	2.9	1.6	2.4
3	Chemistry Physical	24.0	9.8	5.5	2.7	24.4	10.0	5.6	2.8
16	Neurosciences	10.5	6.6	5.0	3.6	18.3	9.8	7.2	4.1
25	Surgery	4.6	5.1	3.5	2.0	11.0	6.3	4.0	2.2
5	Physics Applied	20.1	6.4	4.1	2.6	20.8	6.4	4.1	2.6
19	Electrical Electronic Engineering	13.6	6.6	4.1	1.9	14.0	6.8	4.3	2.0
21	Pharmacology Pharmacy	10.3	6.2	4.3	2.4	14.0	8.3	6.1	2.9
22	Clinical Neurology	6.2	5.6	4.1	3.0	16.9	8.6	6.2	3.5
14	Medicine General Internal	9.7	3.2	1.8	1.2	20.9	5.1	2.9	1.5
6	Cell Biology	14.9	7.4	6.2	3.9	25.8	10.9	8.1	4.3
10	Environmental Sciences	15.7	8.0	4.6	2.7	16.9	8.2	4.7	2.8
18	Cardiac Cardiovascular Systems	5.7	6.2	3.8	2.3	21.9	9.8	5.1	2.8
11	Immunology	11.1	5.6	6.2	3.5	21.0	9.8	7.8	4.2
8	Medicine Research Experimental	11.2	6.4	4.2	3.0	22.2	8.6	5.3	3.2
12	Engineering Chemical	15.5	6.6	3.6	0.7	15.7	6.8	3.7	1.4
2	Nanoscience Nanotechnology	29.7	11.3	4.4	3.9	30.4	11.5	4.5	3.9
17	Gastroenterology Hepatology	4.5	4.7	5.8	3.1	23.4	9.1	7.1	4.1
9	Biotechnology Applied Microbiology	14.7	6.8	4.7	2.6	18.0	7.9	4.9	3.1
20	Hematology	4.9	3.8	3.0	3.2	20.3	8.8	6.4	3.6
24	Radiology Nuclear Medicine Medical Imaging	6.4	5.0	4.5	2.4	13.3	7.1	4.9	2.6
23	Public Environmental Occupational Health	8.8	4.0	3.7	2.4	12.1	6.3	4.4	2.7
	Mean	13.1	6.3	4.3	2.6	19.8	8.2	5.3	3.0
	Standard deviation	7.2	2.0	1.2	0.9	5.2	1.9	1.6	0.9
	Median	11.2	6.4	4.2	2.6	20.8	8.6	4.9	2.8
	Minimum	4.5	2.3	1.2	0.7	11.0	2.9	1.6	1.4
	Maximum	30.4	11.3	6.2	3.9	31.5	11.5	8.1	4.5

Rank is based on the average between the average citations received by Q1 total publications and Q1 articles plus reviews

difference in quality significance (measured in terms of citations received) of publishing in Q1 journals compared to other quartiles in different research is very large.

Uncitedness rates by quartiles

The uncitedness rate for total publications by quartiles is shown in Fig. 5a. Contrary to what expected, the average uncitedness rate did not increase from Q1 to Q4. The average uncitedness rate increased from Q2 to Q4, however, the uncitedness rate in Q1 was

Table 7 Ratio between average citations received by Q1 and Q2, Q3, Q4 quartiles, for total publications and articles plus reviews, of the 25 WoS largest categories (2015 publications)

Rank	Research areas	Total publications			Articles plus reviews		
		Q1/Q2	Q1/Q3	Q1/Q4	Q1/Q2	Q1/Q3	Q1/Q4
5	Materials Science Multidisciplinary	3.0	4.9	10.2	3.0	4.9	9.9
19	Oncology	1.2	1.9	2.2	2.4	3.2	5.0
1	Chemistry Multidisciplinary	3.3	7.4	28.9	3.4	7.5	20.5
15	Biochemistry and Molecular Biology	1.6	2.1	4.0	2.2	3.0	6.2
2	Multidiscplinary Sciences	6.1	11.5	12.3	5.4	9.7	6.6
8	Chemistry Physical	2.4	4.4	8.8	2.4	4.4	8.8
21	Neurosciences	1.6	2.1	2.9	1.9	2.6	4.5
25	Surgery	0.9	1.3	2.4	1.7	2.8	5.0
7	Physics Applied	3.2	4.9	7.8	3.2	5.0	7.9
9	Electrical Electronic Engineering	2.1	3.3	7.3	2.1	3.3	7.0
17	Pharmacology Pharmacy	1.7	2.4	4.2	1.7	2.3	4.8
24	Clinical Neurology	1.1	1.5	2.1	2.0	2.7	4.9
4	Medicine General Internal	3.0	5.4	8.3	4.1	7.2	13.8
13	Cell Biology	2.0	2.4	3.8	2.4	3.2	6.0
10	Environmental Sciences	2.0	3.4	5.9	2.1	3.6	6.1
14	Cardiac Cardiovascular Systems	0.9	1.5	2.5	2.2	4.3	7.7
18	Immunology	2.0	1.8	3.2	2.1	2.7	5.0
12	Medicine Research Experimental	1.7	2.7	3.7	2.6	4.2	6.9
3	Engineering Chemical	2.3	4.3	21.5	2.3	4.2	11.0
6	Nanoscience Nanotechnology	2.6	6.8	7.7	2.6	6.8	7.7
23	Gastroenterology Hepatology	1.0	0.8	1.5	2.6	3.3	5.7
11	Biotechnology Applied Microbiology	2.2	3.1	5.7	2.3	3.7	5.8
20	Hematology	1.3	1.7	1.6	2.3	3.2	5.6
22	Radiology Nuclear Medicine Medical Imaging	1.3	1.4	2.7	1.9	2.7	5.2
16	Public Environmental Occupational Health	2.2	2.4	3.6	1.9	2.8	4.5
	Mean	2.1	3.4	6.6	2.5	4.1	7.3
	Standard deviation	1.1	2.4	6.4	0.8	1.9	3.5
	Median	2.0	2.4	4.0	2.3	3.3	6.1
	Minimum	0.9	0.8	1.5	1.7	2.3	4.5
	Maximum	6.1	11.5	28.9	5.4	9.7	20.5

Rank is based on the average between the ratio Q1/Q2, Q1/Q3 and Q1/Q4 for total publications and the ratio Q1/Q2, Q1/Q3 and Q1/Q4 for articles plus reviews

unexpectedly high (similar to Q3 and Q4): 29.4% in Q1, 24.4% in Q2, 26.7% in Q3 and 36.7% in Q4. The uncitedness rate in total publications varied largely with the research area: from 1.5 to 68.1% in Q1, from 3.4 to 52.6% in Q2, from 10.1 to 57.1% in Q3 and from 21.9 to 74.4%.

The great variability of the result obtained for different research areas cannot be explained only by the different citation behavior in these areas (the documents of some areas are more cited than others). Other important fact explaining this variability are the important differences in the share of document types among areas. It is well known

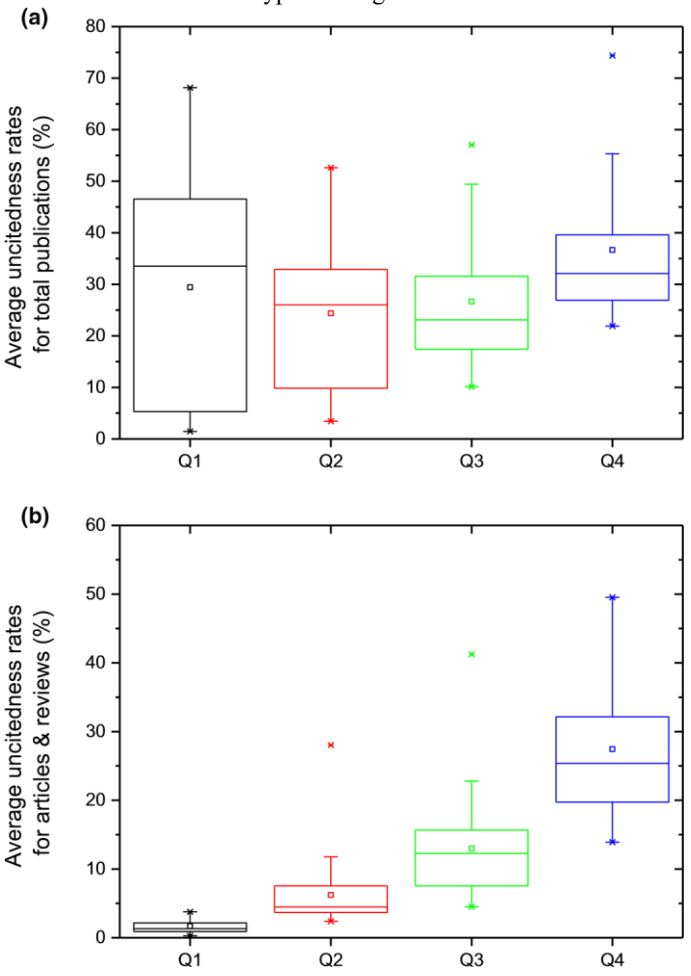

Fig. 5 Box plot for the uncitedness rates in **a** total publications and **b** articles plus reviews, in each quartile of the 25 WoS largest subject categories (2015 publications)

that some types of publications such as editorials, letters to editors, news items, meeting abstracts, and case studies are generally poorly cited (Miranda and Garcia-Carpintero 2018). While the share of these document types is almost negligible in certain areas, there are other areas in which meeting abstracts, for example, is the document type with the highest number of documents. In the 25 research areas considered, the average share of articles plus reviews

in total publications, those document types receiving the largest share of citations from total documents, was 71.9%, however, it varied largely from 33.2% (Hematology) to 97.8% (Nanoscience Nanotechnology). Furthermore, the share of these document types also depends on the considered quartile. The average share of articles plus reviews in total publications increased from 64.1% in Q1 to 76.4% in Q2, and then maintained almost constant in Q3 (81.3%) and Q4 (82.9%). On the contrary, the share of meeting abstracts, decreased significantly from 25.1% in Q1 to 15.6% in Q2, 10.5% in Q3 and 2.3% in Q4 (18.3% average in all quartiles). These facts explain the lowest variability of the uncitedness rates by areas in Q3 and Q4 journals compared to Q1 and Q2 journals.

To avoid these limitations, uncitedness rates were also calculated only for articles and reviews. In this case, the average uncitedness rate was 8.2%, increasing by quartiles from 1.7% in Q1 to 6.2% in Q2, 13.0% in Q3 and 27.4% in Q4 (Fig. 5b). This means the uncitedness rates in Q2, Q3 and Q4, are 3.7. 7.7 and 16.2 times as large as Q1, respectively. Obviously, there are more uncited papers in journals with low impact factors, however, there is also uncited papers in high impact journals (Garg and Kumar 2014).

The variability in the uncitedness rates by research areas was significantly lower when articles plus reviews were considered, due to the removal of the previously commented effect of some common but poorly cited document types. The uncitedness rate varied from 0.3 to 3.8% in Q1, from 2.4 to 28.0% in Q2, from 4.5 to 41.2% in Q3, and from 13.9 to 49.5% in Q4.

As occurs with the citation counts of publications from different fields, uncitedness rates for different fields are very different as a consequence of the large differences in citation density (Waltman 2016; Garg and Kumar 2014). Table 8 shows the uncitedness rates by research areas and quartiles. The areas with the greatest uncitedness rates for articles and reviews are the following (considering all quartiles) (> 9%): Engineering Electrical Electronic, Medicine General Internal, Surgery, Medicine Research Experimental, Physics Applied, Public Environmental Occupational Health, Radiology Nuclear Medicine Medical Imaging, Engineering Chemical and Cardiac Cardiovascular Systems. On the contrary, the areas with the lowest uncitedness rates for articles and reviews (< 6.5%): Cell Biology, Chemistry Physical, Immunology, Neurosciences, Biochemistry Molecular Biology, Oncology, Hematology and Nanoscience Nanotechnology. The areas with the greatest uncitedness rates are in agreement with the data presented by Van Noorden (2017). In this study, it was found that uncitedness for areas such as Engineering and Technology or Mathematics was very high (around 45–50%) compared to others such as Biology (around 15%) (values obtained 3 years since publication for papers published in 2000). In the same sense, Garg and Kumar (2014) found that Physics and Chemistry had the lowest rates of uncitedness, followed by Biological Sciences, Geosciences and Medicine; while the uncitedness rates in Engineering was much higher.

The uncitedness rates obtained in the present study are lower than in previous studies evaluating papers published at early years. This is in agreement with the fact that the share of uncited scientific articles has been decreasing steadily since the beginning of the eighties (Wallace et al. 2009). Recently, Van Noorden (2017) showed around 25% of the articles and reviews published in WoS in 1980 were not cited 10 years after, while this percentage decreased to 19, 16, 13.5 and 10% for papers published in 1985, 1990, 2000 and 2005, respectively. Therefore, it is not strange to obtain an average uncitedness rate of 8.2% for the articles and reviews published in 2015 in the present study, although the uncitedness rates were counted around 3 years since publication. Wallace et al. (2009) explained the

continuous decrease in the share of uncited papers as the combination of several phenomena: the emergence of online biobliographic databases and electronic access of scientific articles, the increased amount in the number of references per paper and the increase of the growth of the world's scientific production; an improved accuracy of the cited references in Web of Science could also have an influence.

Finally, the share of uncitedness in different quartiles compared to Q1 was evaluated (Table 9). Again the most relevant results were obtained analyzing articles plus reviews. The uncitedness for articles and reviews from Q2 was 2.1–8.5 times as large as Q1 (average 4.1), the uncitedness from Q3 publications was 4.3–66.3 times as large as Q1 (average

Table 8 Uncitedness rate for total publications and articles plus reviews, in each quartile of the 25 WoS largest categories (2015 publications)

Rank	Research area	Total publications				Articles plus reviews			
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
6	Materials Science Multidisciplinary	2.7	9.4	16.6	40.4	1.2	8.1	15.2	37.2
23	Oncology	55.5	29.9	42.4	29.6	0.9	3.7	5.6	15.1
5	Chemistry Multidisciplinary	2.5	4.4	16.9	60.1	0.7	3.5	15.7	42.1
22	Biochemistry and Molecular Biology	33.5	17.6	17.3	21.9	0.7	2.7	6.0	18.7
1	Multidiscplinary Sciences	9.6	39.6	57.1	74.4	3.3	28.0	41.2	49.5
17	Chemistry Physical	1.9	4.0	10.1	26.9	0.7	2.9	8.7	25.4
21	Neurosciences	38.5	32.5	31.5	25.2	1.1	3.1	4.8	19.3
8	Surgery	52.2	19.8	23.6	38.8	3.5	7.6	15.4	31.5
7	Physics Applied	4.4	9.8	18.2	33.6	2.2	8.7	17.0	32.2
3	Electrical Electronic Engineering	5.7	12.4	23.1	42.5	3.7	10.5	19.9	38.3
16	Pharmacology Pharmacy	23.8	26.0	33.8	37.6	1.5	3.8	7.6	26.6
19	Clinical Neurology	56.5	32.9	34.8	28.7	1.9	4.8	8.4	19.5
2	Medicine General Internal	36.5	39.5	49.4	55.3	3.8	11.8	22.8	42.5
24	Cell Biology	35.0	31.5	24.3	22.2	0.4	2.8	4.5	15.8
14	Environmental Sciences	5.3	6.0	13.5	27.5	1.1	4.5	11.1	25.4
11	Cardiac Cardiovascular Systems	62.2	29.1	31.2	39.6	1.6	4.7	12.3	26.2
25	Immunology	39.3	40.8	20.1	26.0	1.0	3.7	4.7	13.9
15	Medicine Research Experimental	46.5	25.5	31.6	25.1	1.9	4.4	13.2	21.2
4	Engineering Chemical	2.9	8.2	18.6	73.0	1.9	6.6	16.3	46.8
12	Nanoscience Nanotechnology	1.5	3.4	20.0	23.2	0.3	2.4	18.5	21.5
18	Gastroenterology Hepatology	68.1	47.8	19.5	37.7	1.1	4.5	8.0	22.2
13	Biotechnology Applied Microbiology	16.2	16.6	16.3	36.0	1.3	4.0	13.7	23.6
20	Hematology	65.9	52.6	54.2	27.3	0.8	4.5	7.5	19.7
10	Radiology Nuclear Medicine Medical Imaging	45.2	30.0	17.4	32.1	2.6	6.6	11.9	26.6
9	Public Environmental Occupational Health	24.2	39.9	25.0	31.8	3.3	7.9	14.3	25.5
	Mean	29.4	24.4	26.7	36.7	1.7	6.2	13.0	27.5
	Standard deviation	23.0	14.7	12.7	14.6	1.1	5.2	7.8	10.0
	Median	33.5	26.0	23.1	32.1	1.3	4.5	12.3	25.4
	Minimum	1.5	3.4	10.1	21.9	0.3	2.4	4.5	13.9

	Maximum	68.1	52.6	57.1	74.4	3.8	28.0	41.2	49.5

Rank is based on the average between the uncitedness rates for articles plus reviews in Q1, Q2, Q3 and Q4 quartiles

10.6) and the uncitedness from Q4 publications was 7.7–76.8 times as large as Q1 (average 22.6).

There are two research areas, Chemistry Multidisciplinary and Nanoscience Nanotechnology, which represented the most extreme cases, altering largely the average and the variance of the results among the research areas. If these two areas are excluded, the uncitedness of Q2 publications would be 2.1–8.5 times as large as Q1 (average 3.9), for Q3 publications it would be 4.3–13.0 times as large as Q1 (average 7.7) and for Q4 publications would be 7.7–38.4 times as large as Q1 (average 18.7).

Table 9 Ratio between uncitedness rates in Q2, Q3 and Q4 quartiles compared to Q1 quartile, for total publications and articles plus reviews, of the 25 WoS largest categories (2015 publications)

Rank	Research area	Total publications			Articles plus reviews		
		Q2/Q1	Q3/Q1	Q4/Q1	Q2/Q1	Q3/Q1	Q4/Q1
5	Materials Science Multidisciplinary	3.4	6.0	14.7	6.9	13.0	31.8
14	Oncology	0.5	0.8	0.5	4.1	6.2	16.8
2	Chemistry Multidisciplinary	1.8	6.9	24.4	4.8	21.9	58.8
6	Biochemistry and Molecular Biology	0.5	0.5	0.7	3.9	8.8	27.2
10	Multidiscplinary Sciences	4.1	6.0	7.8	8.5	12.6	15.1
4	Chemistry Physical	2.2	5.4	14.3	4.2	12.6	36.8
16	Neurosciences	0.8	0.8	0.7	3.0	4.6	18.4
24	Surgery	0.4	0.5	0.7	2.1	4.4	8.9
15	Physics Applied	2.2	4.1	7.6	4.0	7.8	14.8
21	Electrical Electronic Engineering	2.2	4.1	7.5	2.8	5.3	10.2
17	Pharmacology Pharmacy	1.1	1.4	1.6	2.6	5.1	18.1
23	Clinical Neurology	0.6	0.6	0.5	2.5	4.4	10.3
19	Medicine General Internal	1.1	1.4	1.5	3.1	6.0	11.3
3	Cell Biology	0.9	0.7	0.6	6.8	10.9	38.4
7	Environmental Sciences	1.1	2.6	5.2	4.2	10.5	23.9
13	Cardiac Cardiovascular Systems	0.5	0.5	0.6	3.0	7.8	16.6
18	Immunology	1.0	0.5	0.7	3.8	4.8	14.2
20	Medicine Research Experimental	0.5	0.7	0.5	2.3	6.9	11.2
9	Engineering Chemical	2.8	6.4	25.2	3.5	8.7	25.0
1	Nanoscience Nanotechnology	2.4	13.8	15.9	8.5	66.3	76.8
11	Gastroenterology Hepatology	0.7	0.3	0.6	4.1	7.4	20.4
12	Biotechnology Applied Microbiology	1.0	1.0	2.2	3.0	10.4	17.9
8	Hematology	0.8	0.8	0.4	5.5	9.0	23.8
22	Radiology Nuclear Medicine Medical Imaging	0.7	0.4	0.7	2.5	4.6	10.2
25	Public Environmental Occupational Health	1.6	1.0	1.3	2.4	4.3	7.7
	Mean	1.4	2.7	5.5	4.1	10.6	22.6
	Standard deviation	1.0	3.2	7.6	1.8	12.3	16.2

Median	1.0	1.0	1.3	3.8	7.8	17.9
Minimum	0.4	0.3	0.4	2.1	4.3	7.7
Maximum	4.1	13.8	25.2	8.5	66.3	76.8

Rank is based on the average between the ratio Q2/Q1, Q3/Q1 and Q4/Q1 for articles plus reviews

Conclusions

Due to incomparability across different research areas, field-normalized JIFs such as JIF quartiles have been introduced and increasingly adopted in research evaluation. The total number of publications and/or the share of total publications in a given quartile, usually first quartile (Q1), play today an important role in the performance-based funding of public research.

At a first sight, one could expect the number of documents published in each quartile journals would be around 25%, in other words, only one in every four publications would be published in Q1 journals. Consequently, the number of publications and/or the share of total publications in Q1 journals could be used as a quality indicator allowing fair comparisons among researchers from different areas. However, this is not the case. The level of exigence for a researcher to publish in Q1 journals (related to the probability to publish in Q1 journals compared to other quartiles) as well as the quality of the publications in Q1 journals (measured in terms of different citation indicators compared to other quartiles), is largely different depending on the research area.

The probability to publish in Q1 journals is almost double than expected: 45.7% total publications and 38.4% articles plus reviews are published in Q1 journals. Even most important, the share of publications in Q1 journals varied largely from 17.1–25.4% (Medicine Research Experimental) to 85.6–88.9% (Multidisciplinary Sciences), this range depending if total publications or only articles plus reviews are considered. This means the probability to publish in Q1 journals of Multidisciplinary Sciences is 3.4–5.2 times as large as in Medicine Research Experimental. Similarly, the ratio between the average citation for Q1 and Q2 publications varied between 0.9 and 6.1 times, or between 0.78 and 11.5 when the average citation for Q1 publications was compared to Q3. This means the expected probability but also the relative quality significance of publishing papers in Q1 compared to other quartiles is largely dependent on the research area.

Other types of normalized citation impact indictors such as the proportion of highly cited publications in a field, i.e. the top 10% or top 25% most highly cited papers, are recommended to avoid the limitations of the number and/or the share of publications in Q1 journals and allow fair comparisons among researchers from different research areas.

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