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Article Placement Order in Rheumatology Journals: A Content Analysis

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Article Placement Order in Rheumatology Journals: A Content Analysis

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Abstract

Objectives. To analyse variables associated with article placement order in serial rheumatology journals.

Design. A content analysis of original articles published in seven rheumatology journals from 2013-2018.

Methods. The following data were extracted from 6,787 articles: order number of article in issue, gender of first and last author, geographical region, industry funding, and disease category. Cumulative density function plots were used to determine whether article placement distribution was different from the expected distribution. Odds ratios for articles published in the first three places of an issue compared with the last three places were calculated. Altmetric score and downloads were meta-analysed.

Results. Article placement order did not associate with author gender, geographical region or funding source, but was associated with disease category. Articles about rheumatoid arthritis were more likely to be ordered at the front of issues ($P < 0.001$). Articles about crystal arthritis, systemic lupus erythematosus, vasculitis, pain syndromes and pediatric rheumatic diseases were more likely to be ordered at the end of issues (all $P < 0.001$). Association of article placement order with disease category was observed only in journals with tables of contents grouped by disease. Articles ordered in the first three places had higher Altmetric and download rates, than articles in the last three places.

Conclusions. Author gender, geographical region, or funding source do not influence article placement order in serial rheumatology journals. However, bias for certain disease categories is reflected in article placement order. Editorial decisions about article placement order can influence the prominence of diseases.

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3 **Keywords:** publication, bias, rheumatology
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For peer review only

Strengths and limitations of the study

- This is the first study to assess the relationship of article placement order in serial medical journals with author gender, geographical region of affiliated institution, industry funding or disease category.
- This content analysis included 6,787 articles from general rheumatology journals.
- This study also analysed the impact of article placement order on research prominence, including Altmetric scores and download rate.
- This analysis did not explore other factors that may have contributed to article placement order such as the originality of the study findings or the presence of “star” authors.

INTRODUCTION

The strong preference for items ordered first, and the important effect of list order on choice, is well-recognised in consumer-based research.[1-3] In online searches for health information, 97% of selected links were displayed in the first 10 results, while only 2% were from the second or following pages.[4] For online academic repositories, earlier listed articles were downloaded more frequently than later listed articles.[5] These primacy effects, which increase when lists are longer,[6] may occur because earlier items, or those at the top of tables of contents, are more visible and more likely to be seen and read.[5]

In academic publishing, the ordering of articles within a journal issue also affects the prominence achieved by that research. Earlier listed articles received more citations over a 25 year period in a single journal.[7] The impact of ordering was also evident in an analysis of emails sent to subscribers disseminating recent research papers listed in random order; with the first paper having a 33% increase in views, 29% increase in downloads and 27% increase in citations, regardless of research quality.[8]

A number of systemic biases have been reported in academic publishing. These include preferential lead and senior authorship of men,[9, 10] higher acceptance rates for articles from the US and Europe,[9, 11] preferential publication of industry-funded research,[12] and disease privileging, wherein particular diseases receive preferential research funding and publication.[13-15] It is unknown whether these systemic biases are reflected in article placement order within medical journals. We analysed serial rheumatology journals for relationships between article placement order and gender of the lead and senior authors, geographical region of the affiliated institution, industry sponsorship, and disease category.

METHODS

Patient and public involvement

There was no patient or public involvement in the design, or conduct, or reporting, of this research.

Identification of journals and articles for inclusion

This was a cross-sectional content analysis of original articles published in general rheumatology journals. Journals were included if they produced regular issues, reported original research and had 2016 Thomas Reuters Impact Factors of > 3.0. Journals were excluded if they published review articles only, were disease-specific (e.g. *Lupus*, *Osteoarthritis and Cartilage*) or produced no issues. The following seven general rheumatology journals met the above criteria and were included: *Annals of the Rheumatic Diseases*, *Arthritis & Rheumatology*, *Arthritis Care & Research*, *Seminars in Arthritis and Rheumatism*, *Rheumatology*, *Journal of Rheumatology*, and *Joint Bone Spine*. Characteristics of the included journals are shown in **Supplementary Table 1**.

All original articles published in the included journals in a five-year period from June 2013 to June 2018 were included in the analysis. To be included, articles could be full or concise reports, and report on original basic science or clinical research, including systematic reviews and meta-analyses. Articles were excluded if they were from a disease-specific thematic issue or supplement, were narrative reviews, recommendations, guidelines, letters, or meeting reports.

Data extraction

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3 Data extraction was undertaken between June and December 2018. The following
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5 information was extracted for each included article: order number of article in the issue,
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7 gender of lead (first) author; gender of senior (final) author; geographical region of affiliated
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9 institution (for the first author); any industry sponsorship (industry-funded and
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11 initiated/industry-funded and investigator-initiated/not industry-funded); and, if available, the
12
13 Altmetric score and number of downloads. The number of citations was not assessed because
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15 of the short time period between publication and data extraction. If author gender could not
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17 be determined by first name or by an internet search of the author's affiliated institution
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19 profile page, then the author's first name was entered into <https://api.genderize.io/?name=>
20
21 which returns the gender and probability of certainty. Probabilities < 0.5 were labelled as
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23 "unknown" and not included in the gender-related analysis. If articles were authored by a
24
25 single author, then this author's gender was entered under first author. Funding was assessed
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27 by review of funding statements, disclosures and author affiliations. Industry-funded studies
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29 were categorized as industry-funded and industry-initiated, or industry-funded and
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31 investigator-initiated, based on these statements. Studies with no evidence of industry
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33 funding were categorized as not industry-funded.

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41 Articles were coded according to the following 13 disease categories: ankylosing spondylitis
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43 and other spondyloarthropathy, crystal arthritis, osteoarthritis, miscellaneous rheumatic
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45 disease, pediatric rheumatology, pain syndromes, psoriatic arthritis, rheumatoid arthritis,
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47 systemic lupus erythematosus, systemic sclerosis/scleroderma, other connective tissue
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49 disorders, vasculitis, and not disease-specific. The title of each article was used to determine
50
51 the disease category. If there was uncertainty about the disease category from the title, then
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53 the abstract and/or full paper were reviewed.

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57 To ensure standardisation in data extraction, two authors (SS, ND) independently reviewed
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59 eligible papers from ten randomly selected issues. A total of 208 articles were reviewed, with
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3 kappas of 1.00 for author gender, geographic region and industry funding, while disease
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5 category had a kappa of 0.84 (86.1% agreement (95% confidence interval (CI) 81.0%,
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7 90.5%)). All disease category disagreements were discussed to reach a consensus and a set of
8
9 rules for categorising was established. The exercise was then repeated in which the two
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11 authors reviewed disease categories in a further five randomly selected issues totalling 85
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13 articles, with a kappa of 0.99 (98.8% agreement (95% CI 94.3%, 99.9%)) for disease
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15 category. A single reviewer (SS) then independently extracted the data.
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23 **Data analysis**

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26 The primary analyses assessed the relationships between article placement order and: gender
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28 of first authors, gender of last authors, geographical region (North America vs. Europe vs.
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30 Other), industry funding categories (industry-funded and initiated vs. industry-funded and
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32 investigator-initiated vs. not industry-funded), and disease categories. In order to identify
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34 whether these factors were associated with article placement order within journal issues with
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36 different numbers of articles, each article within each issue was assigned a standard article
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38 placement index (SAPI), which was defined as the order of the article in the issue/total
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40 number of articles in the issue. For example, the first article in an issue of 21 articles was
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42 given an SAPI of $1/21 = 0.0476$ and the last article $21/21 = 1$. Cumulative distribution
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44 functions (CDF) were analysed to determine the associations between article placement order
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46 and author gender, geographical region industry funding and disease category. A uniform
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48 distribution would be expected if there was no association with article placement order:
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50 skewed deviations from the expected uniform distribution would support an association with
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52 article placement order. To test whether the distribution of SAPIs were different between
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54 author genders, geographical regions, and industry funding categories, two-sample
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3 Kolmogorov-Smirnov Z tests were conducted. Effect sizes (D) were computed with values
4 ranging from 0 (no difference in distribution of SAPI between comparisons) to 1 (large
5 difference in distribution of SAPI between comparisons). To determine whether the
6 distribution of SAPIs for each disease category was different from a uniform distribution
7 CDF (expected distribution if no bias reflected in article placement order), the area under the
8 curve (AUC) of the observed CDF and uniform distribution CDF were each calculated using
9 a trapezoidal method and the difference between these estimated for each of the 13 disease
10 categories. Mean differences between the observed CDF and the uniform distribution CDF
11 were computed from bootstrapped samples (500 replicates, sampled with replacement) and
12 95% confidence intervals estimated as the 2.5th and 97.5th percentile of the bootstrap
13 distribution. P-values were calculated for each disease category from these confidence
14 intervals using the method of Altman and Bland.[16]
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32 A secondary analysis was undertaken to further explore article placement order, in which
33 mid-P exact P-values were computed to compare the proportion of articles appearing in at
34 least one of the first three places of an issue compared to at least one of the last three places
35 of an issue for genders of first and last authors, geographical region, industry funding
36 category, and each disease category. Odds ratios (OR) and their 95% CIs were also computed
37 for articles in the first three places vs. last three places of an issue.
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47 As some journals presented their content grouped by disease category, additional analyses
48 were undertaken to determine whether article placement order of disease categories was
49 different between journals which presented content grouped by disease category vs. journals
50 without disease category content grouping. This was tested statistically using CDF plots of
51 SAPI distributions, two-sample Kolmogorov Smirnov Z tests and effect sizes (D) as
52 described above.
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3 Finally, to determine the impact of article placement order on Altmetric scores and article
4 download rates (as available), meta-analyses were used to determine differences in the means
5 for each variable between the first and last three articles in journal issues. Altmetric scores
6 were provided by *Arthritis & Rheumatology*, *Annals of the Rheumatic Diseases*,
7 *Rheumatology* and *Arthritis Care & Research*. *Annals of the Rheumatic Diseases*,
8 *Rheumatology* and *The Journal of Rheumatology* had article download data available, but for
9 the latter two journals, the data were available in only the 6 months prior to data extraction.
10 Therefore, analyses of article downloads were undertaken for *Annals of the Rheumatic*
11 *Diseases* only. For Altmetric scores, which generally do not change over time, mean scores
12 were calculated by total Altmetric scores/total number of articles. For downloads, which are
13 time dependent, rates were calculated by total number of downloads/total article-years from
14 time of publication to time of data extraction. These analyses were undertaken within disease
15 categories, adjusted by journal, as appropriate, and weighted using the inverse-variance
16 method. Random effects models were used for all I^2 values $> 0\%$.

17 All analyses were performed in SPSS (v25 IBM Corp), SAS v9.4 (SAS Institute Inc, Cary,
18 NC) and openepi.com (v3.01). All tests were two-tailed and false discovery rate (FDR)-
19 adjusted P values[17] were computed for all analyses with an alpha level of < 0.05
20 considered significant.

21 RESULTS

22 Characteristics of included articles

23 A total of 6,787 articles were included. First authors were male in 3250 (47.9%) articles,
24 female in 3517 (51.8%) articles and unknown in 20 (0.3%) articles. Last authors were male in
25 4412 (65.0%) articles, female in 2359 (34.8%) articles and unknown/not applicable in 16
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3 (0.2%) articles. 596 (8.8%) articles were industry-funded and initiated, 640 (9.4%) were
4 industry-funded and investigator-initiated, and 5551 (81.8%) were not industry-funded. The
5 geographical region was North America in 2177 (32.1%) articles, Europe in 3486 (51.4%)
6 articles, and Other in 1124 (16.6%) articles. Disease categories were rheumatoid arthritis (n =
7 1946, 28.7%), osteoarthritis (n = 773, 11.4%), systemic lupus erythematosus (n = 642, 9.5%),
8 ankylosing spondylitis (n = 496, 7.3%), pediatric rheumatology (n = 443, 6.5%), systemic
9 sclerosis (n = 433, 6.4%), not disease-specific (n = 422, 6.2%), vasculitis (n = 362, 5.3%),
10 other connective tissue disease (n = 339, 5.0%), miscellaneous (n = 277, 4.1%), crystal
11 arthritis (n = 269, 4.0%), psoriatic arthritis (n = 242, 3.6%), and pain syndromes (n = 143,
12 2.1%). The specific diseases which were categorised under crystal arthritis, other connective
13 tissue disease, and miscellaneous are shown in **Supplementary Table 2**.

32 **Distribution of article placement within issues**

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35 Inspection of the cumulative distribution function plots showed no association of article
36 placement order with author gender, geographical region, or industry funding (**Figure 1**).
37 However, differences in article placement order were observed for disease category (**Figure 2**
38 and **Table 1**). Articles about rheumatoid arthritis were more likely to be placed towards the
39 front of issues. The placement of articles about ankylosing spondylitis, osteoarthritis and
40 psoriatic arthritis conformed to a uniform distribution. Articles about systemic lupus
41 erythematosus, other connective tissue diseases, crystal arthritis, systemic sclerosis,
42 vasculitis, pediatric rheumatology and pain syndromes were more likely to be placed towards
43 the back of issues.

Table 1. Difference in distribution of standard article placement indices (SAPI) from a uniform distribution for each disease category

	N (%)	SAPI, mean (SD)	Difference in AUC between CDF and uniform distribution Mean (95% confidence interval) ^a	FDR-adjusted <i>P</i>
Ankylosing spondylitis	496 (7.3%)	0.51 (0.24)	+0.001 (-0.022, +0.014)	0.94
Crystal arthritis	269 (4.0%)	0.63 (0.28)	-0.134 (-0.141, -0.110)	<0.001
Miscellaneous	277 (4.1%)	0.68 (0.29)	-0.182 (-0.205, -0.150)	<0.001
Not disease-specific	422 (6.2%)	0.61 (0.30)	-0.092 (-0.103, -0.069)	<0.001
Osteoarthritis	773 (11.4%)	0.49 (0.24)	+0.002 (-0.014, +0.021)	0.88
Other connective tissue diseases	339 (5.0%)	0.62 (0.25)	-0.110 (-0.127, -0.090)	<0.001
Pediatric rheumatology	443 (6.5%)	0.69 (0.28)	-0.190 (-0.230, -0.180)	<0.001
Pain syndromes	143 (2.1%)	0.69 (0.27)	-0.183 (-0.260, -0.152)	<0.001
Psoriatic arthritis	242 (3.6%)	0.53 (0.24)	-0.012 (-0.045, 0.015)	0.55
Rheumatoid arthritis	1946 (28.7%)	0.36 (0.28)	+0.144 (+0.141, +0.157)	<0.001
Systemic lupus erythematosus	642 (9.5%)	0.58 (0.21)	-0.073 (-0.087, -0.050)	<0.001
Systemic sclerosis	433 (6.4%)	0.64 (0.24)	-0.140 (-0.147, -0.122)	<0.001
Vasculitis	362 (5.3%)	0.65 (0.24)	-0.154 (-0.180, -0.122)	<0.001

AUC = area under the curve; CDF = cumulative density function; SAPI = standard articles placement index. ^aPositive differences indicate deviations from a uniform distribution above the uniform distribution function (i.e. article skewed towards the front of an issue), while negative differences indicate deviations from a uniform distribution below the uniform distribution function (i.e. article skewed towards the back of an issue).

Articles in the first and last three places of an issue

There were no significant differences in the proportion of articles in the first vs. last three places of an issue for author gender, geographical regions, or industry funding category (**Supplementary Table 3**). However, consistent with the cumulative distribution function analysis, differences for disease category were observed (**Figure 3 and Supplementary Table 3**). There was a significantly greater proportion of articles in the first three compared to the last three places of an issue for rheumatoid arthritis (35.6% vs. 8.7% $P < 0.001$) with an OR (95% CI) of 5.77 (4.80, 6.92). There was a similar proportion of articles in the first three and last three places of an issue for ankylosing spondylitis, osteoarthritis, or psoriatic arthritis. There was a significantly lower proportion of articles in the first three compared to the last three places of an issue for crystal arthritis (10.8% vs. 26.8%), other connective tissue diseases (6.8% vs., 16.5%), pediatric rheumatology (8.4% vs. 38.8%), pain syndromes (8.4% vs. 37.1%), systemic lupus erythematosus (4.7% vs. 9.7%), systemic sclerosis (4.4% vs. 18.2%) and vasculitis (6.4% vs. 18.0%) (all $P \leq 0.001$).

Journals with and without content grouped by disease category

Arthritis & Rheumatology, *Seminars in Arthritis and Rheumatism*, *Arthritis Care & Research* and *The Journal of Rheumatology* grouped issue content by disease category with disease-specific tables of contents sections, while *Annals of the Rheumatic Diseases*, *Rheumatology*, and *Joint Bone Spine* did not group issue content by disease category (**Supplementary Table 1**). Journals with content grouped by disease showed an association between article placement order and disease category, whereas this was less evident for journals without content grouped by disease (**Figure 4**). Comparisons between journals with and without content grouped by disease category demonstrated a significant difference in the SAPI

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3 distributions for every disease category, with articles on rheumatoid arthritis placed towards
4 the front of issues, and articles on crystal arthritis, pain syndromes, pediatric rheumatology,
5 systemic sclerosis and vasculitis placed towards the end of issues, in journals with content
6 grouped by disease category (Supplementary Table 4).
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16 **The impact of article placement order on Altmetric scores and downloads**

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19 The impact of article placement order was evident in the meta-analysis results, which showed
20 a higher Altmetric score (adjusted for journal) for articles published in the first three places of
21 an issue compared with the last three, (mean difference in Altmetric score of 5.11, 95% CI
22 1.50, 8.71, $Z = 2.78$, $P = 0.005$) (Figure 5). The difference in Altmetric scores varied across
23 different disease categories (I^2 76%; $P < 0.001$), with the largest difference between
24 positioning in the first three places and positioning in the last three places being observed for
25 articles about rheumatoid arthritis and psoriatic arthritis.
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36 Similarly, meta-analysis showed that articles published in the first three places of an issue
37 had a higher download rate compared to articles in the last three places of an issue (pooled
38 rate difference (95% CI) 442.1 (293.0, 591.2) downloads/article year, $Z = 5.81$, $P < 0.001$)
39 (Figure 5). The difference in download rate between the first and last three articles was
40 similar across different disease categories (I^2 24%; $P = 0.21$).
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51 **DISCUSSION**

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54 In this analysis of serial rheumatology journals, no relationship between article placement
55 order and author gender, geographical region or industry sponsorship was observed.
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58 However, differences for disease category were apparent, with more frequent positioning of
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3 articles about rheumatoid arthritis towards the front of journal issues, and articles about
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5 crystal arthritis, other connective tissue diseases, pediatric rheumatology, pain syndromes,
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7 systemic lupus erythematosus, systemic sclerosis and vasculitis towards the back of issues.
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10 Analyses of Altmetric scores and download rates suggested that article placement order
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12 influences research prominence, with earlier placed articles receiving more attention.
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15 Medical journals are central to evidence-based practice and represent a key source of new
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17 knowledge for medical professionals.[18, 19] Unbiased publication practices are important in
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19 allowing a variety of perspectives and emphases to expand the scope of research and clinical
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21 practice. Although bias has been previously reported in academic journals based on
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23 authorship ordering of genders,[9, 10] representation of geographical regions,[9, 11] and
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25 acceptance and time to publication based on industry sponsorship,[12] our analysis showed
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27 that these factors were not associated with article placement order within serial rheumatology
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29 journals.
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34 Articles about rheumatoid arthritis were preferentially placed towards the front of
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36 rheumatology journals, while other conditions, particularly pain syndromes, crystal arthritis,
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38 pediatric syndromes, and connective tissue diseases, were ordered towards the back.
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41 Rheumatoid arthritis was the disease category with the greatest number of articles, therefore
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43 giving it the greatest opportunity to be listed first, but our analyses accounted for the variation
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45 in article numbers between disease categories. Although rheumatoid arthritis is a very
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47 important rheumatic disease,[20] general rheumatology practice involves the diagnosis and
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49 treatment of a wide range of diseases.[21, 22] General rheumatology journals should ideally
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51 reflect that diversity of clinical practice. A similar distribution of articles on each disease
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53 category would therefore be expected if there was no bias for disease category.
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3 The reason for the observed differences in article placement for disease category is unclear.
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5 Disease privileging in other fields of medical research has been reported, with some prevalent
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7 diseases with high global impact being under-funded and under-researched.[13-15] Crystal
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9 arthritis, osteoarthritis and pain syndromes are common and have high global burden,[23-25]
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11 but may be viewed by rheumatologists and journal editors as less important or less
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13 severe.[26, 27] These perceptions of some rheumatic diseases have the potential to impact
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15 attitudes in clinical practice and contribute to lower quality of care.[27, 28] Rheumatic
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17 diseases such as vasculitis, pediatric rheumatic disease, and scleroderma are less common,
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19 but can lead to major morbidity and reduced quality of life. Improving the impact and
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21 accessibility of research published on 'lower priority' or less common rheumatic diseases
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23 may have an important impact on clinicians' understanding about and attitudes towards these
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25 conditions in clinical practice.
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31 Differences in article placement order for disease category was particularly evident in
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33 journals with disease-specific tables of contents sections within issues, rather than journals
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35 that did not group issue content by disease category. It has been suggested that grouping
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37 article content by disease category may improve the reader experience.[29] However, such
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39 decisions have the potential to further reduce readers' exposure to diseases that are already
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41 under-studied or less well understood. Editorial decisions to remove grouping by disease
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43 category, or to cycle the order of disease category groups for each issue may be a simple
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45 solution to overcome bias for disease category reflected in article placement order.
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50 In our analysis, articles appearing in the first three places of an issue had higher Altmetric
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52 scores and download rates compared to articles appearing in the last three places of an issue.
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54 This is consistent with prior studies which also demonstrate the impact of the primacy effect
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56 on research prominence.[6-8] Collectively, these findings indicate that articles placed at the
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58 front of journal issues receive greater prominence. The prominence and impact of research
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3 published in journals has an important role in not only providing information to improve
4 knowledge and treatment, but also in financing further research[30] and obtaining academic
5 promotion.[31]
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10 The current analysis has some limitations. Firstly, Altmetric and download data were not
11 available from all journals included in the analysis, and it is unclear whether similar
12 differences are present across all journals. Secondly, citation rates were not evaluated because
13 of the short time period between article publication and data extraction which would not have
14 reflected true citation rates, which increase over time. Finally, this analysis did not explore
15 other factors that may have contributed to article placement order such as quality, impact, or
16 originality of the study, or the presence of prolific or “star” authors.[32]
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27 In conclusion, author gender, geographical region, or funding source do not influence article
28 placement order in serial rheumatology journals. However, bias for certain disease categories
29 is reflected in article placement order. Article placement order may have an impact on
30 research prominence, including Altmetric scores and download rate. Editorial choices about
31 the serial position of articles within journals can influence prioritisation of certain diseases.
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None.

Competing interests

ND has received consulting fees, speaker fees or grants from AstraZeneca, Horizon, Amgen, Dyve Bio, Hengrui, Abbvie, Pfizer, and Janssen, outside the submitted work. ND and SS work primarily in the field of gout research (a condition that was analysed in this research project). GG and AG declare no competing interests.

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Author contributions

SS contributed towards acquisition, analysis and interpretation of the data. GG contributed towards design of the study and analysis and interpretation of the data. AG contributed towards design of the study and interpretation of the data. ND contributed towards design of the study, and acquisition and interpretation of the data. All authors were involved in drafting of the work or revising it critically for important intellectual content. All authors approved the final version to be published and agree to be accountable for all aspects of the work.

Data statement

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3 All extracted data used in the analyses are available upon reasonable request from the
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5 corresponding author.
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Figure legends

Figure 1. Cumulative distribution function plots of standardised article placement indices (SAPI) for first author gender (**A.**), senior author gender (**B.**), industry funding (**C.**), and first author's geographic region of affiliated institution (**D.**). Left skewed distributions suggest prioritisation towards the front of journal issues.

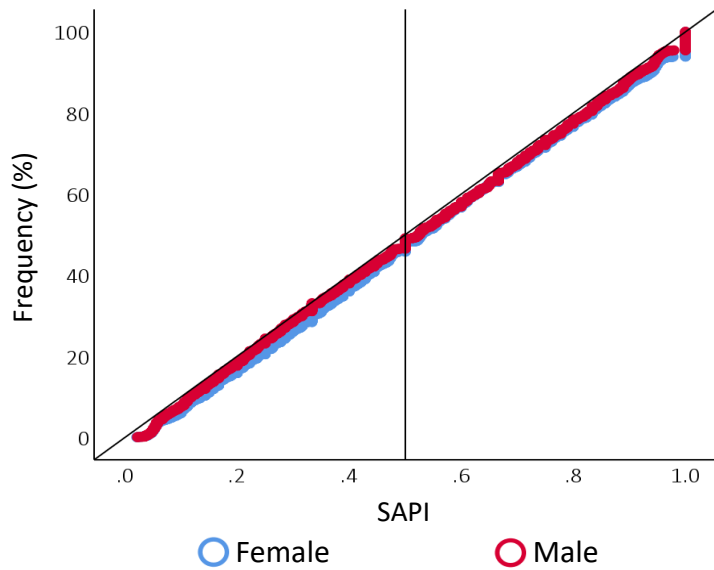
Figure 2. Cumulative distribution function plots of standardised article placement indices (SAPI) for each disease category. Left skewed distributions suggest prioritisation towards the front of journal issues.

Figure 3. Percentage of articles (per disease category) published in first three and last three places of an issue (*P*-values indicate difference between proportions of articles in first and last three places of an issue).

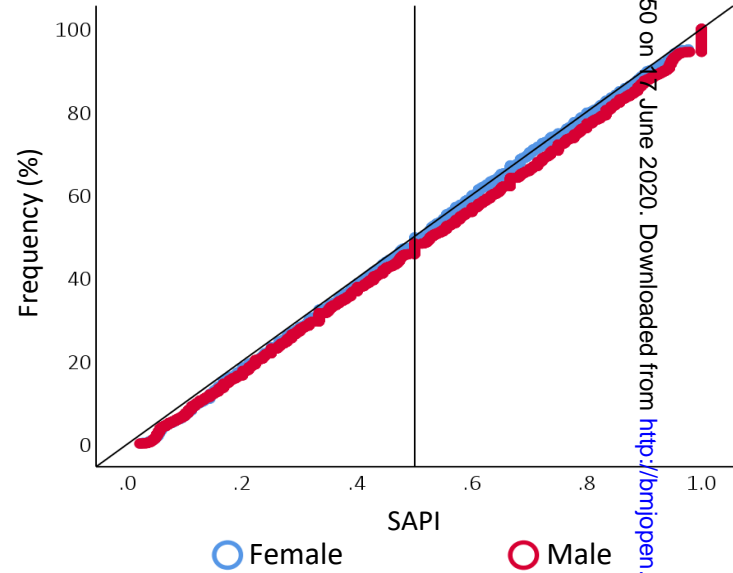
Figure 4. Cumulative distribution function plots of standardised article placement indices (SAPI) for each disease category for journals with (**A.**) and without (**B.**) contents grouped by disease. Left skewed distributions suggest prioritization towards the front of journal issues.

Figure 5. Forest plots showing the mean differences for each disease category for Altmetric scores (**A.**) and download rates (**B.**) between articles published in the first vs. last three places of an issue. Positive differences indicate a higher Altmetric score/download rate for articles published in one of the first three places of an issue. Differences in Altmetric scores are adjusted for journal. Download data was available from one journal. CTD: connective tissue disease.

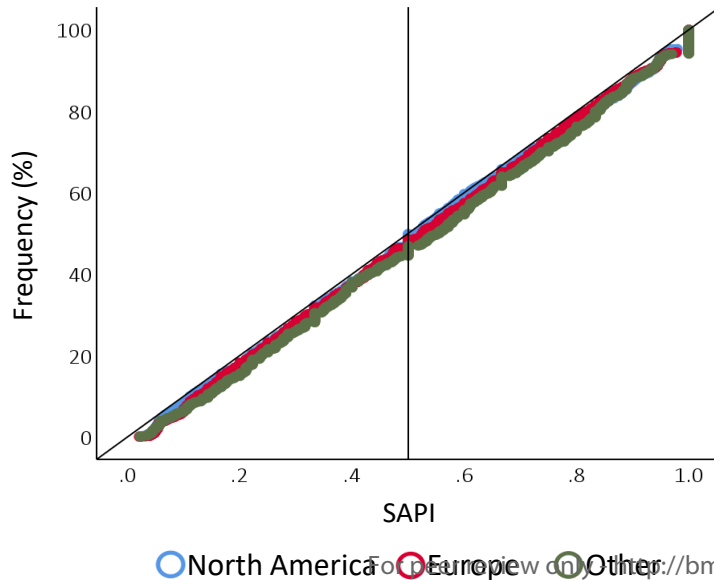
A. First author gender



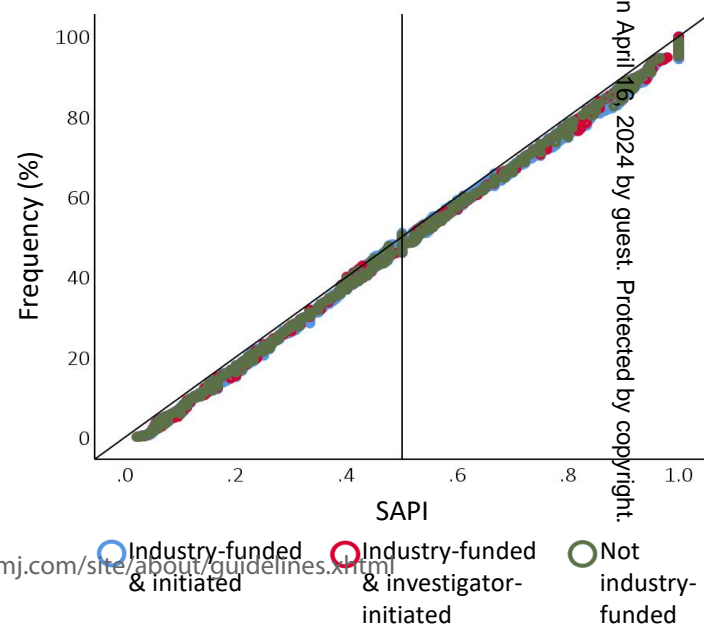
B. Senior author gender



C. Geographical region



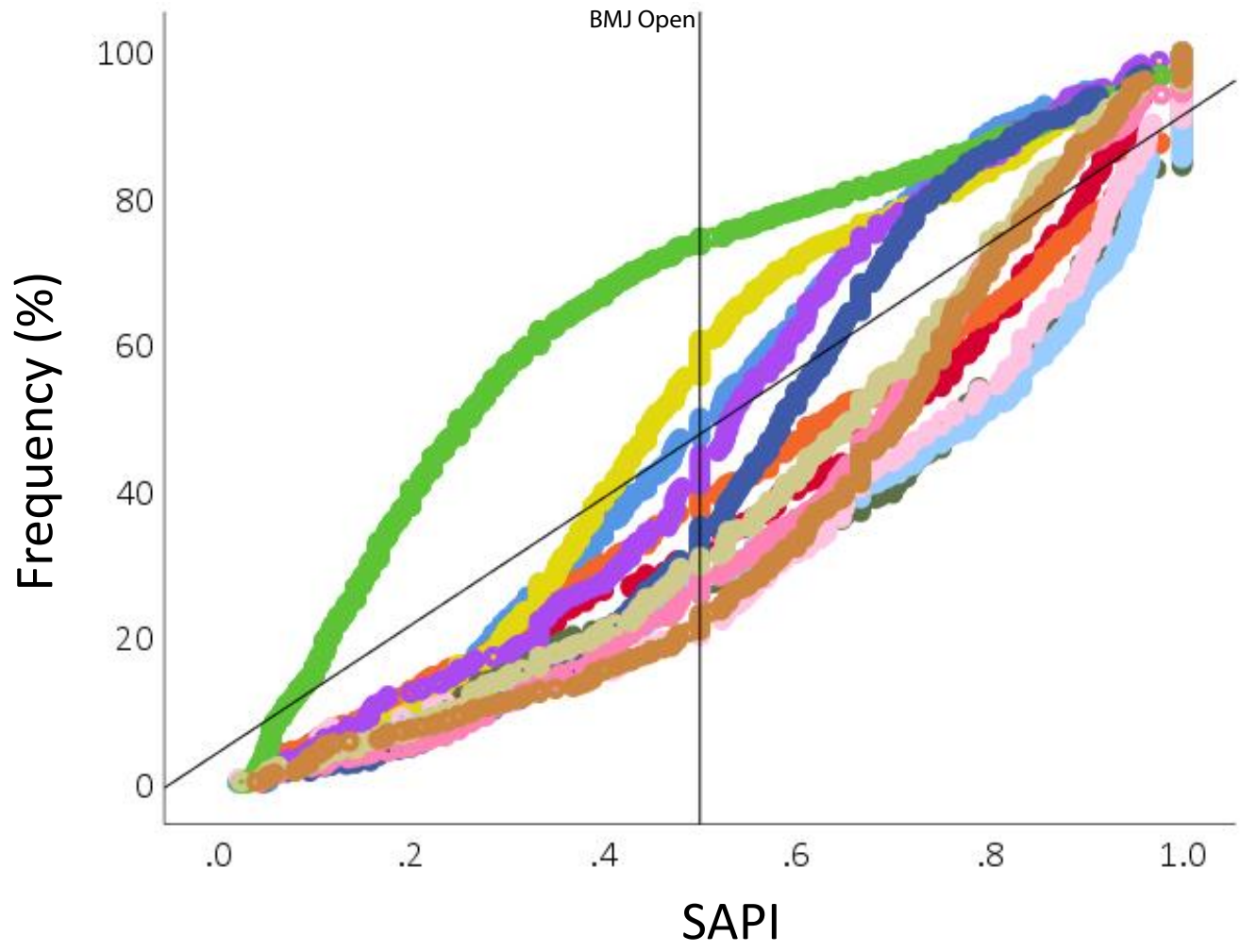
D. Industry funding



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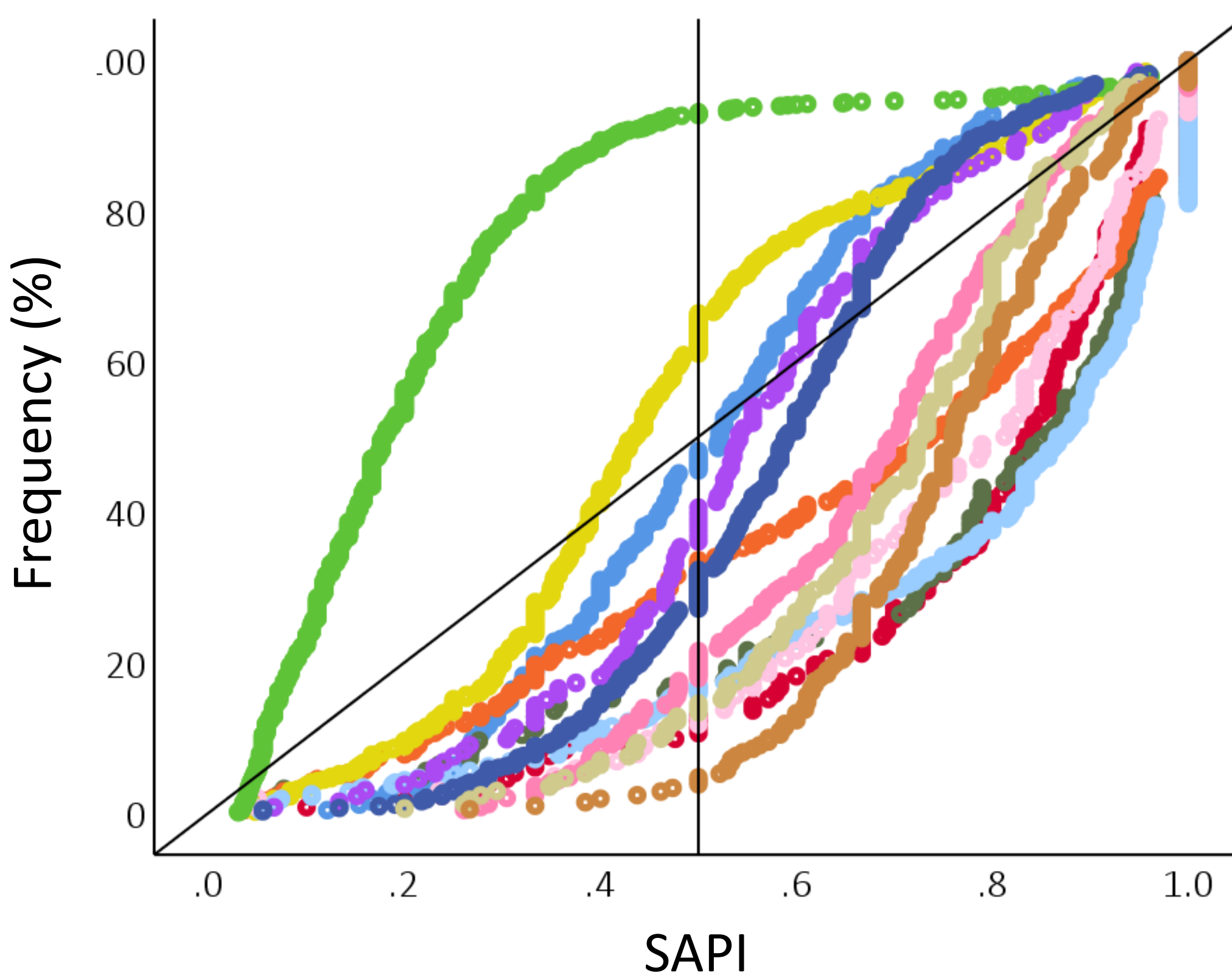
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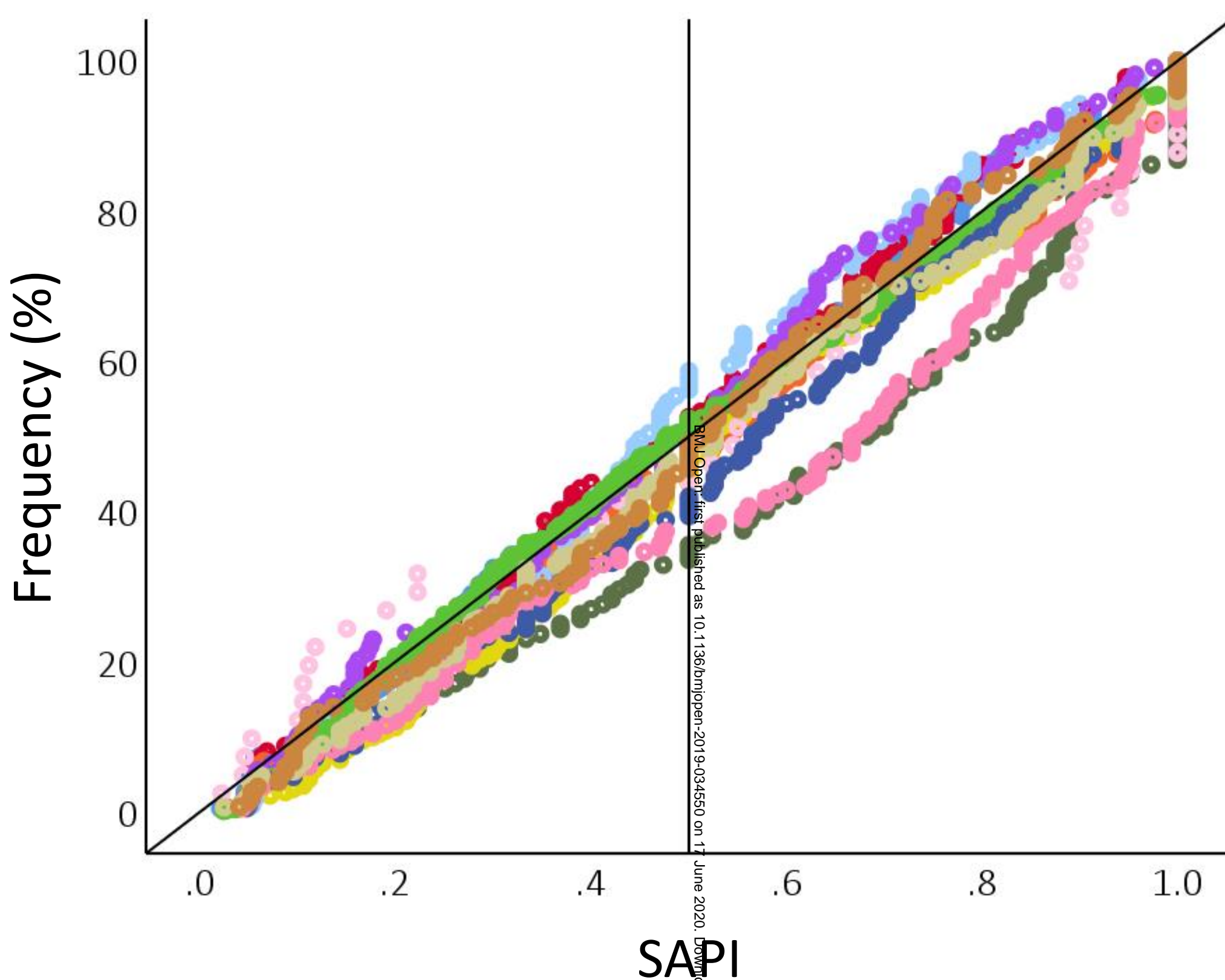
- 31 ○ Crystal arthritis
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- 33 ○ Not disease-specific
- 34 ○ Pain syndromes
- 35 ○ Systemic lupus erythematosus
- 36 ○ Psoriatic arthritis
- 37 ○ Other connective tissue disease
- 38 ○ Vasculitis
- 39 ○ Miscellaneous
- 40 ○ Osteoarthritis
- 41 ○ Pediatric rheumatology
- Rheumatoid arthritis
- Systemic sclerosis

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A. Journals with issue content grouped by disease

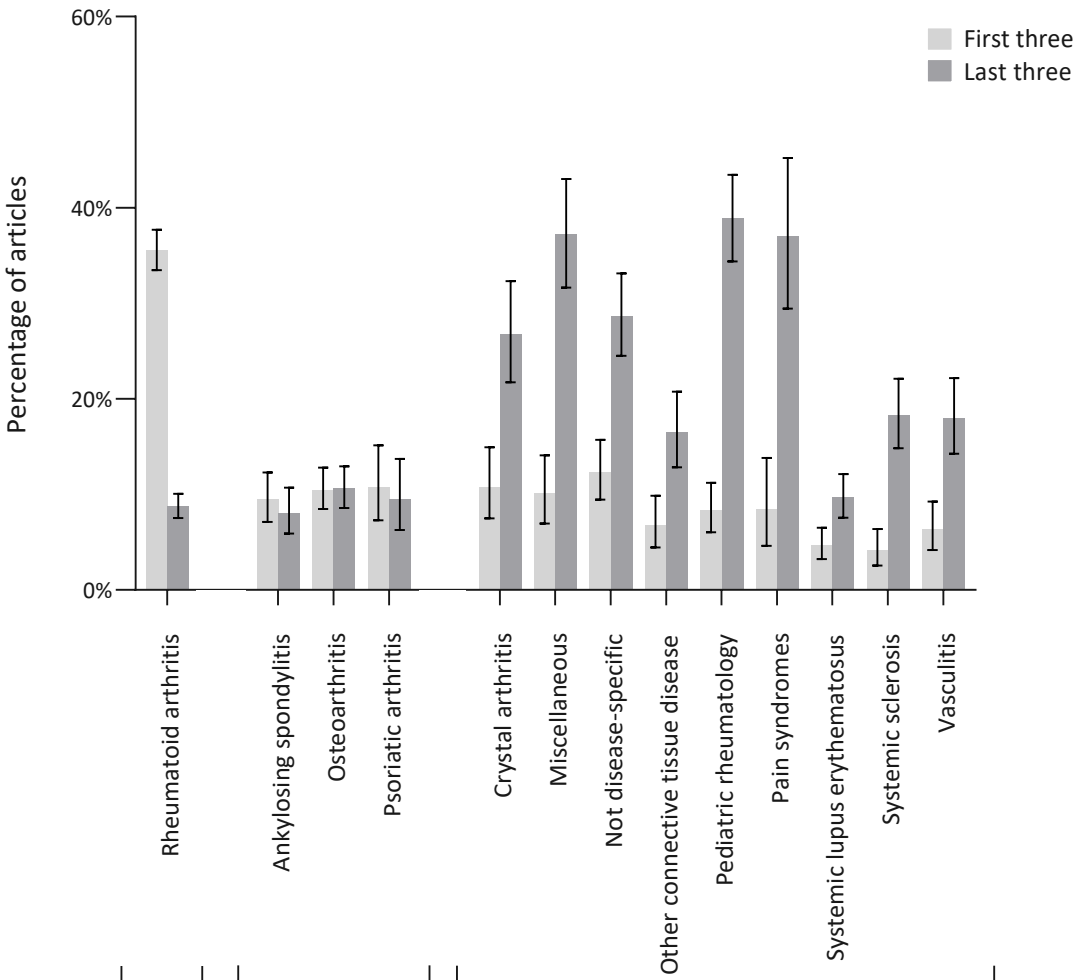


B. Journals without issue content grouped by disease



- Ankylosing spondylitis ○ Crystal arthritis ○ Miscellaneous
- Not disease-specific ○ Osteoarthritis ○ Pediatric rheumatology
- Pain syndromes ○ Psoriatic arthritis ○ Rheumatoid arthritis
- Systemic lupus erythematosus ○ Systemic sclerosis
- Other connective tissue disease ○ Vasculitis

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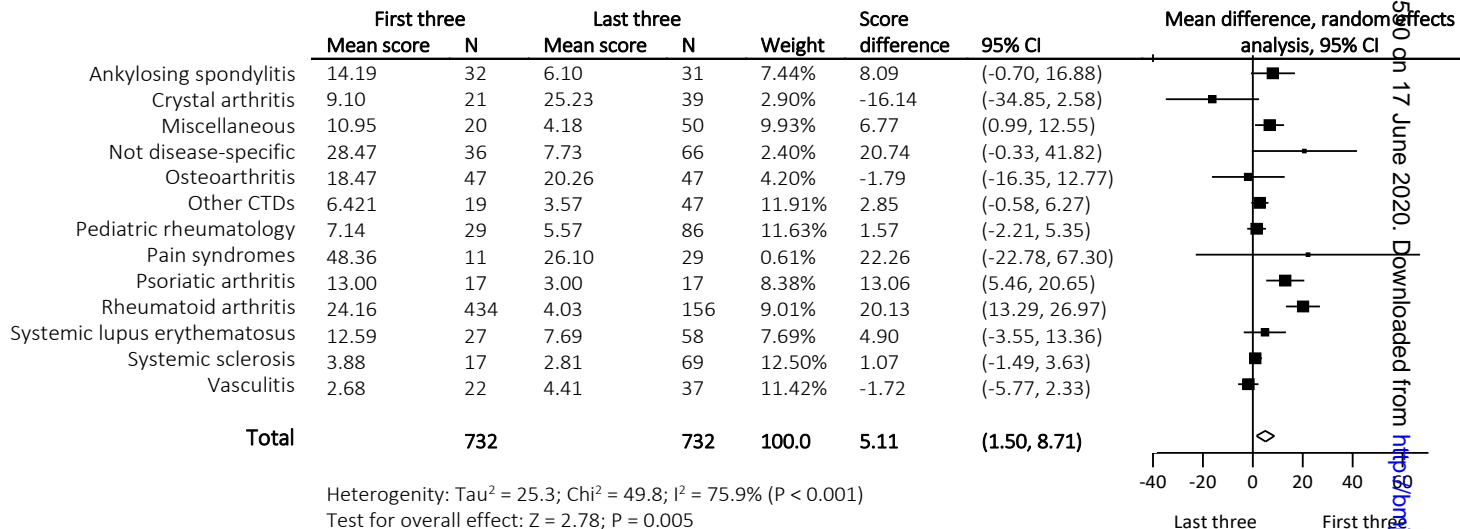
Greater number of articles in first three places (P < 0.001)

No order bias (all P > 0.51)

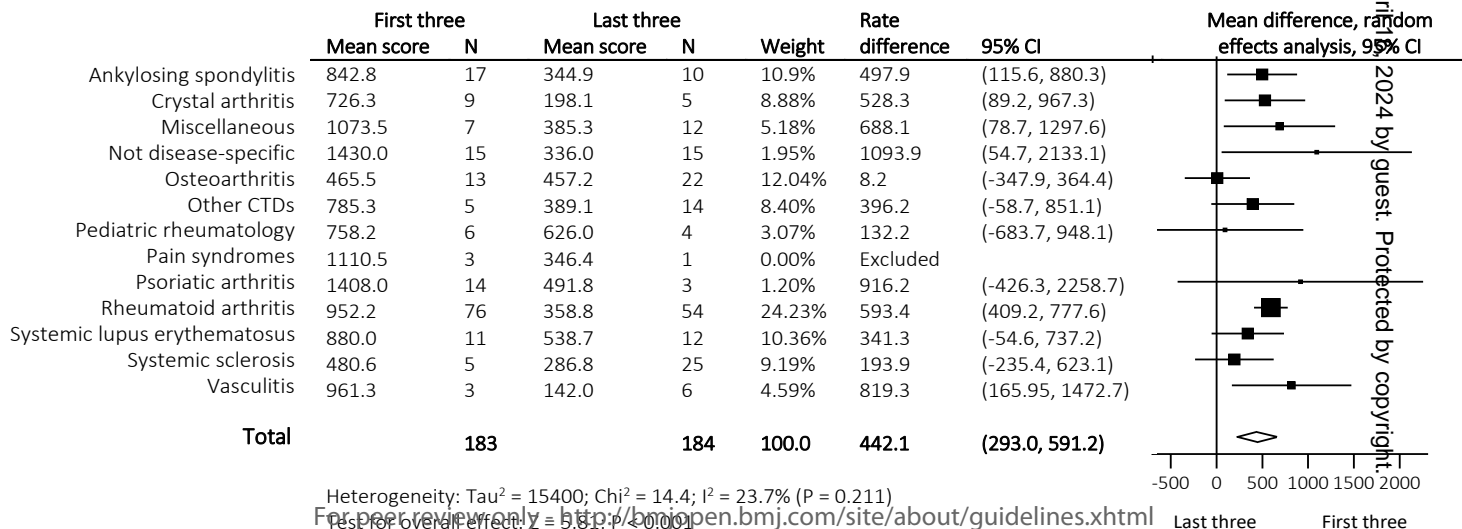
Greater number of articles in last three places (all P < 0.001)

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A. Differences in Altmetric scores between articles in first and last three places of an issue



B. Differences in download rates between articles in first and last three places of an issue



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SUPPLEMENTARY MATERIAL

Supplementary Tables

Supplementary Table 1. Journal characteristics

	Publisher	Country of publication	2016 Impact Factor	Relevant affiliated society	Issues per year	Contents grouped by disease	Total number of articles included, n	Number of included articles per issue, mean (SD)
Annals of the Rheumatic Diseases	BMJ Publishing Group Ltd	United Kingdom	12.811	European League Against Rheumatism	12	o	1374	13.2 (9.4)
Arthritis & Rheumatology	John Wiley & Sons	United States	6.918	American College of Rheumatology	12	es	1367	12.5 (7.6)
Rheumatology	Oxford University Press	United Kingdom	4.818	British Society for Rheumatology	12	o	1158	10.2 (5.7)
Seminars in Arthritis and Rheumatism	Elsevier	United States	4.498	None	6	es	403	7.3 (4.1)
Joint Bone Spine	Elsevier	United States	3.329	French Society of Rheumatology	6	o	239	4.6 (2.6)
Arthritis Care & Research	John Wiley & Sons	United States	3.319	American College of Rheumatology, Association of Rheumatology Health Professionals	12	es	1098	9.6 (5.4)
The Journal of Rheumatology	Journal of Rheumatology Publishing Company Limited	Canada	3.150	Canadian Rheumatology Association	12	es	1148	10.3 (6.1)

Supplementary Table 2. Number of articles within each disease category for crystal arthritis, miscellaneous and other connective tissue diseases

	Frequency	Percent
<i>Crystal arthritis (n = 269)</i>		
Gout	260	96.7
Calcium crystal diseases	9	3.3
<i>Miscellaneous Disease (n = 277 articles)</i>		
Regional musculoskeletal syndromes	48	17.3
Osteoporosis	22	7.9
IgG4-related disease	20	7.2
FMF	20	7.2
Polymyalgia rheumatica	19	6.9
CAPS	16	5.8
Still's disease	10	3.6
Septic arthritis	8	2.9
Fibrosis	8	2.9
Sarcoidosis	7	2.5
Chikungunya Virus	7	2.5
SAPHO syndrome	6	2.2
TRAPS	5	1.8
Polychondritis	5	1.8
Ehlers-Danlos Syndrome	4	1.4
Lyme disease	4	1.4
Alkaptonuria	4	1.4
Hemophagocytic syndromes	3	1.1
Vertebral fractures	2	0.7
Uveitis	2	0.7
Undifferentiated arthritis	2	0.7
Tuberculosis	2	0.7
Periodic fever syndrome	2	0.7
Löfgren syndrome	2	0.7
Erdheim-Chester disease	2	0.7
Dupuytren's disease	2	0.7
ACPA-negative undifferentiated arthritis	1	0.4
Yellow fever	1	0.4
Whipple disease	1	0.4
Vertebral endplate lesions	1	0.4
Tumoral calcinosis	1	0.4
Tenosynovial giant cell tumor	1	0.4
Systemic autoinflammatory disease (SAID)	1	0.4
Schnitzler's syndrome	1	0.4
Ribbing disease	1	0.4
Receptor-associated periodic syndrome	1	0.4
Pyogenic sterile arthritis pyoderma gangrenosum and acne (PAPA) syndrome	1	0.4
Pyogenic arthritis	1	0.4
Primary angiitis of the CNS	1	0.4
Preeclampsia	1	0.4
Pigmented villonodular synovitis	1	0.4
Periodic fever, aphthous stomatitis, pharyngitis, and cervical adenitis (PFAPA) syndrome	1	0.4

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Paraneoplastic rheumatic syndrome	1	0.4
Palindromic rheumatism	1	0.4
Paget's disease	1	0.4
Osteonecrosis	1	0.4
Osteomyelitis	1	0.4
NOD2-associated autoinflammatory diseases	1	0.4
Muckle-wells syndrome	1	0.4
Mikulicz's disease	1	0.4
Mevalonate kinase deficiency	1	0.4
Medial meniscal tears	1	0.4
Macrophage activation syndrome	1	0.4
Leri's pleonosteosis	1	0.4
Kikuchi-Fujimoto disease	1	0.4
Joint hypermobility syndrome	1	0.4
Immune reconstitution inflammatory syndrome	1	0.4
Hereditary recurrent fever syndromes	1	0.4
Hereditary haemochromatosis	1	0.4
Haploinsufficiency of A20	1	0.4
Glomerulonephritis	1	0.4
Gaucher disease	1	0.4
Femoral fractures	1	0.4
Fabry disease	1	0.4
Ebola virus	1	0.4
Discitis	1	0.4
Chronic graft-versus-host disease	1	0.4
Blau syndrome	1	0.4
Biphosphate trochanteric fracture	1	0.4
Amyloidosis	1	0.4
Aicardi-Goutières syndrome	1	0.4
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<i>Other connective tissue disease (n = 339 articles)</i>		
Sjogren's syndrome	174	51.3
Inflammatory myositis	115	33.9
Antiphospholipid syndrome	41	12.1
Mixed connective tissue disease	7	2.1
CTD-associated interstitial lung disease	1	0.3
Undifferentiated connective tissue disease	1	0.3
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Supplementary Table 3. Number of articles appearing in at least one article in first and last three articles of an issue for author gender, geographical region of affiliated institution, industry funding category, and disease category

	Total articles	First three N	% of total	Last three N	% of total	Odds ratio (OR) ^a	95% CI for OR	P ^b
First author gender								
Female	3517	537	15.3%	586	16.7%	0.90	0.79, 1.02	0.17
Male	3250	557	17.1%	509	15.7%	1.11	0.98, 1.27	0.17
Last author gender								
Female	2359	393	16.7%	355	15.0%	1.13	0.97, 1.32	0.17
Male	4412	705	16.0%	737	16.7%	0.95	0.85, 1.01	0.37
Geographical region of affiliated institution (first author)								
North America	2177	362	16.6%	352	16.2%	1.03	0.88, 1.21	0.68
Europe	3486	573	16.4%	556	16.0%	1.04	0.91, 1.18	0.68
Other	1124	163	14.5%	190	16.9%	0.83	0.66, 1.05	0.35
Industry funding								
Industry-funded and initiated	640	104	16.3%	109	17.0%	0.95	0.70, 1.27	0.71
Industry-funded and investigator-initiated	596	87	14.6%	111	18.6%	0.75	0.55, 1.01	0.09
Not industry-funded	5551	907	16.3%	878	15.8%	1.04	0.94, 1.15	0.09
Disease category								
Ankylosing spondylitis	496	47	9.5%	40	8.1%	1.19	0.77, 1.86	0.51
Crystal arthritis ^c	269	29	10.8%	72	26.8%	0.33	0.21, 0.53	<0.001
Miscellaneous	277	28	10.1%	103	37.2%	0.19	0.12, 0.30	<0.001
Not disease-specific	422	52	12.3%	121	28.7%	0.35	0.24, 0.50	<0.001
Osteoarthritis	773	81	10.5%	82	10.6%	0.99	0.71, 1.37	0.934
Other connective tissue diseases	339	23	6.8%	56	16.5%	0.37	0.22, 0.61	<0.001
Pediatric rheumatology	443	37	8.4%	172	38.8%	0.14	0.10, 0.21	<0.001
Pain syndromes	143	12	8.4%	53	37.1%	0.16	0.08, 0.31	<0.001
Psoriatic arthritis ^c	242	26	10.7%	23	9.5%	1.15	0.63, 2.07	0.71
Rheumatoid arthritis	1946	692	35.6%	170	8.7%	5.77	4.80, 6.92	<0.001
Systemic lupus erythematosus	642	30	4.7%	62	9.7%	0.46	0.29, 0.72	0.001
Systemic sclerosis	433	18	4.4%	79	18.2%	0.19	0.11, 0.33	<0.001
Vasculitis	362	23	6.4%	65	18.0%	0.31	0.19, 0.51	<0.001

^aThe odds of being in at least one article in the first three places of an issue; ^bFDR-adjusted Mid-P exact P-value. Bolded values indicate significance at < 0.05. ^cOne article in each of 'Crystal arthritis' and 'Psoriatic arthritis' came from issues which included 5 articles and were therefore counted in both the 'first' and 'last' three categories.

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Supplementary Table 4. Difference in cumulative density function distribution of standard article placement indices (SAPI) between journals with and without contents grouped by disease for articles with related editorials and for each disease category

	Journals with contents not grouped by disease			Journals with contents grouped by disease			Two-sample Kolmogorov-Smirnov Z test ^b	
	N (%)	SAPI ^a		N (%)	SAPI ^a		Effect size (D)	FDR-adjusted P
		Mean	SD		Mean	SD		
Ankylosing spondylitis	228 (8.2%)	0.49	0.28	268 (6.7%)	0.52	0.19	0.20	<0.001
Crystal arthritis	137 (4.9%)	0.49	0.28	132 (3.3%)	0.78	0.20	0.50	<0.001
Miscellaneous	152 (5.5%)	0.62	0.30	125 (3.1%)	0.76	0.26	0.29	<0.001
Not disease-specific	178 (6.4%)	0.53	0.30	244 (6.1%)	0.66	0.29	0.22	<0.001
Osteoarthritis	231 (8.3%)	0.55	0.27	542 (13.5%)	0.47	0.22	0.20	<0.001
Other connective tissue diseases	167 (6.0%)	0.49	0.29	172 (4.3%)	0.70	0.17	0.36	<0.001
Pediatric rheumatology	121 (4.4%)	0.48	0.26	322 (8.0%)	0.77	0.25	0.50	<0.001
Pain syndromes	41 (1.5%)	0.54	0.35	102 (2.5%)	0.75	0.21	0.36	0.001
Psoriatic arthritis	109 (3.9%)	0.48	0.27	133 (3.3%)	0.56	0.20	0.22	0.005
Rheumatoid arthritis	881 (31.8%)	0.51	0.29	1065 (26.5%)	0.23	0.20	0.49	<0.001
Systemic lupus erythematosus	193 (7.0%)	0.56	0.28	449 (11.2%)	0.58	0.17	0.19	<0.001
Systemic sclerosis	182 (6.6%)	0.60	0.30	251 (6.3%)	0.68	0.18	0.26	<0.001
Vasculitis	151 (5.4%)	0.51	0.28	211 (5.3%)	0.75	0.14	0.50	<0.001

^aLower SAPI scores equate to articles ordered at the front of issues, while higher SAPI scores equate to articles ordered at the end of issues. ^bTest of difference in distribution of SAPI between journals with and without contents grouped by disease sections. Bolded P-values indicated significant difference at < 0.05.

BMJ Open

Article Placement Order in Rheumatology Journals: A Content Analysis

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Keywords:	publication, bias, RHEUMATOLOGY

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3 **1 Article Placement Order in Rheumatology Journals: A Content Analysis**
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3 14 **Abstract**
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6 15 **Objectives.** To analyse variables associated with article placement order in serial
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8 16 rheumatology journals.
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11 17 **Design.** A content analysis of original articles published in seven rheumatology journals from
12
13 18 2013-2018.
14

15
16 19 **Methods.** The following data were extracted from 6,787 articles: order number of article in
17
18 20 issue, gender of first and last author, geographical region, industry funding, and disease
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20 21 category. Cumulative density function plots were used to determine whether article
21
22 22 placement distribution was different from the expected distribution. Odds ratios for articles
23
24 23 published in the first three places of an issue compared with the last three places were
25
26 24 calculated. Altmetric score and downloads were meta-analysed.
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31 25 **Results.** Article placement order did not associate with author gender, geographical region or
32
33 26 funding source, but was associated with disease category. Articles about rheumatoid arthritis
34
35 27 were more likely to be ordered at the front of issues ($P<0.001$). Articles about crystal
36
37 28 arthritis, systemic lupus erythematosus, vasculitis, pain syndromes and pediatric rheumatic
38
39 29 diseases were more likely to be ordered at the end of issues (all $P<0.001$). Association of
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41 30 article placement order with disease category was observed only in journals with tables of
42
43 31 contents grouped by disease. Articles ordered in the first three places had higher Altmetric
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45 32 and download rates, than articles in the last three places.
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50 33 **Conclusions.** Author gender, geographical region, or funding source do not influence article
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52 34 placement order in serial rheumatology journals. However, bias for certain disease categories
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54 35 is reflected in article placement order. Editorial decisions about article placement order can
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56 36 influence the prominence of diseases.
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38 **Keywords:** publication, bias, rheumatology

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3 40 **Strengths and limitations of the study**
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- 6 41 • This is the first study to assess the relationship of article placement order in serial medical
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8 42 journals with author gender, geographical region of affiliated institution, industry funding
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11 43 or disease category.
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13 44 • This content analysis included 6,787 articles from general rheumatology journals.
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15 45 • This study also analysed the impact of article placement order on research prominence,
16
17 46 including Altmetric scores and download rate.
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20 47 • This analysis did not explore other factors that may have contributed to article placement
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22 48 order such as the originality of the study findings or the presence of “star” authors.
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50 INTRODUCTION

51 The strong preference for items ordered first, and the important effect of list order on choice,
52 is well-recognised in consumer-based research.[1-3] In online searches for health
53 information, 97% of selected links were displayed in the first 10 results, while only 2% were
54 from the second or following pages.[4] For online academic repositories, earlier listed articles
55 were downloaded more frequently than later listed articles.[5] These primacy effects, which
56 increase when lists are longer,[6] may occur because earlier items, or those at the top of
57 tables of contents, are more visible and more likely to be seen and read.[5]

58 In academic publishing, the ordering of articles within a journal issue also affects the
59 prominence achieved by that research. Earlier listed articles received more citations over a 25
60 year period in a single journal.[7] The impact of ordering was also evident in an analysis of
61 emails sent to subscribers disseminating recent research papers listed in random order; with
62 the first paper having a 33% increase in views, 29% increase in downloads and 27% increase
63 in citations, regardless of research quality.[8]

64 A number of systemic biases have been reported in academic publishing. These include
65 preferential lead and senior authorship of men,[9, 10] higher acceptance rates for articles
66 from the US and Europe,[9, 11] preferential publication of industry-funded research,[12] and
67 disease privileging, wherein particular diseases receive preferential research funding and
68 publication.[13-15] It is unknown whether these systemic biases are reflected in article
69 placement order within medical journals. We analysed serial rheumatology journals for
70 relationships between article placement order and gender of the lead and senior authors,
71 geographical region of the affiliated institution, industry sponsorship, and disease category.

73 METHODS

74 **Patient and public involvement**

75 There was no patient or public involvement in the design, or conduct, or reporting, of this
76 research.

78 **Identification of journals and articles for inclusion**

79 This was a cross-sectional content analysis of original articles published in general
80 rheumatology journals. Journals were included if they produced regular issues, reported
81 original research and had 2016 Thomas Reuters Impact Factors of > 3.0. Journals were
82 excluded if they published review articles only, were disease-specific (e.g. *Lupus*,
83 *Osteoarthritis and Cartilage*) or produced no issues. The following seven general
84 rheumatology journals met the above criteria and were included: *Annals of the Rheumatic*
85 *Diseases*, *Arthritis & Rheumatology*, *Arthritis Care & Research*, *Seminars in Arthritis and*
86 *Rheumatism*, *Rheumatology*, *Journal of Rheumatology*, and *Joint Bone Spine*. Characteristics
87 of the included journals are shown in **Supplementary Table 1**.

88 All original articles published in the included journals in a five-year period from June 2013 to
89 June 2018 were included in the analysis. To be included, articles could be full or concise
90 reports, and report on original basic science or clinical research, including systematic reviews
91 and meta-analyses. Articles were excluded if they were from a disease-specific thematic issue
92 or supplement, were narrative reviews, recommendations, guidelines, letters, or meeting
93 reports.

95 **Data extraction**

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3 96 Data extraction was undertaken between June and December 2018. The following
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5 97 information was extracted for each included article: order number of article in the issue,
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7 98 gender of lead (first) author; gender of senior (final) author; geographical region of affiliated
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9 99 institution (for the first author); any industry sponsorship (industry-funded and
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11 100 initiated/industry-funded and investigator-initiated/not industry-funded); and, if available, the
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13 101 Altmetric score and number of downloads. The number of citations was not assessed because
14
15 102 of the short time period between publication and data extraction. If author gender could not
16
17 103 be determined by first name or by an internet search of the author's affiliated institution
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19 104 profile page, then the author's first name was entered into <https://api.genderize.io/?name=>
20
21 105 which returns the gender and probability of certainty. Probabilities < 0.5 were labelled as
22
23 106 "unknown" and not included in the gender-related analysis. If articles were authored by a
24
25 107 single author, then this author's gender was entered under first author. Funding was assessed
26
27 108 by review of funding statements, disclosures and author affiliations. Industry-funded studies
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29 109 were categorized as industry-funded and industry-initiated, or industry-funded and
30
31 110 investigator-initiated, based on these statements. Studies with no evidence of industry
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33 111 funding were categorized as not industry-funded.

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35 112 Articles were coded according to the following 13 disease categories: ankylosing spondylitis
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37 113 and other spondyloarthropathy, crystal arthritis, osteoarthritis, miscellaneous rheumatic
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39 114 disease, pediatric rheumatology, pain syndromes, psoriatic arthritis, rheumatoid arthritis,
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41 115 systemic lupus erythematosus, systemic sclerosis/scleroderma, other connective tissue
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43 116 disorders, vasculitis, and not disease-specific. The title of each article was used to determine
44
45 117 the disease category. If there was uncertainty about the disease category from the title, then
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47 118 the abstract and/or full paper were reviewed.

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49 119 To ensure standardisation in data extraction, two authors (SS, ND) independently reviewed
50
51 120 eligible papers from ten randomly selected issues. A total of 208 articles were reviewed, with

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3 121 kappas of 1.00 for author gender, geographic region and industry funding, while disease
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5 122 category had a kappa of 0.84 (86.1% agreement (95% confidence interval (CI) 81.0%,
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7 123 90.5%)). All disease category disagreements were discussed to reach a consensus and a set of
8
9 124 rules for categorising was established. The exercise was then repeated in which the two
10
11 125 authors reviewed disease categories in a further five randomly selected issues totalling 85
12
13 126 articles, with a kappa of 0.99 (98.8% agreement (95% CI 94.3%, 99.9%)) for disease
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15 127 category. A single reviewer (SS) then independently extracted the data.
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23 129 **Data analysis**

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26 130 The primary analyses assessed the relationships between article placement order and: gender
27
28 131 of first authors, gender of last authors, geographical region (North America vs. Europe vs.
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30 132 Other), industry funding categories (industry-funded and initiated vs. industry-funded and
31
32 133 investigator-initiated vs. not industry-funded), and disease categories. In order to identify
33
34 134 whether these factors were associated with article placement order within journal issues, each
35
36 135 article within each issue was assigned a standard article placement index (SAPI), which was
37
38 136 defined as the order of the article in the issue/total number of articles in the issue. For
39
40 137 example, the first article in an issue of 21 articles was given an SAPI of $1/21 = 0.0476$ and
41
42 138 the last article $21/21 = 1$. This metric allowed standardisation of article placement order
43
44 139 within issues with the expectation that the number of articles within each issue would vary
45
46 140 widely across different journals. For example, the SAPI could scale between article
47
48 141 placement in a journal issue of five articles and one with 50 articles. Therefore, this metric
49
50 142 addressed the large variation in the number of articles between different journal issues and
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52 143 overcame the potential issue of skewed average article placement order data resulting from
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54 144 issues with large numbers of articles. The SAPI as a placement metric enabled the
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3 145 examination of article placement order without an assumption that the mean (or median)
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5 146 article placement order was different. Cumulative distribution functions (CDF) of SAPIs
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7 147 were analysed to determine the associations between article placement order and author
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9 148 gender, geographical region industry funding and disease category. A uniform distribution
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11 149 would be expected if there was no association with article placement order: deviations from
12
13 150 the expected uniform distribution would support an association with article placement order.
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15 151 To test whether the distribution of SAPIs were different between author genders,
16
17 152 geographical regions, and industry funding categories, two-sample Kolmogorov-Smirnov Z
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19 153 tests were conducted. Due to the sensitivity of this test [16], the effect sizes (D) were also
20
21 154 computed with values ranging from 0 (no difference in distribution of SAPI between
22
23 155 comparisons) to 1 (large difference in distribution of SAPI between comparisons) to provide
24
25 156 further description of the deviations between the observed distributions. To determine
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27 157 whether the distribution of SAPIs for each disease category was different from a uniform
28
29 158 distribution CDF (expected distribution if no bias reflected in article placement order), the
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31 159 area under the curve (AUC) of the observed CDF and uniform distribution CDF were each
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33 160 calculated using a trapezoidal method and the difference between these estimated for each of
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35 161 the 13 disease categories. Mean differences between the observed CDF and the uniform
36
37 162 distribution CDF AUCs were computed from bootstrapped samples (500 replicates, sampled
38
39 163 with replacement) and 95% confidence intervals estimated as the 2.5th and 97.5th percentile of
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41 164 the bootstrap distribution. P-values were calculated for each disease category from these
42
43 165 confidence intervals using the method of Altman and Bland.[17] This analysis method
44
45 166 allowed for an assumption-free comparison of the observed and expected distributions of
46
47 167 SAPIs.[18] CDF-based comparisons are estimates and do not systematically increase or
48
49 168 decrease with sample size. The estimated CDF, like an estimated mean, is unbiased at any
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51 169 sample size. The estimation of the CDF (like estimation of a mean) assumed only that each
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3 170 variable examined provided some incremental information; that is, that collinearity was not
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5 171 close to perfect.[19] Unlike the comparison of a central tendency statistic (i.e. mean or
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8 172 median order placement), comparing these distributions allowed testing of any early and late
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10 173 article placement (bimodal) clustering (primacy and recency) as well as a uniform
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12 174 distribution of placement. CDF plots of SAPIs also provided a visually clear representation of
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15 175 article placement order and potential differences between groups.

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18 176 A secondary analysis was undertaken to further explore article placement order, in which
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20 177 mid-P exact P-values were computed to compare the proportion of articles appearing in at
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23 178 least one of the first three places of an issue compared to at least one of the last three places
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25 179 of an issue for genders of first and last authors, geographical region, industry funding
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27 180 category, and each disease category. Odds ratios (OR) and their 95% CIs were also computed
28
29 181 for articles in the first three places vs. last three places of an issue.

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33 182 As some journals presented their content grouped by disease category, additional analyses
34
35 183 were undertaken to determine whether article placement order of disease categories was
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38 184 different between journals which presented content grouped by disease category vs. journals
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40 185 without disease category content grouping. This was tested statistically using CDF plots of
41
42 186 SAPI distributions, two-sample Kolmogorov Smirnov Z tests and effect sizes (D) as
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45 187 described above.

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48 188 To further explore factors associated with article placement order, a supplementary *post hoc*
49
50 189 analysis was undertaken to compare the median order of an article within an issue between
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53 190 genders, geographical regions, industry funding categories and disease categories using
54
55 191 Mann-Whitney U or Kruskal Wallis tests, as appropriate.

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3 192 Finally, to determine the impact of article placement order on Altmetric scores and article
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5 193 download rates (as available), meta-analyses were used to determine differences in the means
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7 194 for each variable between the first and last three articles in journal issues. Altmetric scores
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9 195 were provided by *Arthritis & Rheumatology*, *Annals of the Rheumatic Diseases*,
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11 196 *Rheumatology* and *Arthritis Care & Research*. *Annals of the Rheumatic Diseases*,
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13 197 *Rheumatology* and *The Journal of Rheumatology* had article download data available, but for
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15 198 the latter two journals, the data were available in only the 6 months prior to data extraction.
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17 199 Therefore, analyses of article downloads were undertaken for *Annals of the Rheumatic*
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19 200 *Diseases* only. For Altmetric scores, which generally do not change over time, mean scores
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21 201 were calculated by total Altmetric scores/total number of articles. For downloads, which are
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23 202 time dependent, rates were calculated by total number of downloads/total article-years from
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25 203 time of publication to time of data extraction. These analyses were undertaken within disease
26
27 204 categories, adjusted by journal, as appropriate, and weighted using the inverse-variance
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29 205 method. Random effects models were used for all I^2 values $> 0\%$.
30
31 206 All analyses were performed in SPSS (v25 IBM Corp), SAS v9.4 (SAS Institute Inc, Cary,
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33 207 NC) and openepi.com (v3.01). All tests were two-tailed and false discovery rate (FDR)-
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35 208 adjusted P values [20] were computed for all analyses with an alpha level of < 0.05
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37 209 considered significant.
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49 211 **RESULTS**

50 212 **Characteristics of included articles**

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52 213 A total of 6,787 articles were included; 488 (7.2%) were randomised controlled trials, 438
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54 214 (6.5%) were systematic literature reviews or meta-analyses, 4,466 (65.8%) were other clinical
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56 215 research studies, and 1,395 (20.6%) reported basic research. First authors were male in 3250
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3 216 (47.9%) articles, female in 3517 (51.8%) articles and unknown in 20 (0.3%) articles. Last
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5 217 authors were male in 4412 (65.0%) articles, female in 2359 (34.8%) articles and unknown/not
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7 218 applicable in 16 (0.2%) articles. 596 (8.8%) articles were industry-funded and initiated, 640
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9 219 (9.4%) were industry-funded and investigator-initiated, and 5551 (81.8%) were not industry-
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11 220 funded. The geographical region was North America in 2177 (32.1%) articles, Europe in
12
13 221 3486 (51.4%) articles, and Other in 1124 (16.6%) articles. Disease categories were
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15 222 rheumatoid arthritis (n = 1946, 28.7%), osteoarthritis (n = 773, 11.4%), systemic lupus
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17 223 erythematosus (n = 642, 9.5%), ankylosing spondylitis (n = 496, 7.3%), pediatric
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19 224 rheumatology (n = 443, 6.5%), systemic sclerosis (n = 433, 6.4%), not disease-specific (n =
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21 225 422, 6.2%), vasculitis (n = 362, 5.3%), other connective tissue disease (n = 339, 5.0%),
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23 226 miscellaneous (n = 277, 4.1%), crystal arthritis (n = 269, 4.0%), psoriatic arthritis (n = 242,
24
25 227 3.6%), and pain syndromes (n = 143, 2.1%). The specific diseases which were categorised
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27 228 under crystal arthritis, other connective tissue disease, and miscellaneous are shown in
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29 229 **Supplementary Table 2.**
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231 **Distribution of article placement within issues**

42 232 Inspection of the cumulative distribution function plots showed no association of article
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44 233 placement order with author gender, geographical region, or industry funding (**Figure 1**).
45
46 234 However, differences in article placement order were observed for disease category (**Figure 2**
47
48 235 and **Table 1**). Articles about rheumatoid arthritis were more likely to be placed towards the
49
50 236 front of issues. The placement of articles about ankylosing spondylitis, osteoarthritis and
51
52 237 psoriatic arthritis conformed to a uniform distribution. Articles about systemic lupus
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54 238 erythematosus, other connective tissue diseases, crystal arthritis, systemic sclerosis,
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56 239 vasculitis, pediatric rheumatology and pain syndromes were more likely to be placed towards
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3 240 the back of issues. Analysis of the association between article placement order and research
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5 241 type demonstrated that articles reporting on randomised controlled trials, systematic literature
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7 242 reviews or meta-analyses, and other clinical research were more likely to be placed towards
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9 243 the front of issues compared to basic science research articles, with a significant difference in
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11 244 CDFs (all $P < 0.05$) (**Supplementary Figure 1**).

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Table 1. Difference in distribution of standard article placement indices (SAPI) from a uniform distribution for each disease category

	N (%)	SAPI, mean (SD)	Difference in AUC between CDF and uniform distribution Mean (95% confidence interval) ^a	FDR-adjusted <i>P</i>
Ankylosing spondylitis	496 (7.3%)	0.51 (0.24)	+0.001 (-0.022, +0.014)	0.94
Crystal arthritis	269 (4.0%)	0.63 (0.28)	-0.134 (-0.141, -0.110)	<0.001
Miscellaneous	277 (4.1%)	0.68 (0.29)	-0.182 (-0.205, -0.150)	<0.001
Not disease-specific	422 (6.2%)	0.61 (0.30)	-0.092 (-0.103, -0.069)	<0.001
Osteoarthritis	773 (11.4%)	0.49 (0.24)	+0.002 (-0.014, +0.021)	0.88
Other connective tissue diseases	339 (5.0%)	0.62 (0.25)	-0.110 (-0.127, -0.090)	<0.001
Pediatric rheumatology	443 (6.5%)	0.69 (0.28)	-0.190 (-0.230, -0.180)	<0.001
Pain syndromes	143 (2.1%)	0.69 (0.27)	-0.183 (-0.260, -0.152)	<0.001
Psoriatic arthritis	242 (3.6%)	0.53 (0.24)	-0.012 (-0.045, 0.015)	0.55
Rheumatoid arthritis	1946 (28.7%)	0.36 (0.28)	+0.144 (+0.141, +0.157)	<0.001
Systemic lupus erythematosus	642 (9.5%)	0.58 (0.21)	-0.073 (-0.087, -0.050)	<0.001
Systemic sclerosis	433 (6.4%)	0.64 (0.24)	-0.140 (-0.147, -0.122)	<0.001
Vasculitis	362 (5.3%)	0.65 (0.24)	-0.154 (-0.180, -0.122)	<0.001

AUC = area under the curve; CDF = cumulative density function; SAPI = standard articles placement index. ^aPositive differences indicate deviations from a uniform distribution above the uniform distribution function (i.e. article placement towards the front of an issue), while negative differences indicate deviations from a uniform distribution below the uniform distribution function (i.e. article placement towards the back of an issue).

246

247 **Articles in the first and last three places of an issue**

248 There were no significant differences in the proportion of articles in the first vs. last three
249 places of an issue for author gender, geographical regions, or industry funding category
250 (**Supplementary Table 3**). However, consistent with the cumulative distribution function
251 analysis, differences for disease category were observed (**Figure 3 and Supplementary**
252 **Table 3**). There was a significantly greater proportion of articles in the first three compared
253 to the last three places of an issue for rheumatoid arthritis (35.6% vs. 8.7% $P < 0.001$) with
254 an OR (95% CI) of 5.77 (4.80, 6.92). There was a similar proportion of articles in the first
255 three and last three places of an issue for ankylosing spondylitis, osteoarthritis, or psoriatic
256 arthritis. There was a significantly lower proportion of articles in the first three compared to
257 the last three places of an issue for crystal arthritis (10.8% vs. 26.8%), other connective tissue
258 diseases (6.8% vs., 16.5%), pediatric rheumatology (8.4% vs. 38.8%), pain syndromes (8.4%
259 vs. 37.1%), systemic lupus erythematosus (4.7% vs. 9.7%), systemic sclerosis (4.4% vs.
260 18.2%) and vasculitis (6.4% vs. 18.0%) (all $P \leq 0.001$). Differences in the proportion of
261 articles in the first vs. last three places of an issue were also observed for research type, with
262 a significantly higher proportion of articles in the first three compared to the last three places
263 of an issue for randomised controlled trials (26.4% vs. 10.9%), systematic literature
264 reviews/meta analyses (24.2% vs. 16.7%) and other clinical research (17.0% vs. 13.6%) (all
265 $P \leq 0.003$) and a significantly lower proportion of articles in the first three compared to last
266 three for basic science research (7.6% vs. 26.2% $P < 0.001$) (**Supplementary Table 3**).

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268 **Comparison of median article placement order rank**

269 *Post hoc* analyses of the differences in median article placement order between genders,
270 geographical regions and industry funding categories and disease categories are shown in

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3 271 **Supplementary Table 4.** Significant differences in median article placement order were
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5 272 observed between disease categories, with all categories demonstrating greater median article
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7 273 placement order (indicative of placement towards the back of journal issues) compared to
8
9 274 rheumatoid arthritis (all $P < 0.001$).

275

276 **Journals with and without content grouped by disease category**

277 *Arthritis & Rheumatology*, *Seminars in Arthritis and Rheumatism*, *Arthritis Care & Research*
278 and *The Journal of Rheumatology* grouped issue content by disease category with disease-
279 specific tables of contents sections, while *Annals of the Rheumatic Diseases*, *Rheumatology*,
280 and *Joint Bone Spine* did not group issue content by disease category (**Supplementary Table**
281 **1**). Journals with content grouped by disease showed an association between article
282 placement order and disease category, whereas this was less evident for journals without
283 content grouped by disease (**Figure 4**). Comparisons between journals with and without
284 content grouped by disease category demonstrated a significant difference in the SAPI
285 distributions for every disease category, with articles on rheumatoid arthritis placed towards
286 the front of issues, and articles on crystal arthritis, pain syndromes, pediatric rheumatology,
287 systemic sclerosis and vasculitis placed towards the end of issues, in journals with content
288 grouped by disease category (**Supplementary Table 5**).

289

290 **The impact of article placement order on Altmetric scores and downloads**

291 The impact of article placement order was evident in the meta-analysis results, which showed
292 a higher Altmetric score (adjusted for journal) for articles published in the first three places of
293 an issue compared with the last three, (mean difference in Altmetric score of 5.11, 95% CI
294 1.50, 8.71, $Z = 2.78$, $P = 0.005$) (**Figure 5**). The difference in Altmetric scores varied across

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3 295 different disease categories (I^2 76%; $P < 0.001$), with the largest difference between
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5 296 positioning in the first three places and positioning in the last three places being observed for
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7
8 297 articles about rheumatoid arthritis and psoriatic arthritis.

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10 298 Similarly, meta-analysis showed that articles published in the first three places of an issue
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13 299 had a higher download rate compared to articles in the last three places of an issue (pooled
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15 300 rate difference (95% CI) 442.1 (293.0, 591.2) downloads/article year, $Z = 5.81$, $P < 0.001$)
16
17 301 (**Figure 5**). The difference in download rate between the first and last three articles was
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20 302 similar across different disease categories (I^2 24%; $P = 0.21$).

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24 25 26 304 **DISCUSSION**

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29 305 In this analysis of serial rheumatology journals, no relationship between article placement
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31 306 order and author gender, geographical region or industry sponsorship was observed.

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33 307 However, differences for disease category were apparent, with more frequent positioning of
34
35 308 articles about rheumatoid arthritis towards the front of journal issues, and articles about
36
37 309 crystal arthritis, other connective tissue diseases, pediatric rheumatology, pain syndromes,
38
39 310 systemic lupus erythematosus, systemic sclerosis and vasculitis towards the back of issues.

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41 311 Analyses of Altmetric scores and download rates suggested that article placement order
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43 312 influences research prominence, with earlier placed articles receiving more attention.

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45 313 Medical journals are central to evidence-based practice and represent a key source of new
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47 314 knowledge for medical professionals.[21, 22] Unbiased publication practices are important in
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49 315 allowing a variety of perspectives and emphases to expand the scope of research and clinical
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51 316 practice. Although bias has been previously reported in academic journals based on
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53 317 authorship ordering of genders,[9, 10] representation of geographical regions,[9, 11] and
54
55 318 acceptance and time to publication based on industry sponsorship,[12] our analysis showed

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3 319 that these factors were not associated with article placement order within serial rheumatology
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5 320 journals.

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8 321 Articles about rheumatoid arthritis were preferentially placed towards the front of
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10 322 rheumatology journals, while other conditions, particularly pain syndromes, crystal arthritis,
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12 323 pediatric syndromes, and connective tissue diseases, were ordered towards the back.
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15 324 Rheumatoid arthritis was the disease category with the greatest number of articles, therefore
16
17 325 giving it the greatest opportunity to be listed first, but our analyses accounted for the variation
18
19 326 in article numbers between disease categories. Although rheumatoid arthritis is a very
20
21 327 important rheumatic disease,[23] general rheumatology practice involves the diagnosis and
22
23 328 treatment of a wide range of diseases.[24, 25] General rheumatology journals should ideally
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25 329 reflect that diversity of clinical practice. A similar distribution of articles on each disease
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27 330 category would therefore be expected if there was no bias for disease category.

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32 331 The reason for the observed differences in article placement for disease category is unclear.
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34 332 Disease privileging in other fields of medical research has been reported, with some prevalent
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36 333 diseases with high global impact being under-funded and under-researched.[13-15] Crystal
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38 334 arthritis, osteoarthritis and pain syndromes are common; for example, prevalence estimates
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40 335 for US adults for gout are 3.9%, [26] for osteoarthritis are 13.4%, [27] and for low back pain
41
42 336 are 26.4%.[28] However, these conditions may be viewed by rheumatologists and journal
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44 337 editors as less important or less severe.[29, 30] Our analysis of article placement order, which
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46 338 did not reflect prioritising of diseases based on epidemiology or severity, emphasises the
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48 339 disconnect between the prevalence of disease and health research. These perceptions of some
49
50 340 rheumatic diseases have the potential to impact attitudes in clinical practice and contribute to
51
52 341 lower quality of care.[30, 31] Rheumatic diseases such as vasculitis, pediatric rheumatic
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54 342 disease, and scleroderma are less common, but can lead to major morbidity and reduced
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56 343 quality of life. Improving the impact and accessibility of research published on 'lower
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3 344 priority' or less common rheumatic diseases may have an important impact on clinicians'
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5 345 understanding about and attitudes towards these conditions in clinical practice.
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8 346 Differences in article placement order for disease category was particularly evident in
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10 347 journals with disease-specific tables of contents sections within issues, rather than journals
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12 348 that did not group issue content by disease category. It has been suggested that grouping
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14 349 article content by disease category may improve the reader experience.[32] However, such
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16 350 decisions have the potential to further reduce readers' exposure to diseases that are already
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18 351 under-studied or less well understood. Editorial decisions to remove grouping by disease
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20 352 category, or to cycle the order of disease category groups for each issue may be a simple
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22 353 solution to overcome bias for disease category reflected in article placement order.
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26
27 354 In our analysis, articles appearing in the first three places of an issue had higher Altmetric
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29 355 scores and download rates compared to articles appearing in the last three places of an issue.
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31 356 This is consistent with prior studies which also demonstrate the impact of the primacy effect
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33 357 on research prominence.[6-8] Collectively, these findings indicate that articles placed at the
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35 358 front of journal issues receive greater prominence. The prominence and impact of research
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37 359 published in journals has an important role in not only providing information to improve
38
39 360 knowledge and treatment, but also in financing further research[33] and obtaining academic
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41 361 promotion.[34]
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46 362 The current analysis has some limitations. Firstly, Altmetric and download data were not
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48 363 available from all journals included in the analysis, and it is unclear whether similar
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50 364 differences are present across all journals. Secondly, citation rates were not evaluated because
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52 365 of the short time period between article publication and data extraction which would not have
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54 366 reflected true citation rates, which increase over time. Finally, this analysis did not explore
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56 367 other factors that may have contributed to article placement order such as quality, impact, or
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3 368 originality of the study, or the presence of prolific or “star” authors.[35] Further research may
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5 369 also focus on identifying factors influencing editorial decisions about the placement order of
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8 370 articles about different diseases. For example, we did observe that basic science articles were
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10 371 placed towards the back of an issue, suggesting that editors prioritise clinical research over
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12 372 laboratory-based research. A strength of this paper is the use of multiple methods of analysis
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14 373 to explore the relationship between disease category and article placement order, including an
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16 374 analysis of the distribution of article placement, an analysis of the difference in proportion of
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18 375 articles appearing in the first and last three places of an issue, and an analysis of the
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20 376 comparison of median article placement order between disease categories. Collectively, these
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22 377 results provide robust and detailed evidence that bias for certain disease categories is
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24 378 reflected in article placement order.
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29 379 In conclusion, author gender, geographical region, or funding source do not influence article
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31 380 placement order in serial rheumatology journals. However, bias for certain disease categories
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33 381 is reflected in article placement order. Article placement order may have an impact on
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35 382 research prominence, including Altmetric scores and download rate. Editorial choices about
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37 383 the serial position of articles within journals can influence prioritisation of certain diseases.
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3 385 **Acknowledgements**
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6 386 None.
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12 388 **Competing interests**
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14

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16
17 390 Arthroci, Dyve Biosciences, Hengrui, Abbvie, Pfizer, and Janssen, outside the submitted
18
19 391 work. ND and SS work primarily in the field of gout research (a condition that was analysed
20
21
22 392 in this research project). GG and AG declare no competing interests.
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33 396 or not-for-profit sectors.
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39 398 **Author contributions**
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41

42 399 SS contributed towards acquisition, analysis and interpretation of the data. GG contributed
43
44 400 towards design of the study and analysis and interpretation of the data. AG contributed
45
46 401 towards design of the study and interpretation of the data. ND contributed towards design of
47
48 402 the study, and acquisition and interpretation of the data. All authors were involved in drafting
49
50 403 of the work or revising it critically for important intellectual content. All authors approved
51
52 404 the final version to be published and agree to be accountable for all aspects of the work.
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59 406 **Data statement**
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407 All extracted data used in the analyses are available upon reasonable request from the
408 corresponding author.

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For peer review only

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Figure legends

Figure 1. Cumulative distribution function plots of standardised article placement indices (SAPI) for first author gender (**A.**), senior author gender (**B.**), industry funding (**C.**), and first author's geographic region of affiliated institution (**D.**). Left deviated distributions suggest prioritisation towards the front of journal issues.

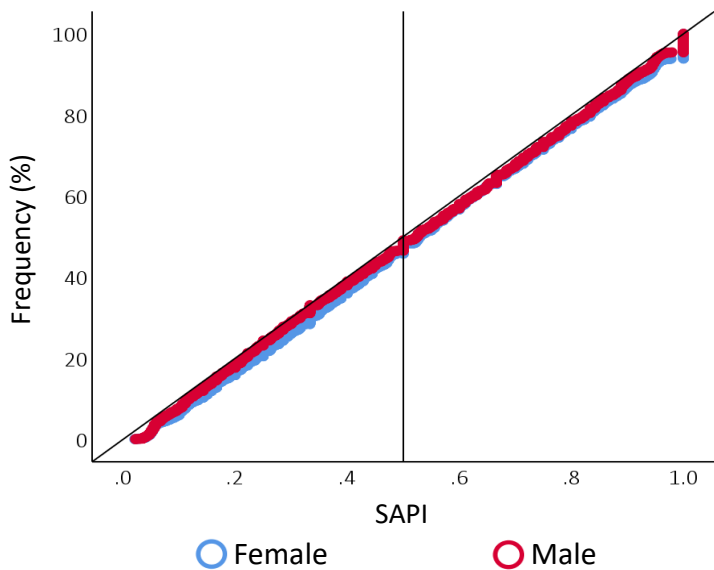
Figure 2. Cumulative distribution function plots of standardised article placement indices (SAPI) for each disease category. Left deviated distributions suggest prioritisation towards the front of journal issues.

Figure 3. Percentage of articles (per disease category) published in first three and last three places of an issue (*P*-values indicate difference between proportions of articles in first and last three places of an issue).

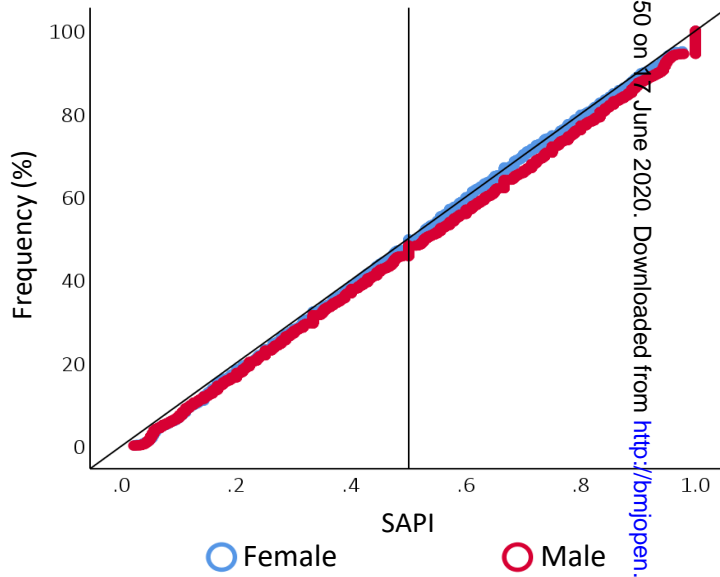
Figure 4. Cumulative distribution function plots of standardised article placement indices (SAPI) for each disease category for journals with (**A.**) and without (**B.**) contents grouped by disease. Left deviated distributions suggest prioritization towards the front of journal issues.

Figure 5. Forest plots showing the mean differences for each disease category for Altmetric scores (**A.**) and download rates (**B.**) between articles published in the first vs. last three places of an issue. Positive differences indicate a higher Altmetric score/download rate for articles published in one of the first three places of an issue. Differences in Altmetric scores are adjusted for journal. Download data was available from one journal. CTD: connective tissue disease.

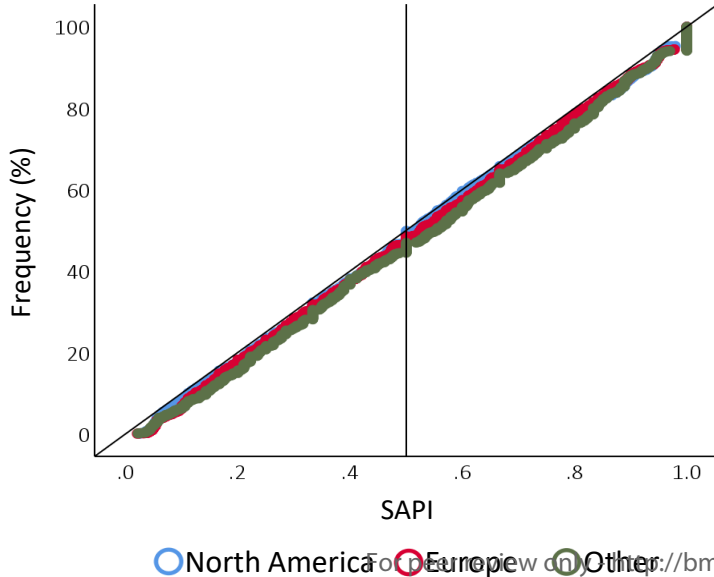
A. First author gender



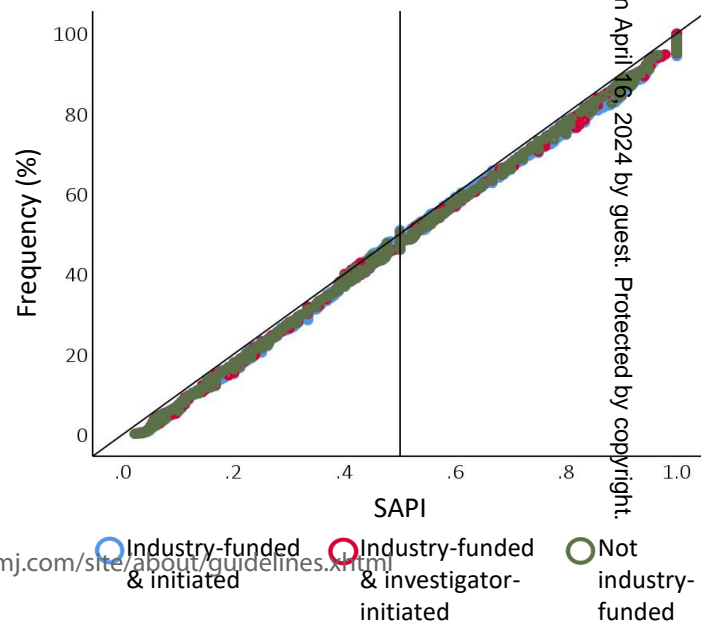
B. Senior author gender



C. Geographical region

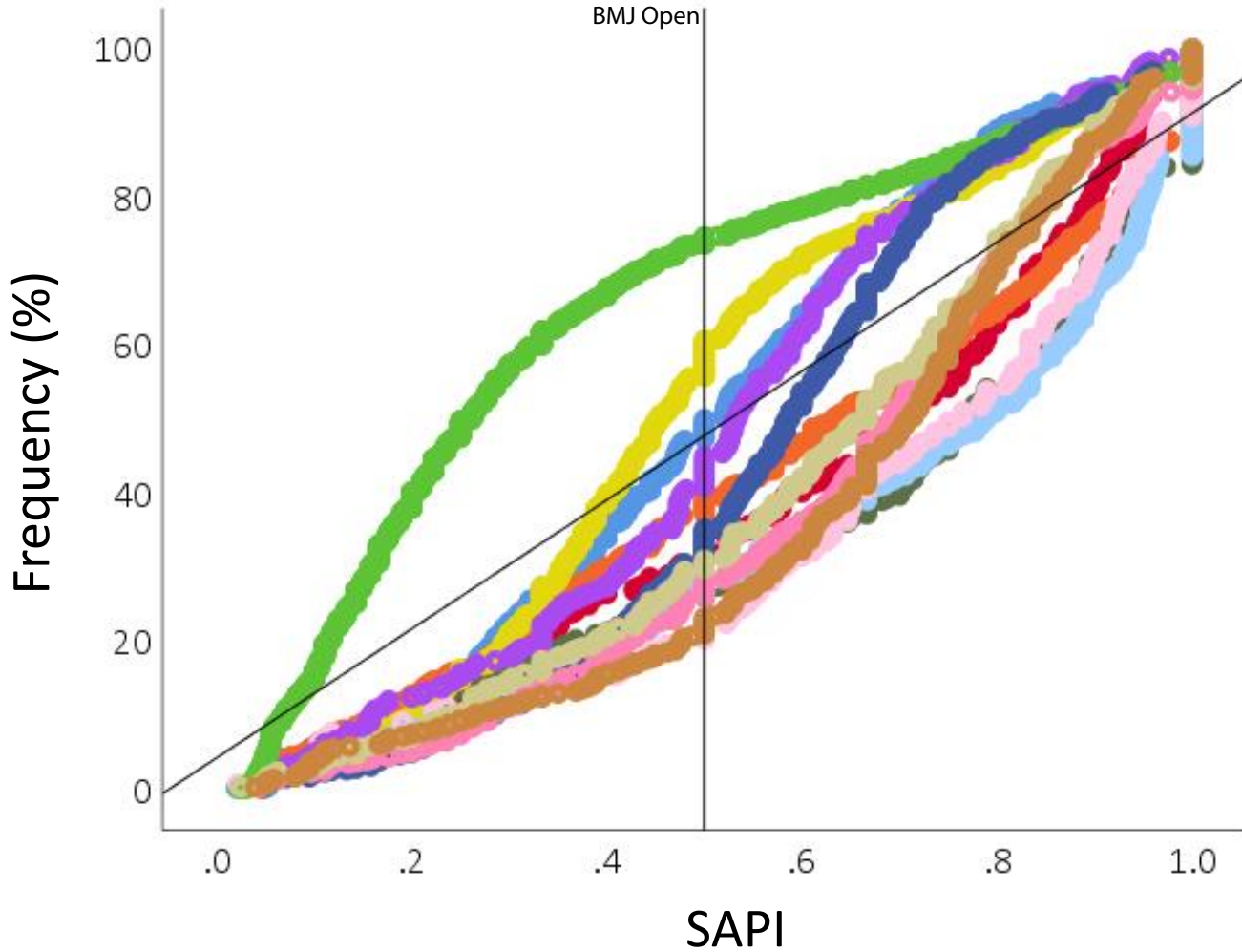


D. Industry funding



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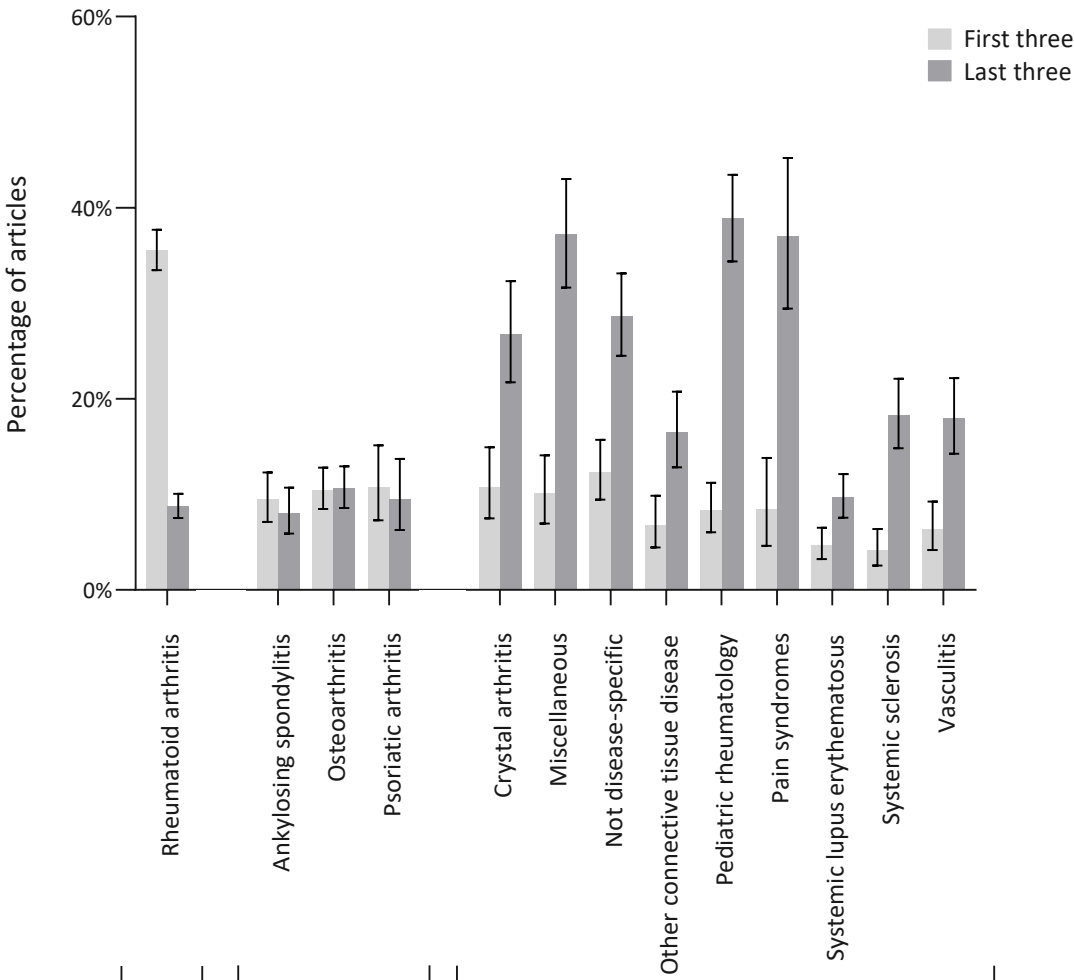
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- Ankylosing spondylitis ○ Crystal arthritis ○ Miscellaneous
- Not disease-specific ○ Osteoarthritis ○ Pediatric rheumatology
- Pain syndromes ○ Psoriatic arthritis ○ Rheumatoid arthritis
- Systemic lupus erythematosus ○ Systemic sclerosis
- Other connective tissue disease ○ Vasculitis

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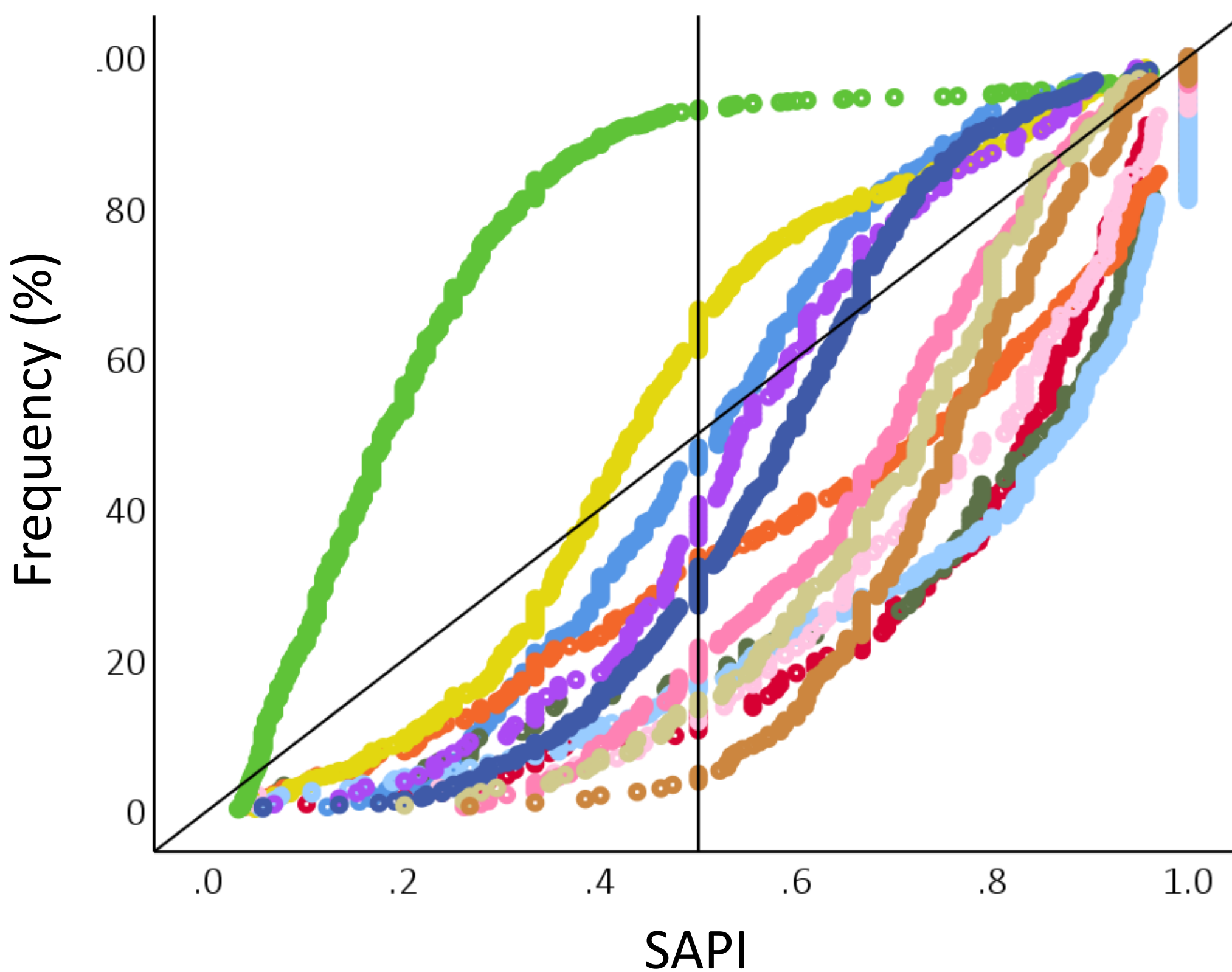
Greater number of articles in first three places (P < 0.001)

No difference (all P > 0.51)

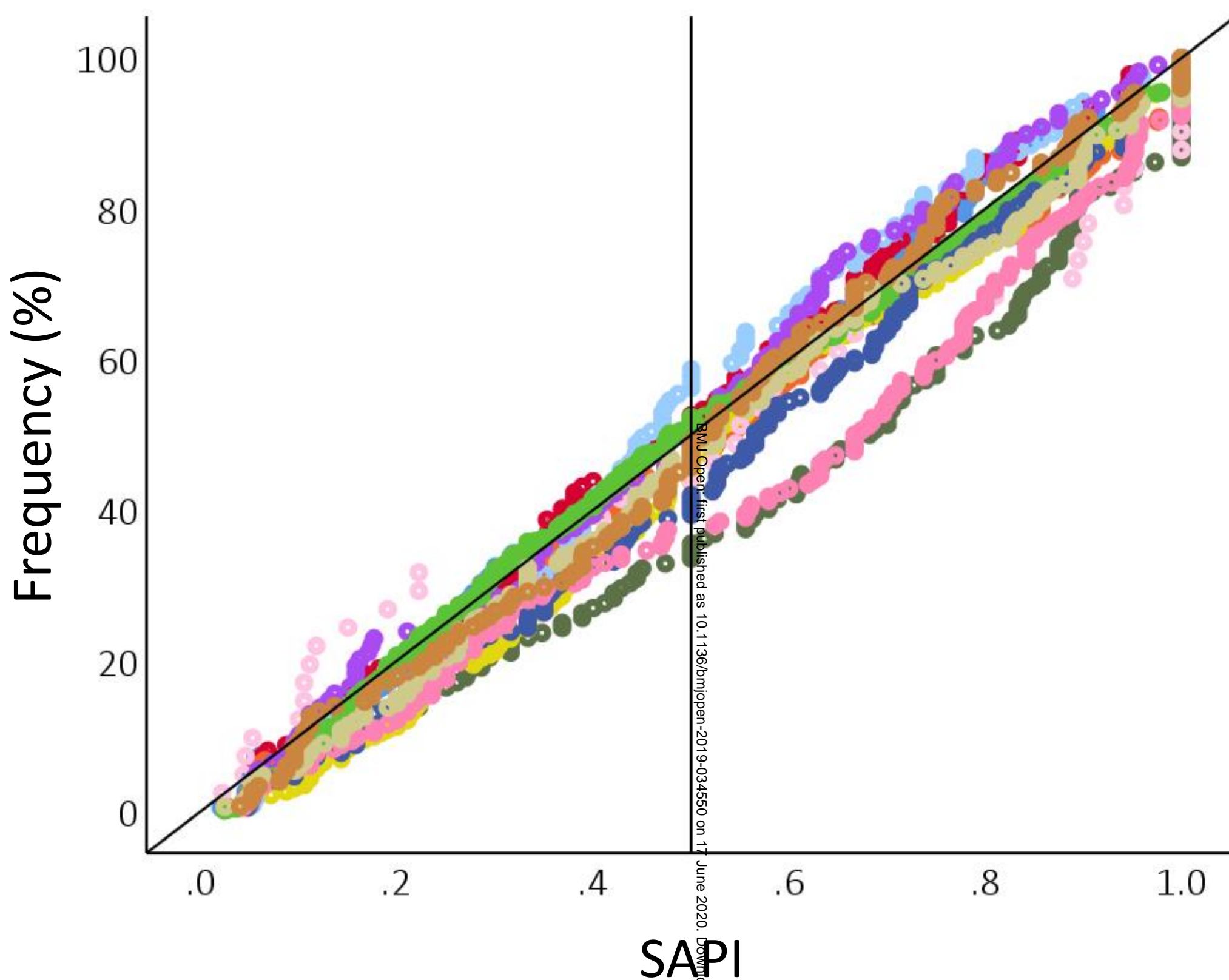
Greater number of articles in last three places (all P < 0.001)

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A. Journals with issue content grouped by disease



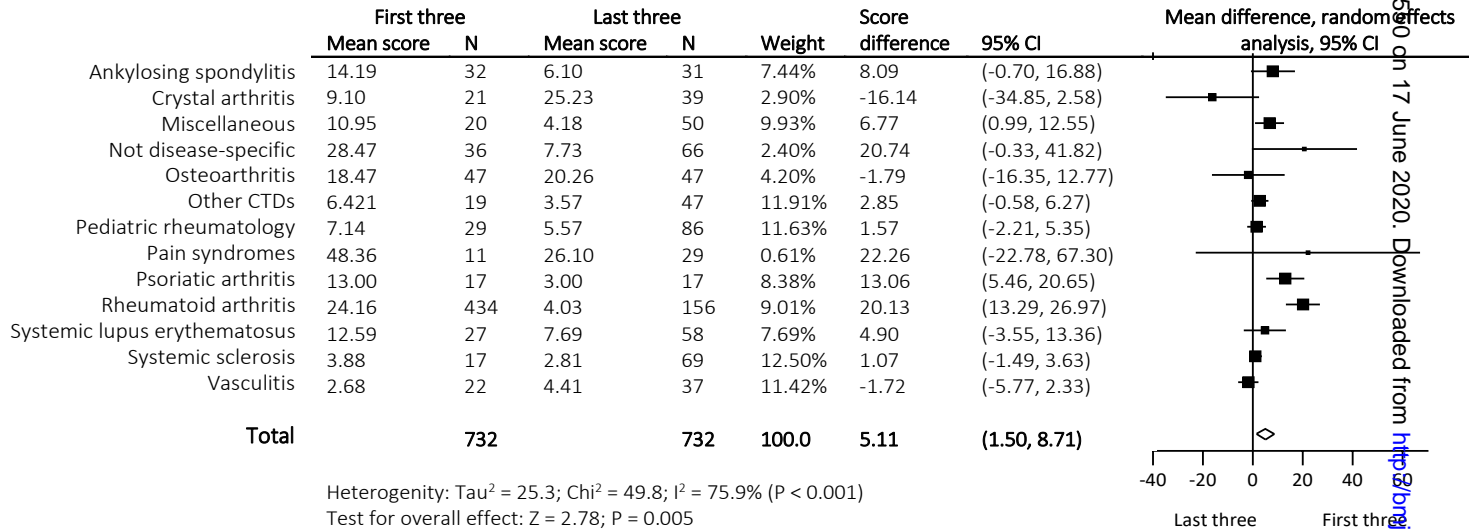
B. Journals without issue content grouped by disease



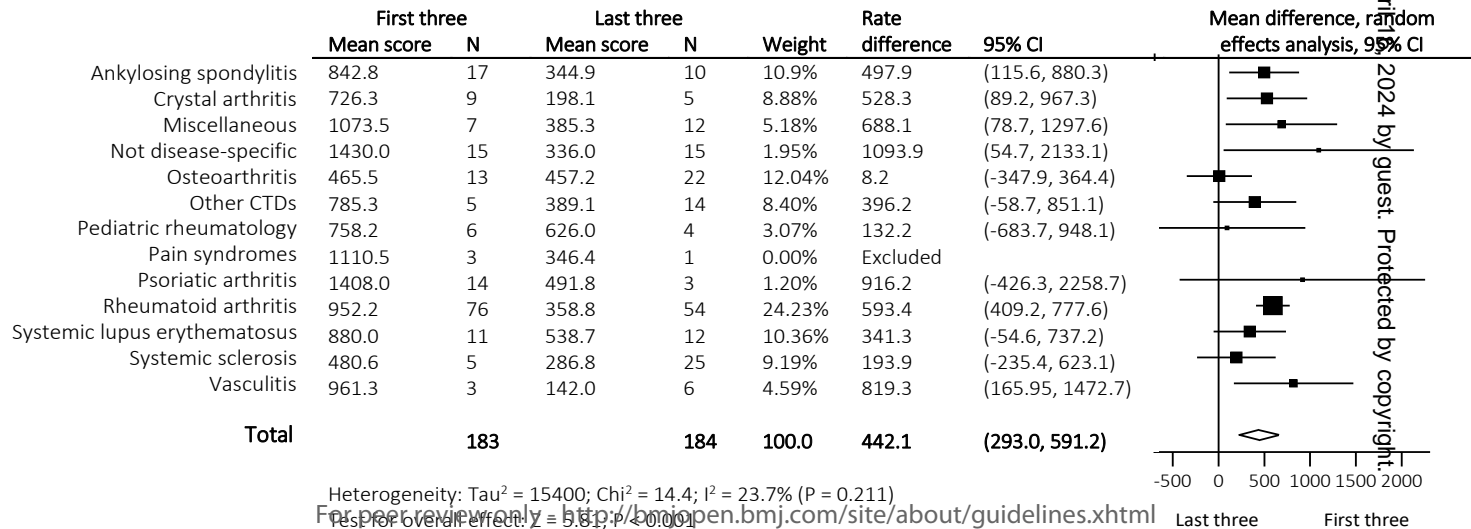
- Ankylosing spondylitis
- Crystal arthritis
- Miscellaneous
- Not disease-specific
- Osteoarthritis
- Pediatric rheumatology
- Pain syndromes
- Psoriatic arthritis
- Rheumatoid arthritis
- Systemic lupus erythematosus
- Systemic sclerosis
- Other connective tissue disease
- Vasculitis

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A. Differences in Altmetric scores between articles in first and last three places of an issue



B. Differences in download rates between articles in first and last three places of an issue



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3 **SUPPLEMENTARY MATERIAL**
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6 Supplementary Tables
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9 **Supplementary Table 1. Journal characteristics**
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	Publisher	Country of publication	2016 Impact Factor	Relevant affiliated society	Issues per year	Contents grouped by disease	Total number of articles included, n	Number of included articles per issue, mean (SD)
Annals of the Rheumatic Diseases	BMJ Publishing Group Ltd	United Kingdom	12.811	European League Against Rheumatism	12	0	1374	13.2 (9.4)
Arthritis & Rheumatology	John Wiley & Sons	United States	6.918	American College of Rheumatology	12	es	1367	12.5 (7.6)
Rheumatology	Oxford University Press	United Kingdom	4.818	British Society for Rheumatology	12	0	1158	10.2 (5.7)
Seminars in Arthritis and Rheumatism	Elsevier	United States	4.498	None	6	es	403	7.3 (4.1)
Joint Bone Spine	Elsevier	United States	3.329	French Society of Rheumatology	6	0	239	4.6 (2.6)
Arthritis Care & Research	John Wiley & Sons	United States	3.319	American College of Rheumatology, Association of Rheumatology Health Professionals	12	es	1098	9.6 (5.4)
The Journal of Rheumatology	Journal of Rheumatology Publishing Company Limited	Canada	3.150	Canadian Rheumatology Association	12	es	1148	10.3 (6.1)

Supplementary Table 2. Number of articles within each disease category for crystal arthritis, miscellaneous and other connective tissue diseases

	Frequency	Percent
<i>Crystal arthritis (n = 269)</i>		
Gout	260	96.7
Calcium crystal diseases	9	3.3
<i>Miscellaneous Disease (n = 277 articles)</i>		
Regional musculoskeletal syndromes	48	17.3
Osteoporosis	22	7.9
IgG4-related disease	20	7.2
FMF	20	7.2
Polymyalgia rheumatica	19	6.9
CAPS	16	5.8
Still's disease	10	3.6
Septic arthritis	8	2.9
Fibrosis	8	2.9
Sarcoidosis	7	2.5
Chikungunya Virus	7	2.5
SAPHO syndrome	6	2.2
TRAPS	5	1.8
Polychondritis	5	1.8
Ehlers-Danlos Syndrome	4	1.4
Lyme disease	4	1.4
Alkaptonuria	4	1.4
Hemophagocytic syndromes	3	1.1
Vertebral fractures	2	0.7
Uveitis	2	0.7
Undifferentiated arthritis	2	0.7
Tuberculosis	2	0.7
Periodic fever syndrome	2	0.7
Löfgren syndrome	2	0.7
Erdheim-Chester disease	2	0.7
Dupuytren's disease	2	0.7
ACPA-negative undifferentiated arthritis	1	0.4
Yellow fever	1	0.4
Whipple disease	1	0.4
Vertebral endplate lesions	1	0.4
Tumoral calcinosis	1	0.4
Tenosynovial giant cell tumor	1	0.4
Systemic autoinflammatory disease (SAID)	1	0.4
Schnitzler's syndrome	1	0.4
Ribbing disease	1	0.4
Receptor-associated periodic syndrome	1	0.4
Pyogenic sterile arthritis pyoderma gangrenosum and acne (PAPA) syndrome	1	0.4
Pyogenic arthritis	1	0.4
Primary angiitis of the CNS	1	0.4
Preeclampsia	1	0.4
Pigmented villonodular synovitis	1	0.4
Periodic fever, aphthous stomatitis, pharyngitis, and cervical adenitis (PFAPA) syndrome	1	0.4

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3	Paraneoplastic rheumatic syndrome	1	0.4
4	Palindromic rheumatism	1	0.4
5	Paget's disease	1	0.4
6	Osteonecrosis	1	0.4
7	Osteomyelitis	1	0.4
8	NOD2-associated autoinflammatory diseases	1	0.4
9	Muckle-wells syndrome	1	0.4
10	Mikulicz's disease	1	0.4
11	Mevalonate kinase deficiency	1	0.4
12	Medial meniscal tears	1	0.4
13	Macrophage activation syndrome	1	0.4
14	Leri's pleonosteosis	1	0.4
15	Kikuchi-Fujimoto disease	1	0.4
16	Joint hypermobility syndrome	1	0.4
17	Immune reconstitution inflammatory syndrome	1	0.4
18	Hereditary recurrent fever syndromes	1	0.4
19	Hereditary haemochromatosis	1	0.4
20	Haploinsufficiency of A20	1	0.4
21	Glomerulonephritis	1	0.4
22	Gaucher disease	1	0.4
23	Femoral fractures	1	0.4
24	Fabry disease	1	0.4
25	Ebola virus	1	0.4
26	Discitis	1	0.4
27	Chronic graft-versus-host disease	1	0.4
28	Blau syndrome	1	0.4
29	Biphosphate trochanteric fracture	1	0.4
30	Amyloidosis	1	0.4
31	Aicardi-Goutières syndrome	1	0.4
32	Other connective tissue disease (n = 339 articles)		
33	Sjogren's syndrome	174	51.3
34	Inflammatory myositis	115	33.9
35	Antiphospholipid syndrome	41	12.1
36	Mixed connective tissue disease	7	2.1
37	CTD-associated interstitial lung disease	1	0.3
38	Undifferentiated connective tissue disease	1	0.3
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Supplementary Table 3. Number of articles appearing in at least one article in first and last three articles of an issue for author gender, geographical region of affiliated institution, industry funding category, and disease category

	Total articles	First three N	% of total	Last three N	% of total	Odds ratio (OR) ^a	95% CI for OR	P ^b
First author gender								
Female	3517	537	15.3%	586	16.7%	0.90	0.79, 1.02	0.17
Male	3250	557	17.1%	509	15.7%	1.11	0.98, 1.27	0.17
Last author gender								
Female	2359	393	16.7%	355	15.0%	1.13	0.97, 1.32	0.17
Male	4412	705	16.0%	737	16.7%	0.95	0.85, 1.01	0.37
Geographical region of affiliated institution (first author)								
North America	2177	362	16.6%	352	16.2%	1.03	0.88, 1.21	0.68
Europe	3486	573	16.4%	556	16.0%	1.04	0.91, 1.18	0.68
Other	1124	163	14.5%	190	16.9%	0.83	0.66, 1.05	0.35
Industry funding								
Industry-funded and initiated	640	104	16.3%	109	17.0%	0.95	0.70, 1.27	0.71
Industry-funded and investigator-initiated	596	87	14.6%	111	18.6%	0.75	0.55, 1.01	0.09
Not industry-funded	5551	907	16.3%	878	15.8%	1.04	0.94, 1.15	0.09
Research type								
Randomised controlled trials	488	129	26.4%	53	10.9%	2.95	2.08, 4.18	<0.001
Systematic literature reviews / meta-analyses	438	106	24.2%	73	16.7%	1.60	1.14, 2.23	0.003
Other clinical research	4466	757	17.0%	606	13.6%	1.30	1.16, 1.46	<0.001
Basic science	1395	106	7.6%	366	26.2%	0.23	0.18, 0.29	<0.001
Disease category								
Ankylosing spondylitis	496	47	9.5%	40	8.1%	1.19	0.77, 1.86	0.51
Crystal arthritis ^c	269	29	10.8%	72	26.8%	0.33	0.21, 0.53	<0.001
Miscellaneous	277	28	10.1%	103	37.2%	0.19	0.12, 0.30	<0.001
Not disease-specific	422	52	12.3%	121	28.7%	0.35	0.24, 0.50	<0.001
Osteoarthritis	773	81	10.5%	82	10.6%	0.99	0.71, 1.37	0.934
Other connective tissue diseases	339	23	6.8%	56	16.5%	0.37	0.22, 0.61	<0.001
Pediatric rheumatology	443	37	8.4%	172	38.8%	0.14	0.10, 0.21	<0.001
Pain syndromes	143	12	8.4%	53	37.1%	0.16	0.08, 0.31	<0.001
Psoriatic arthritis ^c	242	26	10.7%	23	9.5%	1.15	0.63, 2.07	0.71
Rheumatoid arthritis	1946	692	35.6%	170	8.7%	5.77	4.80, 6.92	<0.001
Systemic lupus erythematosus	642	30	4.7%	62	9.7%	0.46	0.29, 0.72	0.001
Systemic sclerosis	433	18	4.4%	79	18.2%	0.19	0.11, 0.33	<0.001
Vasculitis	362	23	6.4%	65	18.0%	0.31	0.19, 0.51	<0.001

^aThe odds of being in at least one article in the first three places of an issue; ^bFDR-adjusted Mid-P exact P-value. Bolded values indicate significance at < 0.05. ^cOne article in each of 'Crystal arthritis' and 'Psoriatic arthritis' came from issues which included 5 articles and were therefore counted in both the 'first' and 'last' three categories.

Supplementary Table 4. Comparison of median article placement order between genders of first and last authors, geographical regions, industry funding categories and disease categories.

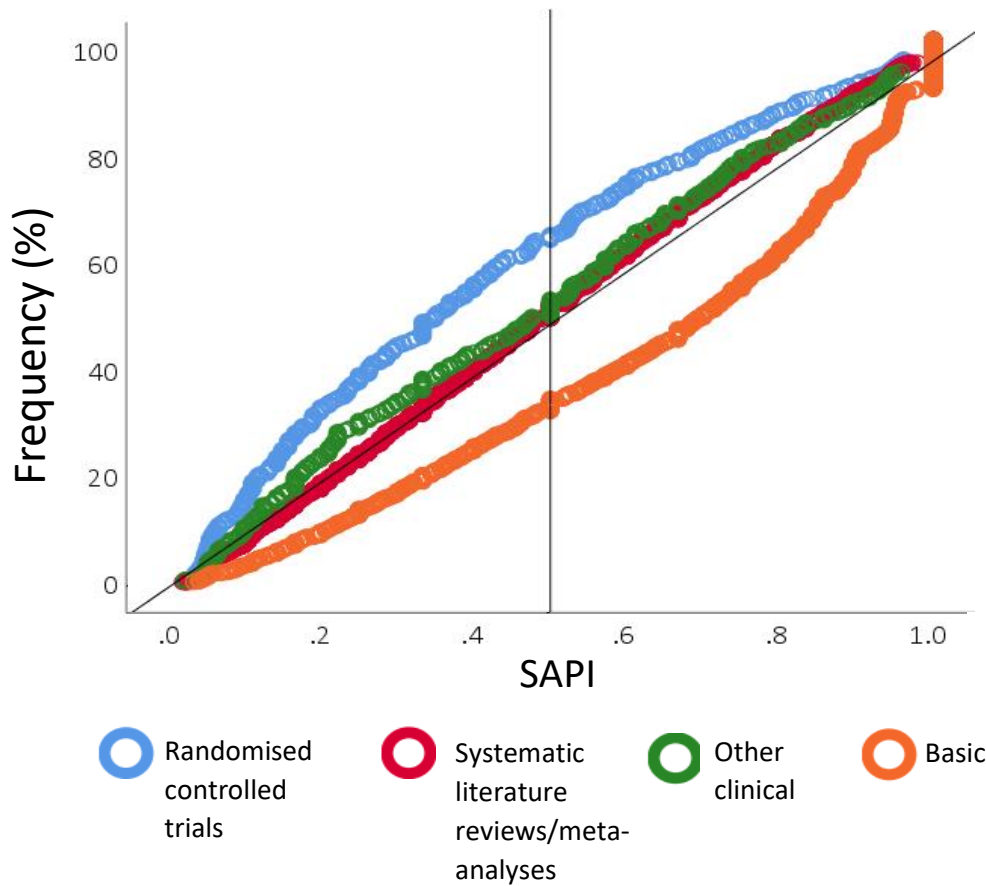
	Article placement order Median (IQR)	Min-max	<i>P</i> for difference in medians ^a
First author gender			
Female	10 (10)	1-45	0.643
Male	10 (10)	1-49	
Last author gender			
Female	10 (10)	1-46	0.017
Male	10 (10)	1-49	
Geographical region			
North America	10 (10)	1-48	0.906
Europe	10 (10)	1-49	
Other	10 (10)	1-47	
Industry funding			
Not industry funded	10 (10)	1-48	<0.001
Industry funded and initiated	8 (10)	1-48	
Industry funded and investigator initiated	8 (9)	1-42	
Disease category			<i>P</i> for comparison with rheumatoid arthritis ^b
Ankylosing spondylitis	9 (7)	1-40	<0.001
Crystal arthritis	12 (10)	1-38	<0.001
Miscellaneous	13 (10)	1-49	<0.001
Not disease-specific	11 (10)	1-43	<0.001
Osteoarthritis	10 (8)	1-42	<0.001
Other connective tissue diseases	12 (9)	1-47	<0.001
Paediatric rheumatology	14 (11)	1-35	<0.001
Pain syndromes	13 (9)	1-32	<0.001
Psoriatic arthritis	10 (7)	1-45	<0.001
Rheumatoid arthritis	5 (8)	1-48	<0.001
Systemic lupus erythematosus	12 (7)	1-41	<0.001
Systemic sclerosis	13 (9)	1-45	<0.001
Vasculitis	13 (9)	1-39	<0.001

^aKruskal Wallis or Mann-Whitney U tests, as appropriate; ^bMann-Whitney U tests

Supplementary Table 5. Difference in cumulative density function distribution of standard article placement indices (SAPI) between journals with and without contents grouped by disease for articles with related editorials and for each disease category

	Journals with contents not grouped by disease			Journals with contents grouped by disease			Two-sample Kolmogorov-Smirnov Z test ^b	
	N (%)	SAPI ^a		N (%)	SAPI ^a		Effect size (D)	FDR-adjusted P
		Mean	SD		Mean	SD		
Ankylosing spondylitis	228 (8.2%)	0.49	0.28	268 (6.7%)	0.52	0.19	0.20	<0.001
Crystal arthritis	137 (4.9%)	0.49	0.28	132 (3.3%)	0.78	0.20	0.50	<0.001
Miscellaneous	152 (5.5%)	0.62	0.30	125 (3.1%)	0.76	0.26	0.29	<0.001
Not disease-specific	178 (6.4%)	0.53	0.30	244 (6.1%)	0.66	0.29	0.22	<0.001
Osteoarthritis	231 (8.3%)	0.55	0.27	542 (13.5%)	0.47	0.22	0.20	<0.001
Other connective tissue diseases	167 (6.0%)	0.49	0.29	172 (4.3%)	0.70	0.17	0.36	<0.001
Pediatric rheumatology	121 (4.4%)	0.48	0.26	322 (8.0%)	0.77	0.25	0.50	<0.001
Pain syndromes	41 (1.5%)	0.54	0.35	102 (2.5%)	0.75	0.21	0.36	0.001
Psoriatic arthritis	109 (3.9%)	0.48	0.27	133 (3.3%)	0.56	0.20	0.22	0.005
Rheumatoid arthritis	881 (31.8%)	0.51	0.29	1065 (26.5%)	0.23	0.20	0.49	<0.001
Systemic lupus erythematosus	193 (7.0%)	0.56	0.28	449 (11.2%)	0.58	0.17	0.19	<0.001
Systemic sclerosis	182 (6.6%)	0.60	0.30	251 (6.3%)	0.68	0.18	0.26	<0.001
Vasculitis	151 (5.4%)	0.51	0.28	211 (5.3%)	0.75	0.14	0.50	<0.001

^aLower SAPI scores equate to articles ordered at the front of issues, while higher SAPI scores equate to articles ordered at the end of issues. ^bTest of difference in distribution of SAPI between journals with and without contents grouped by disease sections. Bolded P-values indicated significant difference at < 0.05.



Supplementary Figure 1. Cumulative distribution function plots of standardised article placement indices (SAPI) for research types. Left deviated distributions suggest prioritisation towards the front of journal issues.

BMJ Open

Article Placement Order in Rheumatology Journals: A Content Analysis

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2019-034550.R2
Article Type:	Original research
Date Submitted by the Author:	25-Feb-2020
Complete List of Authors:	Stewart, Sarah; The University of Auckland, Medicine Gamble, Greg; University of Auckland, Department of Medicine Grey, Andrew; University of Auckland Dalbeth, Nicola; University of Auckland,
Primary Subject Heading:	Rheumatology
Secondary Subject Heading:	Evidence based practice
Keywords:	publication, bias, RHEUMATOLOGY

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3 **1 Article Placement Order in Rheumatology Journals: A Content Analysis**
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15 5 Nicola Dalbeth^{1,2}, MD
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3 14 **Abstract**
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6 15 **Objectives.** To analyse variables associated with article placement order in serial
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8 16 rheumatology journals.
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11 17 **Design.** Content analysis.
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14 18 **Setting.** Original articles published in seven rheumatology journals from 2013-2018.
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17 19 **Primary and secondary outcome measures.** The following data were extracted from 6,787
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19 20 articles: order number of article in issue, gender of first and last author, geographical region,
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22 21 industry funding, research design, and disease category. Cumulative density function plots
23
24 22 were used to determine whether article placement distribution was different from the
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26 23 expected distribution. Odds ratios for articles published in the first three places of an issue
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28 24 compared with the last three places were calculated. Altmetric score and downloads were
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30 25 meta-analysed.
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34 26 **Results.** Article placement order did not associate with author gender or geographical region
35
36 27 but was associated with funding source and research design. In addition, articles about
37
38 28 rheumatoid arthritis were more likely to be ordered at the front of issues ($P<0.001$). Articles
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40 29 about crystal arthritis, systemic lupus erythematosus, vasculitis, pain syndromes and pediatric
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42 30 rheumatic diseases were more likely to be ordered at the end of issues (all $P<0.001$).
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44 31 Association of article placement order with disease category was observed only in journals
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46 32 with tables of contents grouped by disease. Articles ordered in the first three places had
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48 33 higher Altmetric and download rates, than articles in the last three places.
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53 34 **Conclusions.** Author gender and geographical region do not influence article placement order
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55 35 in serial rheumatology journals. However, bias for certain disease categories is reflected in
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57 36 article placement order. Editorial decisions about article placement order can influence the
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59 37 prominence of diseases.
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39 **Keywords:** publication, bias, rheumatology

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For peer review only

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3 41 **Strengths and limitations of the study**
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- 6 42 • This is the first study to assess the relationship of article placement order in serial medical
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8 43 journals with author gender, geographical region of affiliated institution, industry
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10 44 funding, research design or disease category.
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13 45 • This content analysis included 6,787 articles from general rheumatology journals.
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15 46 • This study also analysed the impact of article placement order on research prominence,
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17 47 including Altmetric scores and download rate.
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20 48 • This analysis did not explore other factors that may have contributed to article placement
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22 49 order such as the originality of the study findings or the presence of “star” authors.
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51 INTRODUCTION

52 The strong preference for items ordered first, and the important effect of list order on choice,
53 is well-recognised in consumer-based research.[1-3] In online searches for health
54 information, 97% of selected links were displayed in the first 10 results, while only 2% were
55 from the second or following pages.[4] For online academic repositories, earlier listed articles
56 were downloaded more frequently than later listed articles.[5] These primacy effects, which
57 increase when lists are longer,[6] may occur because earlier items, or those at the top of
58 tables of contents, are more visible and more likely to be seen and read.[5]

59 In academic publishing, the ordering of articles within a journal issue also affects the
60 prominence achieved by that research. Earlier listed articles received more citations over a 25
61 year period in a single journal.[7] The impact of ordering was also evident in an analysis of
62 emails sent to subscribers disseminating recent research papers listed in random order; with
63 the first paper having a 33% increase in views, 29% increase in downloads and 27% increase
64 in citations, regardless of research quality.[8]

65 A number of systemic biases have been reported in academic publishing. These include
66 preferential lead and senior authorship of men,[9, 10] higher acceptance rates for articles
67 from the US and Europe,[9, 11] preferential publication of industry-funded research,[12] and
68 disease privileging, wherein particular diseases receive preferential research funding and
69 publication.[13-15] It is unknown whether these systemic biases are reflected in article
70 placement order within medical journals. We analysed serial rheumatology journals for
71 relationships between article placement order and gender of the lead and senior authors,
72 geographical region of the affiliated institution, industry sponsorship, and disease category.

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3 75 **METHODS**
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6 76 **Patient and public involvement**
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9 77 There was no patient or public involvement in the design, or conduct, or reporting, of this
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11 78 research.
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17 80 **Identification of journals and articles for inclusion**
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20 81 This was a cross-sectional content analysis of original articles published in general
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22 82 rheumatology journals. Journals were included if they produced regular issues, reported
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24 83 original research and had 2016 Thomas Reuters Impact Factors of > 3.0. Journals were
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26 84 excluded if they published review articles only, were disease-specific (e.g. *Lupus*,
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28 85 *Osteoarthritis and Cartilage*) or produced no issues. The following seven general
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30 86 rheumatology journals met the above criteria and were included: *Annals of the Rheumatic*
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32 87 *Diseases, Arthritis & Rheumatology, Arthritis Care & Research, Seminars in Arthritis and*
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34 88 *Rheumatism, Rheumatology, Journal of Rheumatology, and Joint Bone Spine*. Characteristics
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36 89 of the included journals are shown in **Supplementary Table 1**.
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42 90 All original articles published in the included journals in a five-year period from June 2013 to
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44 91 June 2018 were included in the analysis. To be included, articles could be full or concise
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46 92 reports, and report on original basic science or clinical research, including systematic reviews
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48 93 and meta-analyses. Articles were excluded if they were from a disease-specific thematic issue
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50 94 or supplement, were narrative reviews, recommendations, guidelines, letters, or meeting
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52 95 reports.
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3 **98 Data extraction**
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6 99 Data extraction was undertaken between June and December 2018. The following
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8 100 information was extracted for each included article: order number of article in the issue,
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10 101 gender of lead (first) author; gender of senior (final) author; geographical region of affiliated
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12 102 institution (for the first author); industry funding category (industry-funded and initiated,
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14 103 industry-funded and investigator-initiated, not industry-funded); research design (basic
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16 104 science, other clinical, randomised controlled trial, systematic literature/meta-analysis); and,
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18 105 if available, the Altmetric score and number of downloads. The number of citations was not
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20 106 assessed because of the short time period between publication and data extraction. If author
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22 107 gender could not be determined by first name or by an internet search of the author's
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24 108 affiliated institution profile page, then the author's first name was entered into
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26 109 <https://api.genderize.io/?name=> which returns the gender and probability of certainty.
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28 110 Probabilities < 0.5 were labelled as "unknown" and not included in the gender-related
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30 111 analysis. If articles were authored by a single author, then this author's gender was entered
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32 112 under first author. Funding was assessed by review of funding statements, disclosures and
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34 113 author affiliations. Industry-funded studies were categorized as industry-funded and industry-
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36 114 initiated, or industry-funded and investigator-initiated, based on these statements. Studies
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38 115 with no evidence of industry funding were categorized as not industry-funded.
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41 116 Articles were coded according to the following 13 disease categories: ankylosing spondylitis
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43 117 and other spondyloarthropathy, crystal arthritis, osteoarthritis, miscellaneous rheumatic
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45 118 disease, pediatric rheumatology, pain syndromes, psoriatic arthritis, rheumatoid arthritis,
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47 119 systemic lupus erythematosus, systemic sclerosis/scleroderma, other connective tissue
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49 120 disorders, vasculitis, and not disease-specific. The title of each article was used to determine
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51 121 the disease category. If there was uncertainty about the disease category from the title, then
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53 122 the abstract and/or full paper were reviewed.
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3 123 To ensure standardisation in data extraction, two authors (SS, ND) independently reviewed
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5 124 eligible papers from ten randomly selected issues. A total of 208 articles were reviewed, with
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8 125 kappas of 1.00 for author gender, geographical region, and industry funding category, while
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10 126 disease category had a kappa of 0.84 (86.1% agreement (95% confidence interval (CI)
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12 127 81.0%, 90.5%)). All disease category disagreements were discussed to reach a consensus and
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14 128 a set of rules for categorising was established. The exercise was then repeated in which the
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17 129 two authors reviewed disease categories in a further five randomly selected issues totalling 85
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19 130 articles, with a kappa of 0.99 (98.8% agreement (95% CI 94.3%, 99.9%)) for disease
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21 131 category. A single reviewer (SS) then independently extracted the data.
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27 133 **Data analysis**

31 134 The primary analyses assessed the relationships between article placement order and: gender
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33 135 of first authors, gender of last authors, geographical region (Europe, North America, Other),
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35 136 industry funding categories (industry-funded and initiated, industry-funded and investigator-
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37 137 initiated, not industry-funded), research design (basic science, other clinical research,
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40 138 randomised controlled trial, systematic literature review/meta-analysis) and disease
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42 139 categories. In order to identify whether these factors were associated with article placement
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44 140 order within journal issues, each article within each issue was assigned a standard article
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46 141 placement index (SAPI), which was defined as the order of the article in the issue/total
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49 142 number of articles in the issue. For example, the first article in an issue of 21 articles was
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51 143 given an SAPI of $1/21 = 0.0476$ and the last article $21/21 = 1$. This metric allowed
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54 144 standardisation of article placement order within issues with the expectation that the number
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56 145 of articles within each issue would vary widely across different journals. For example, the
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58 146 SAPI could scale between article placement in a journal issue of five articles and one with 50
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3 147 articles. Therefore, this metric addressed the large variation in the number of articles between
4
5 148 different journal issues and overcame the potential issue of skewed average article placement
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7 149 order data resulting from issues with large numbers of articles. The SAPI as a placement
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10 150 metric enabled the examination of article placement order without an assumption that the
11
12 151 mean (or median) article placement order was different. Cumulative distribution functions
13
14 152 (CDF) of SAPIs were analysed to determine the associations between article placement order
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16
17 153 and author gender, geographical region, industry funding and disease category. A uniform
18
19 154 distribution would be expected if there was no association with article placement order:
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21 155 deviations from the expected uniform distribution would support an association with article
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23 156 placement order. Due to the potential over-sensitivity of this test, [16] the effect sizes (D)
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25
26 157 were also computed with values ranging from 0 (no difference in distribution of SAPI
27
28 158 between comparisons) to 1 (large difference in distribution of SAPI between comparisons) to
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30
31 159 provide further description of the deviations between the observed distributions. To
32
33 160 determine whether the distribution of SAPIs for variable was different from a uniform
34
35 161 distribution CDF (expected distribution if no bias reflected in article placement order), the
36
37 162 area under the curve (AUC) of the observed CDF and uniform distribution CDF were each
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40 163 calculated using a trapezoidal method and the difference between these estimated for each of
41
42 164 the variable categories. Mean differences between the observed CDF and the uniform
43
44 165 distribution CDF AUCs were computed from bootstrapped samples (500 replicates, sampled
45
46 166 with replacement) and 95% confidence intervals estimated as the 2.5th and 97.5th percentile of
47
48
49 167 the bootstrap distribution. P-values were calculated for each category from these confidence
50
51 168 intervals using the method of Altman and Bland.[17] This analysis method allowed for an
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53 169 assumption-free comparison of the observed and expected distributions of SAPIs.[18] CDF-
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56 170 based comparisons are estimates and do not systematically increase or decrease with sample
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58 171 size. The estimated CDF, like an estimated mean, is unbiased at any sample size. The
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3 172 estimation of the CDF (like estimation of a mean) assumed only that each variable examined
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5 173 provided some incremental information; that is, that collinearity was not close to perfect.[19]
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8 174 Unlike the comparison of a central tendency statistic (i.e. mean or median order placement),
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10 175 comparing these distributions allowed testing of any early and late article placement
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12 176 (bimodal) clustering (primacy and recency) as well as a uniform distribution of placement.
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14 177 CDF plots of SAPIs also provided a visually clear representation of article placement order
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17 178 and potential differences between groups.

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20 179 A secondary analysis was undertaken to further explore article placement order, in which
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22 180 mid-P exact P-values were computed to compare the proportion of articles appearing in at
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24 181 least one of the first three places of an issue compared to at least one of the last three places
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26 182 of an issue for genders of first and last authors, geographical region, industry funding
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28 183 category, and each disease category. Odds ratios (OR) and their 95% CIs were also computed
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30 184 for articles in the first three places vs. last three places of an issue.

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35 185 As some journals presented their content grouped by disease category, additional analyses
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37 186 were undertaken to determine whether article placement order of disease categories was
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39 187 different between journals which presented content grouped by disease category vs. journals
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41 188 without disease category content grouping. This was tested statistically using CDF plots of
42
43 189 SAPI distributions, two-sample Kolmogorov Smirnov Z tests and effect sizes (KS D) as
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45 190 described above.

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50 191 To further explore factors associated with article placement order, a supplementary *post hoc*
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52 192 analysis was undertaken to compare the median SAPIs between genders, geographical
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54 193 regions, industry funding categories and disease categories using Mann-Whitney U or
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56 194 Kruskal Wallis tests, as appropriate. Mann-Whitney U tests were also undertaken to
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58 195 determine whether article placement order for articles about rheumatoid arthritis differed

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3 196 from other disease categories. Cohen's d were computed for each comparison as measures of
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5 197 effect size with scores of 0.2 considered small, 0.5 considered median and 0.8 considered
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8 198 large [20].
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11 199 Finally, to determine the impact of article placement order on Altmetric scores and article
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13 200 download rates (as available), meta-analyses were used to determine differences in the means
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15 201 for each variable between the first and last three articles in journal issues. Altmetric scores
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17 202 were provided by *Arthritis & Rheumatology*, *Annals of the Rheumatic Diseases*,
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19 203 *Rheumatology* and *Arthritis Care & Research*. *Annals of the Rheumatic Diseases*,
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21 204 *Rheumatology* and *The Journal of Rheumatology* had article download data available, but for
22
23 205 the latter two journals, the data were available in only the 6 months prior to data extraction.
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25 206 Therefore, analyses of article downloads were undertaken for *Annals of the Rheumatic*
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27 207 *Diseases* only. For Altmetric scores, which generally do not change over time, mean scores
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29 208 were calculated by total Altmetric scores/total number of articles. For downloads, which are
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31 209 time dependent, rates were calculated by total number of downloads/total article-years from
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33 210 time of publication to time of data extraction. These analyses were undertaken within disease
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35 211 categories, adjusted by journal, as appropriate, and weighted using the inverse-variance
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37 212 method. Random effects models were used.
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44 213 All analyses were performed in SPSS (v25 IBM Corp) and SAS v9.4 (SAS Institute Inc,
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46 214 Cary, NC). All tests were two-tailed and false discovery rate (FDR)-adjusted P values [21]
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48 215 were computed for all analyses with an alpha level of < 0.05 considered significant.
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219 **RESULTS**

220 **Characteristics of included articles**

221 First authors were male in 3250 (47.9%) articles, female in 3517 (51.8%) articles and
222 unknown in 20 (0.3%) articles. Last authors were male in 4412 (65.0%) articles, female in
223 2359 (34.8%) articles and unknown/not applicable in 16 (0.2%) articles. The geographical
224 region was Europe in 3486 (51.4%) articles, North America in 2177 (32.1%) articles, and
225 Other in 1124 (16.6%) articles. 596 (8.8%) articles were industry-funded and initiated, 640
226 (9.4%) were industry-funded and investigator-initiated, and 5551 (81.8%) were not industry-
227 funded. Of the included papers, 1,395 (20.6%) reported basic research, 4466 (65.8%) were
228 categorised as other clinical research studies, 488 (7.2%) were randomised controlled trials
229 and 438 (6.5%) were systematic literature reviews or meta-analyses. Disease categories were
230 rheumatoid arthritis (n = 1946, 28.7%), osteoarthritis (n = 773, 11.4%), systemic lupus
231 erythematosus (n = 642, 9.5%), ankylosing spondylitis (n = 496, 7.3%), pediatric
232 rheumatology (n = 443, 6.5%), systemic sclerosis (n = 433, 6.4%), not disease-specific (n =
233 422, 6.2%), vasculitis (n = 362, 5.3%), other connective tissue disease (n = 339, 5.0%),
234 miscellaneous (n = 277, 4.1%), crystal arthritis (n = 269, 4.0%), psoriatic arthritis (n = 242,
235 3.6%), and pain syndromes (n = 143, 2.1%). The specific diseases which were categorised
236 under crystal arthritis, other connective tissue disease, and miscellaneous are shown in

237 **Supplementary Table 2.**

239 **Distribution of article placement within issues**

240 Inspection of the cumulative distribution function plots showed no association of article
241 placement order with author gender or geographical region. However, differences in article
242 placement order were observed for funding source, research design and disease category

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3 243 (Figure 1, Supplementary Table 3). Industry-funded and initiated studies and industry-
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5 244 funded and investigator-initiated studies were more likely to be placed towards the front of
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7 245 journal issues. Similarly, randomised controlled trials were placed towards the front of issues,
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9 246 while basic science research articles were placed towards the back of issues. Figure 2 and
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11 247 Table 1 display the differences in article placement order for disease category. Articles about
12
13 248 rheumatoid arthritis were more likely to be placed towards the front of issues. The placement
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15 249 of articles about ankylosing spondylitis, osteoarthritis and psoriatic arthritis conformed to a
16
17 250 uniform distribution. Articles about systemic lupus erythematosus, other connective tissue
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19 251 diseases, crystal arthritis, systemic sclerosis, vasculitis, pediatric rheumatology and pain
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21 252 syndromes were more likely to be placed towards the back of issues.
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Table 1. Difference in distribution of standard article placement indices (SAPI) from a uniform distribution for each disease category

	N (%)	SAPI, mean (SD)	Difference in AUC between CDF and uniform distribution Mean (95% confidence interval) ^a	FDR adjusted P	Effect size (KS D) ^b
Ankylosing spondylitis	496 (7.3%)	0.51 (0.24)	+0.00 (-0.02, +0.01)	0.94	0.10
Crystal arthritis	269 (4.0%)	0.63 (0.28)	-0.13 (-0.14, -0.11)	<0.001	0.21
Miscellaneous	277 (4.1%)	0.68 (0.29)	-0.18 (-0.20, -0.15)	<0.001	0.30
Not disease-specific	422 (6.2%)	0.61 (0.30)	-0.09 (-0.10, -0.07)	<0.001	0.15
Osteoarthritis	773 (11.4%)	0.49 (0.24)	+0.00 (-0.01, +0.02)	0.88	0.14
Other connective tissue diseases	339 (5.0%)	0.62 (0.25)	-0.11 (-0.13, -0.09)	<0.001	0.20
Pediatric rheumatology	443 (6.5%)	0.69 (0.28)	-0.19 (-0.23, -0.18)	<0.001	0.29
Pain syndromes	143 (2.1%)	0.69 (0.27)	-0.18 (-0.26, -0.15)	<0.001	0.30
Psoriatic arthritis	242 (3.6%)	0.53 (0.24)	-0.01 (-0.04, 0.02)	0.55	0.10
Rheumatoid arthritis	1946 (28.7%)	0.36 (0.28)	+0.14 (+0.14, +0.16)	<0.001	0.30
Systemic lupus erythematosus	642 (9.5%)	0.58 (0.21)	-0.07 (-0.09, -0.05)	<0.001	0.18
Systemic sclerosis	433 (6.4%)	0.64 (0.24)	-0.14 (-0.15, -0.12)	<0.001	0.23
Vasculitis	362 (5.3%)	0.65 (0.24)	-0.15 (-0.18, -0.12)	<0.001	0.27

AUC = area under the curve; CDF = cumulative density function; SAPI = standard articles placement index. ^aPositive differences indicate deviations from a uniform distribution above the uniform distribution function (i.e. article placement towards the front of an issue), while negative differences indicate deviations from a uniform distribution below the uniform distribution function (i.e. article placement towards the back of an issue). ^bFrom one-sample Kolmogorov-Smirnov Z test.

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256 **Articles in the first and last three places of an issue**

257 There were no significant differences in the proportion of articles in the first vs. last three
258 places of an issue for author gender, geographical regions, or industry funding category
259 (**Supplementary Table 4**). However, consistent with the cumulative distribution function
260 analysis, differences for disease category were observed (**Figure 3, Supplementary Table**
261 **4**). There was a significantly greater proportion of articles in the first three compared to the
262 last three places of an issue for rheumatoid arthritis (35.6% vs. 8.7% $P < 0.001$) with an OR
263 (95% CI) of 5.77 (4.80, 6.92). There was a similar proportion of articles in the first three and
264 last three places of an issue for ankylosing spondylitis, osteoarthritis, or psoriatic arthritis.
265 There was a significantly lower proportion of articles in the first three compared to the last
266 three places of an issue for crystal arthritis (10.8% vs. 26.8%), other connective tissue
267 diseases (6.8% vs., 16.5%), pediatric rheumatology (8.4% vs. 38.8%), pain syndromes (8.4%
268 vs. 37.1%), systemic lupus erythematosus (4.7% vs. 9.7%), systemic sclerosis (4.4% vs.
269 18.2%) and vasculitis (6.4% vs. 18.0%) (all $P \leq 0.001$). Differences in the proportion of
270 articles in the first vs. last three places of an issue were also observed for research type, with
271 a significantly higher proportion of articles in the first three compared to the last three places
272 of an issue for other clinical research (17.0% vs. 13.6%), randomised controlled trials (26.4%
273 vs. 10.9%), and systematic literature reviews/meta analyses (24.2% vs. 16.7%) (all $P \leq$
274 0.003) and a significantly lower proportion of articles in the first three compared to last three
275 for basic science research (7.6% vs. 26.2% $P < 0.001$) (**Supplementary Table 4**).

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277 **Journals with and without content grouped by disease category**

278 *Arthritis & Rheumatology*, *Seminars in Arthritis and Rheumatism*, *Arthritis Care & Research*
279 and *The Journal of Rheumatology* grouped issue content by disease category with disease-

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3 280 specific tables of contents sections, while *Annals of the Rheumatic Diseases*, *Rheumatology*,
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5 281 and *Joint Bone Spine* did not group issue content by disease category (**Supplementary Table**
6
7 282 **1**). Journals with content grouped by disease showed an association between article
8
9 283 placement order and disease category, whereas this was less evident for journals without
10 284 content grouped by disease (**Figure 4**). Comparisons between journals with and without
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12 285 content grouped by disease category demonstrated a significant difference in the SAPI
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14 286 distributions for every disease category, with articles on rheumatoid arthritis placed towards
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16 287 the front of issues, and articles on crystal arthritis, pain syndromes, pediatric rheumatology,
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18 288 systemic sclerosis and vasculitis placed towards the end of issues, in journals with content
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20 289 grouped by disease category (**Supplementary Table 5**).
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30 291 **Comparison of median Standardised Article Placement Indices (SAPIs)**

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32 292 *Post hoc* analyses of the differences in median SAPIs between genders, geographical regions,
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34 293 industry funding categories and disease categories are shown in **Supplementary Table 6 and**
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36 294 **Supplementary Figure 1**. Significant differences in article placement order were observed
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38 295 between disease categories, with all categories demonstrating greater median SAPIs
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40 296 (indicative of placement towards the back of journal issues) compared to rheumatoid arthritis
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42 297 (all $P < 0.001$).
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50 299 **The impact of article placement order on Altmetric scores and downloads**

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52 300 The impact of article placement order was evident in the meta-analysis results, which showed
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54 301 a higher Altmetric score (adjusted for journal) for articles published in the first three places of
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56 302 an issue compared with the last three, (mean difference in Altmetric score of 5.11, 95% CI
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58 303 1.50, 8.71, $Z = 2.78$, $P = 0.005$) (**Figure 5**). The difference in Altmetric scores varied across
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3 304 different disease categories (I^2 76%; $P < 0.001$), with the largest difference between
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5 305 positioning in the first three places and positioning in the last three places being observed for
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8 306 articles about rheumatoid arthritis and psoriatic arthritis.

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10 307 Similarly, meta-analysis showed that articles published in the first three places of an issue
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12 308 had a higher download rate compared to articles in the last three places of an issue (pooled
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14 309 rate difference (95% CI) 442.1 (293.0, 591.2) downloads/article year, $Z = 5.81$, $P < 0.001$)
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17 310 (**Figure 5**). The difference in download rate between the first and last three articles was
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20 311 similar across different disease categories (I^2 24%; $P = 0.21$).
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24 25 313 **DISCUSSION**

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28 314 In this analysis of serial rheumatology journals, no relationship between article placement
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30 315 order and author gender or geographical region was observed. However, differences for
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32 316 funding source, research design, and disease category were apparent. There was more
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34 317 frequent positioning of industry-funded studies and randomised controlled trials towards the
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36 318 front of journal issues. Articles about rheumatoid arthritis were also more frequently
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38 319 positioned towards the front of journal issues, while articles about crystal arthritis, other
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40 320 connective tissue diseases, pediatric rheumatology, pain syndromes, systemic lupus
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42 321 erythematosus, systemic sclerosis and vasculitis towards the back of issues. Analyses of
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44 322 Altmetric scores and download rates suggested that article placement order influences
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46 323 research prominence, with earlier placed articles receiving more attention.
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52 324 Medical journals are central to evidence-based practice and represent a key source of new
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54 325 knowledge for medical professionals.[22, 23] Unbiased publication practices are important in
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56 326 allowing a variety of perspectives and emphases to expand the scope of research and clinical
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58 327 practice. Although bias has been previously reported in academic journals based on
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3 328 authorship ordering of genders,[9, 10] representation of geographical regions,[9, 11] and
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5 329 acceptance and time to publication based on industry sponsorship,[12] our analysis showed
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8 330 that of these factors only industry funding was associated with article placement order within
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10 331 serial rheumatology journals. This finding may reflect the placement of clinical trials towards
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12 332 the front of issues which likely made up the majority of industry-funded studies.

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15 333 Articles about rheumatoid arthritis were preferentially placed towards the front of
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17 334 rheumatology journals, while other conditions, particularly pain syndromes, crystal arthritis,
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19 335 pediatric syndromes, and connective tissue diseases, were ordered towards the back.
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21 336 Rheumatoid arthritis was the disease category with the greatest number of articles, therefore
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23 337 giving it the greatest opportunity to be listed first, but our analyses accounted for the variation
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25 338 in article numbers between disease categories. Although rheumatoid arthritis is a very
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27 339 important rheumatic disease,[24] general rheumatology practice involves the diagnosis and
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29 340 treatment of a wide range of diseases.[25, 26] General rheumatology journals should ideally
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31 341 reflect that diversity of clinical practice. A similar distribution of articles on each disease
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33 342 category would therefore be expected if there was no bias for disease category.

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36 343 The reason for the observed differences in article placement for disease category is unclear.
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38 344 Disease privileging in other fields of medical research has been reported, with some prevalent
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40 345 diseases with high global impact being under-funded and under-researched.[13-15] Crystal
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42 346 arthritis, osteoarthritis and pain syndromes are common; for example, prevalence estimates
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44 347 for US adults for gout are 3.9%,[27] for osteoarthritis are 13.4%,[28] and for low back pain
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46 348 are 26.4%.[29] However, these conditions may be viewed by rheumatologists and journal
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48 349 editors as less important or less severe.[30, 31] Our analysis of article placement order, which
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50 350 did not reflect prioritising of diseases based on epidemiology or severity, emphasises the
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52 351 disconnect between the prevalence of disease and health research. These perceptions of some
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54 352 rheumatic diseases have the potential to impact attitudes in clinical practice and contribute to

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3 353 lower quality of care.[31, 32] Rheumatic diseases such as vasculitis, pediatric rheumatic
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5 354 disease, and scleroderma are less common, but can lead to major morbidity and reduced
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8 355 quality of life. Improving the impact and accessibility of research published on 'lower
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10 356 priority' or less common rheumatic diseases may have an important impact on clinicians'
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12 357 understanding about and attitudes towards these conditions in clinical practice.

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15 358 Differences in article placement order for disease category was particularly evident in
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17 359 journals with disease-specific tables of contents sections within issues, rather than journals
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20 360 that did not group issue content by disease category. It has been suggested that grouping
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22 361 article content by disease category may improve the reader experience.[33] However, such
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24 362 decisions have the potential to further reduce readers' exposure to diseases that are already
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26 363 under-studied or less well understood. Editorial decisions to remove grouping by disease
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28 364 category, or to cycle the order of disease category groups for each issue may be a simple
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30 365 solution to overcome bias for disease category reflected in article placement order.

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34 366 In our analysis, articles appearing in the first three places of an issue had higher Altmetric
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36 367 scores and download rates compared to articles appearing in the last three places of an issue.
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39 368 This finding may be attributed in part to the higher number of clinical trials published
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41 369 towards the front of issues, which generally have a greater impact [34], and is also consistent
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43 370 with prior studies which demonstrate the influence of the primacy effect on research
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45 371 prominence.[6-8] Collectively, these findings indicate that articles placed at the front of
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47 372 journal issues receive greater prominence. The prominence and impact of research published
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49 373 in journals has an important role in not only providing information to improve knowledge and
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51 374 treatment, but also in financing further research[35] and obtaining academic promotion.[36]
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55 375 The current analysis has some limitations. Firstly, Altmetric and download data were not
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57 376 available from all journals included in the analysis, and it is unclear whether similar
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3 377 differences are present across all journals. Secondly, citation rates were not evaluated because
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5 378 of the short time period between article publication and data extraction which would not have
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7 379 reflected true citation rates, which increase over time. Finally, this analysis did not explore
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9 380 other factors that may have contributed to article placement order such as quality, impact, or
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11 381 originality of the study, or the presence of prolific or “star” authors.[37] Further research may
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13 382 also focus on identifying factors influencing editorial decisions about the placement order of
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15 383 articles about different diseases. For example, we did observe that basic science articles were
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17 384 placed towards the back of an issue, suggesting that editors prioritise clinical research over
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19 385 laboratory-based research. A strength of this paper is the use of multiple methods of analysis
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21 386 to explore the relationship between disease category and article placement order, including an
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23 387 analysis of the distribution of article placement, an analysis of the difference in proportion of
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25 388 articles appearing in the first and last three places of an issue, and an analysis of the
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27 389 comparison of median article placement order between disease categories. Collectively, these
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29 390 results provide robust and detailed evidence that bias for industry funded studies, clinical
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31 391 trials and for certain disease categories is reflected in article placement order.
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38 392 In conclusion, author gender and geographical region do not influence article placement order
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40 393 in serial rheumatology journals. However, bias for certain disease categories is reflected in
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42 394 article placement order. Article placement order may have an impact on research prominence,
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44 395 including Altmetric scores and download rate. Editorial choices about the serial position of
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46 396 articles within journals can influence prioritisation of certain diseases.
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14

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18
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20
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41

42 412 SS contributed towards acquisition, analysis and interpretation of the data. GG contributed
43
44 413 towards design of the study and analysis and interpretation of the data. AG contributed
45
46 414 towards design of the study and interpretation of the data. ND contributed towards design of
47
48 415 the study, and acquisition and interpretation of the data. All authors were involved in drafting
49
50 416 of the work or revising it critically for important intellectual content. All authors approved
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52 417 the final version to be published and agree to be accountable for all aspects of the work.
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420 **Data statement**

421 All extracted data used in the analyses are available upon reasonable request from the
422 corresponding author.

423

For peer review only

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Figure legends

Figure 1. Cumulative distribution function plots of standardised article placement indices (SAPI) for first author gender (A.), senior author gender (B.), industry funding (C.), and first author's geographic region of affiliated institution (D.), and research design (E.). Left deviated distributions suggest prioritisation towards the front of journal issues.

Figure 2. Cumulative distribution function plots of standardised article placement indices (SAPI) for each disease category. Left deviated distributions suggest prioritisation towards the front of journal issues.

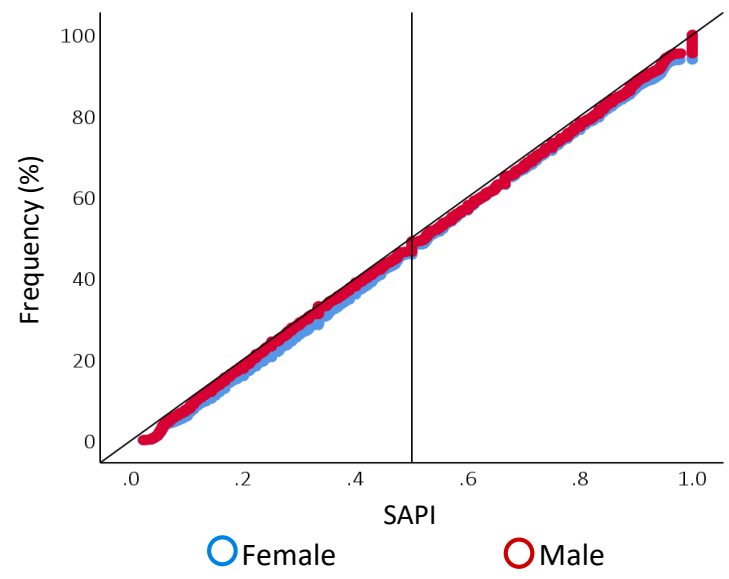
Figure 3. Percentage of articles (per disease category) published in first three and last three places of an issue (*P*-values indicate difference between proportions of articles in first and last three places of an issue).

Figure 4. Cumulative distribution function plots of standardised article placement indices (SAPI) for each disease category for journals with (A.) and without (B.) contents grouped by disease. Left deviated distributions suggest prioritization towards the front of journal issues.

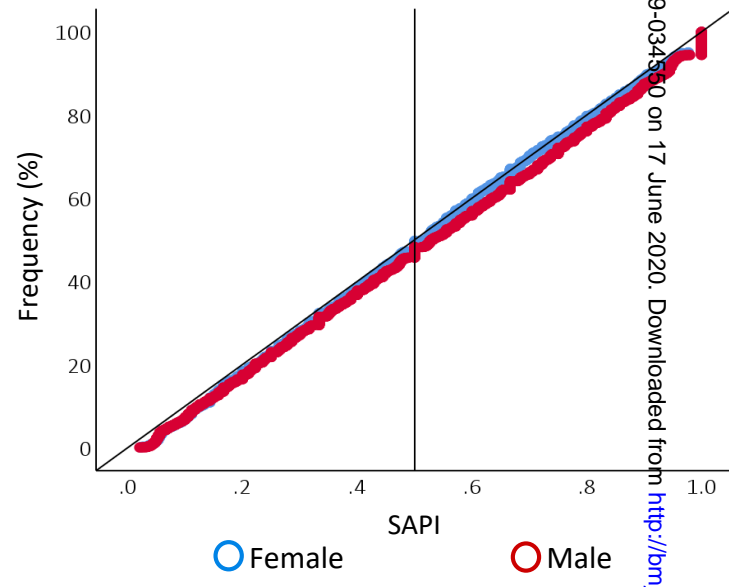
Figure 5. Forest plots showing the mean differences for each disease category for Altmetric scores (A.) and download rates (B.) between articles published in the first vs. last three places of an issue. Positive differences indicate a higher Altmetric score/download rate for articles published in one of the first three places of an issue. Differences in Altmetric scores are adjusted for journal. Download data was available from one journal. CTD: connective tissue disease.

36/bmjopen-2019-034850 on 17 June 2020. Downloaded from <http://bmjopen.bmj.com/> on April 16, 2024 by guest. Protected by copyright.

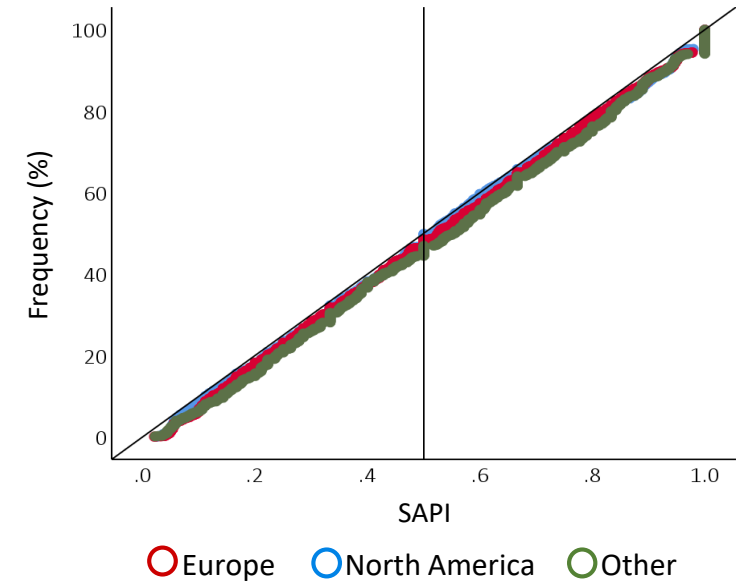
A. First author gender



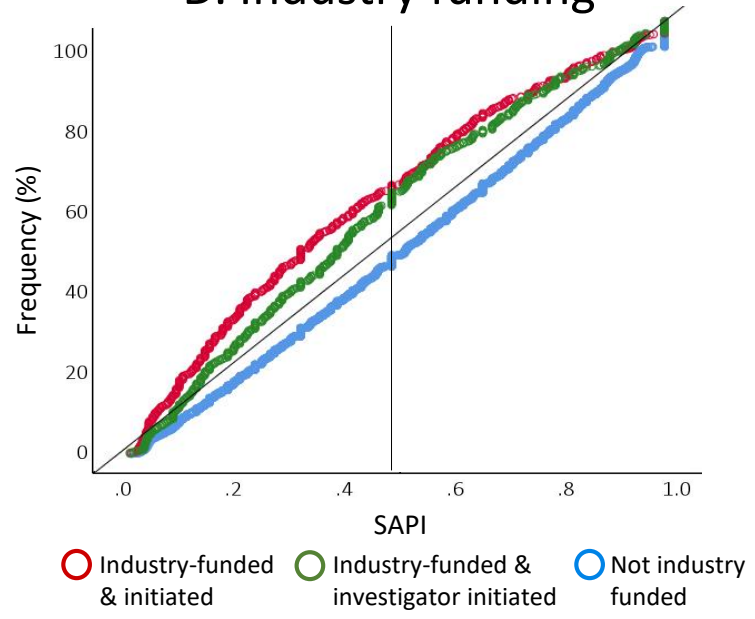
B. Senior author gender



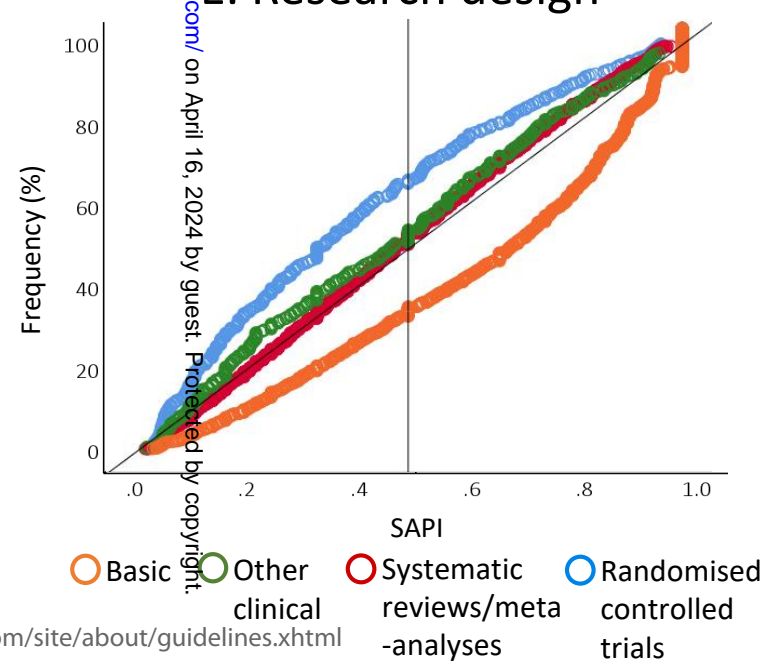
C. Geographical region

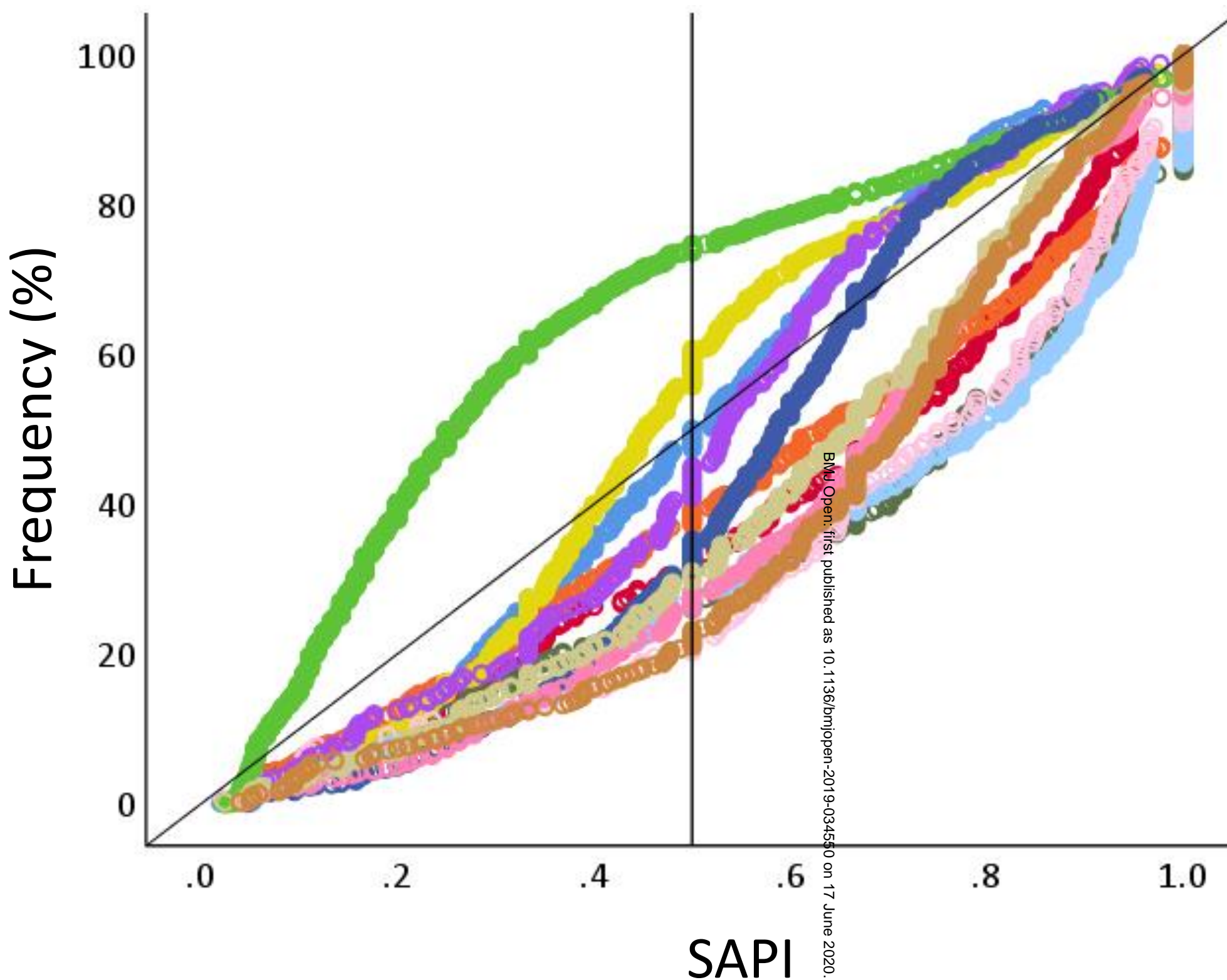


D. Industry funding



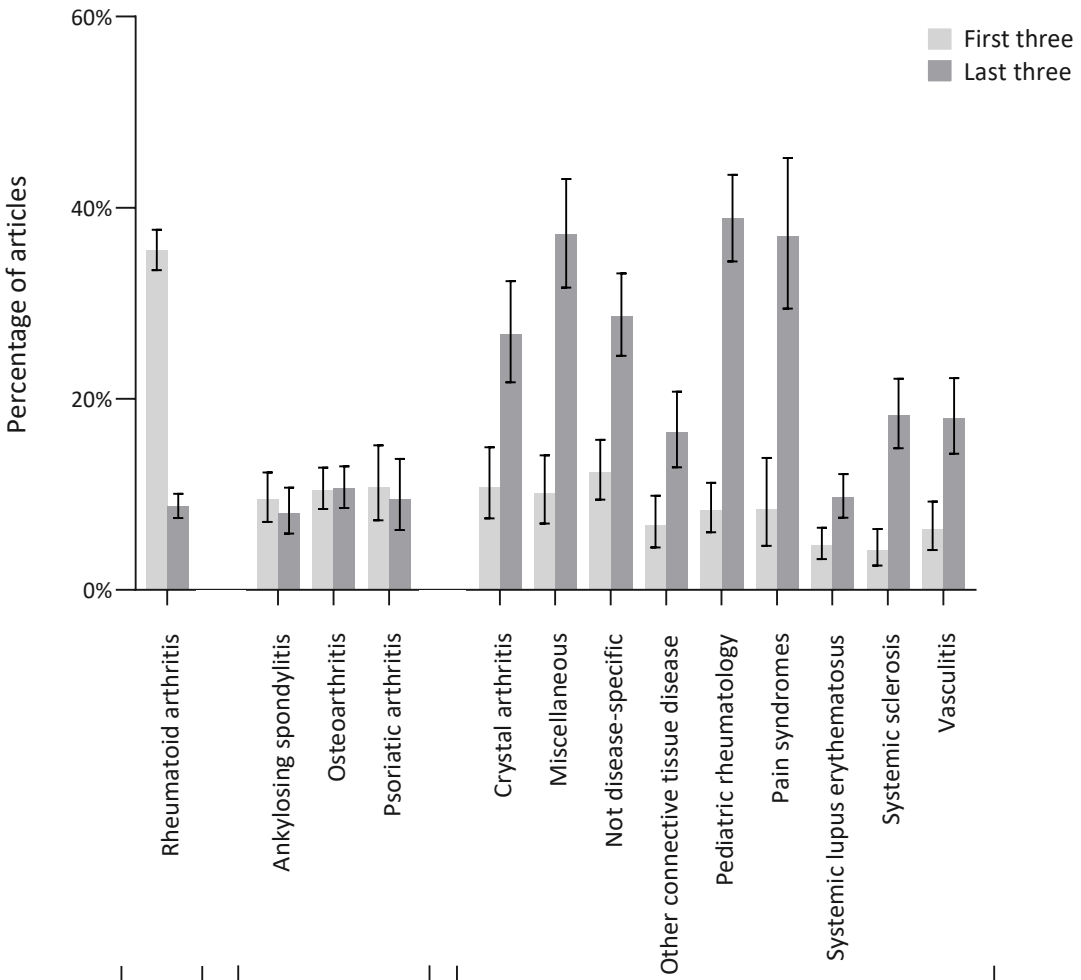
E. Research design





- Ankylosing spondylitis ○ Crystal arthritis ○ Miscellaneous
- Not disease-specific ○ Osteoarthritis ○ Pediatric rheumatology
- Pain syndromes ○ Psoriatic arthritis ○ Rheumatoid arthritis
- Systemic lupus erythematosus ○ Systemic sclerosis
- Other connective tissue disease ○ Vasculitis

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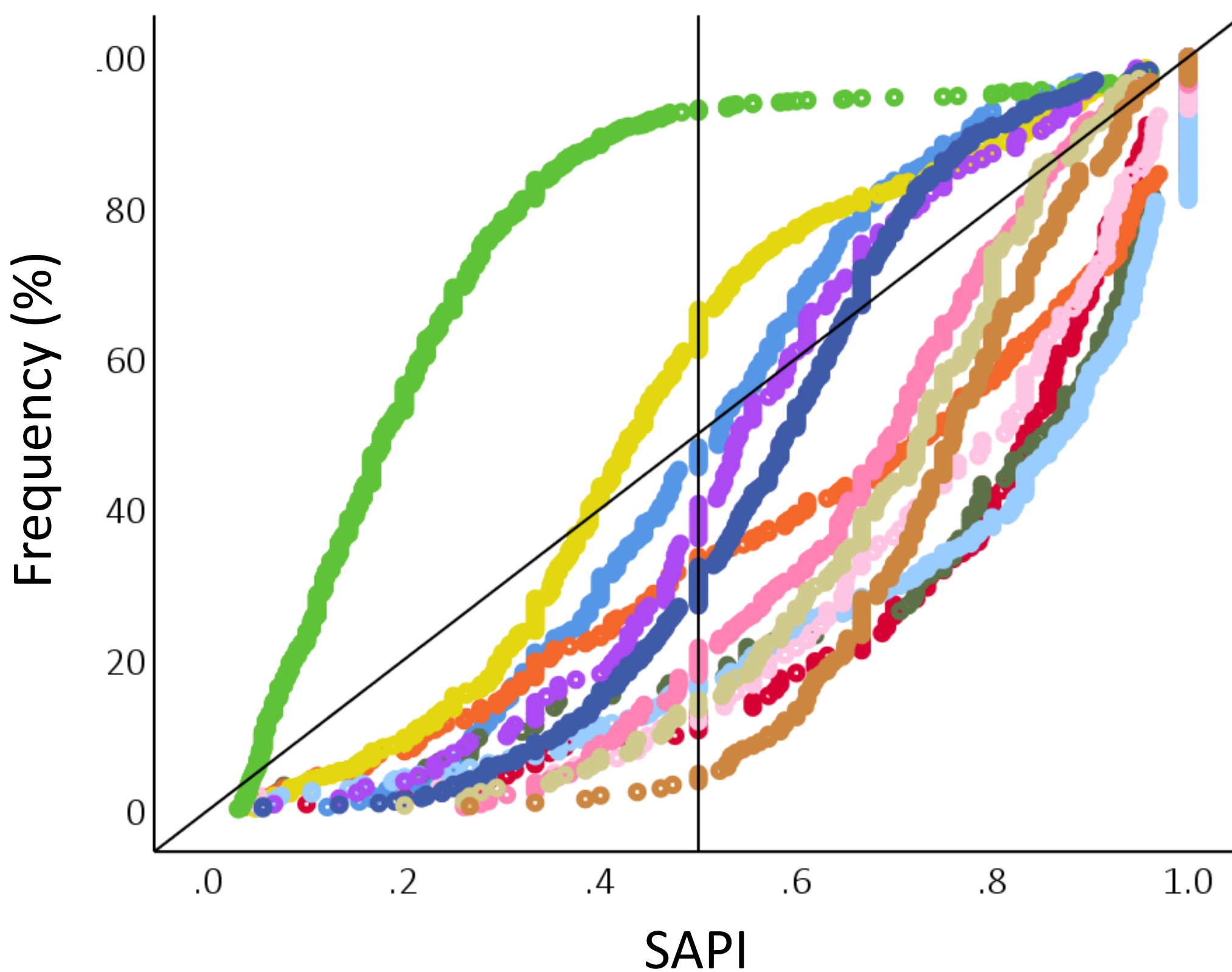
Greater number of articles in first three places (P < 0.001)

No difference (all P > 0.51)

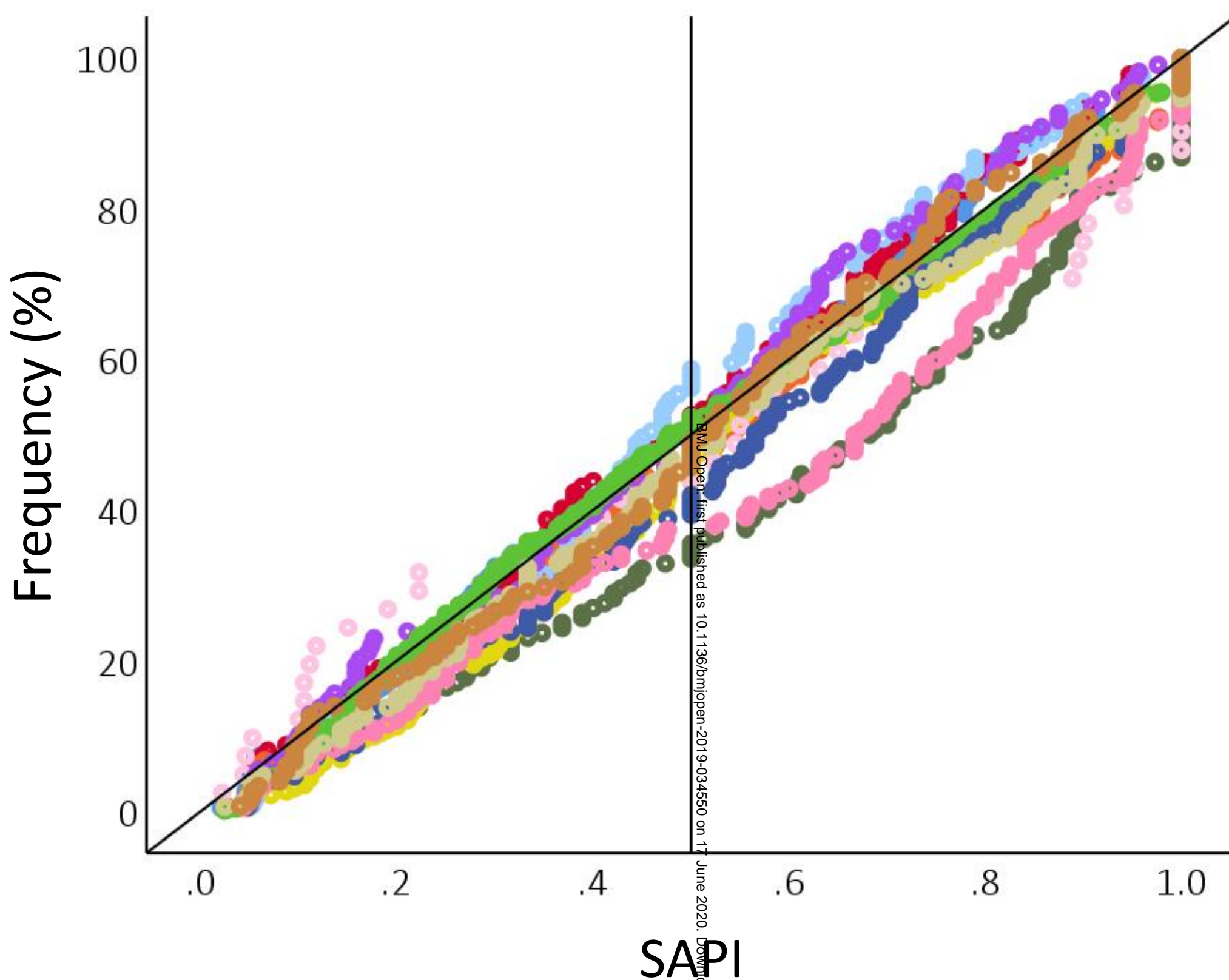
Greater number of articles in last three places (all P < 0.001)

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A. Journals with issue content grouped by disease



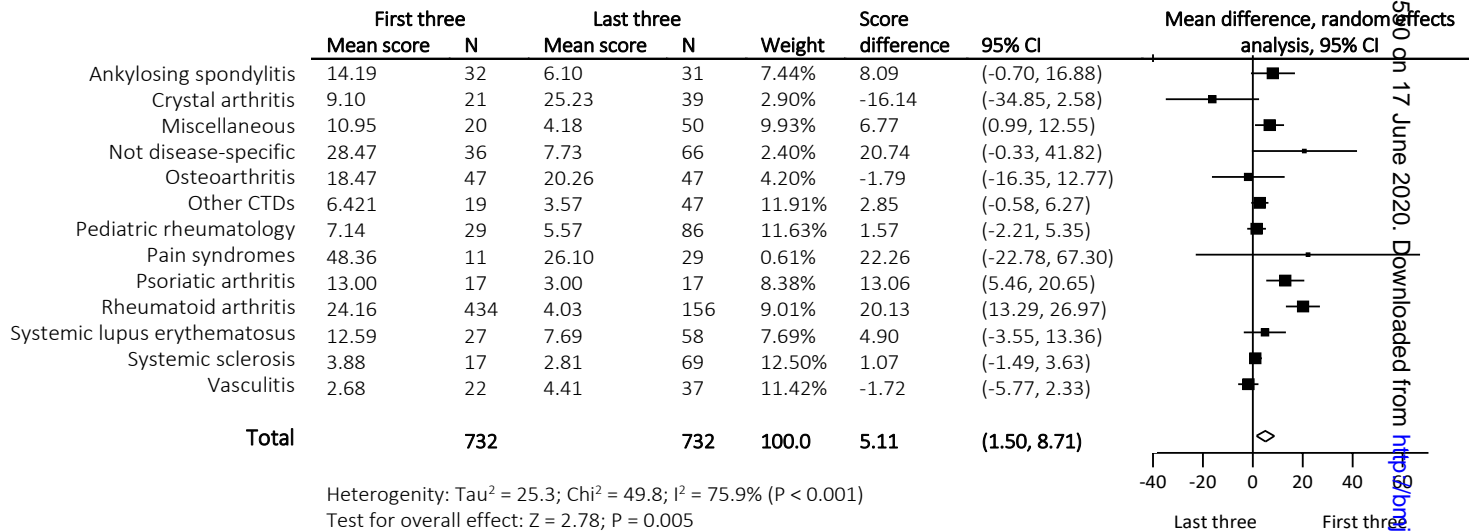
B. Journals without issue content grouped by disease



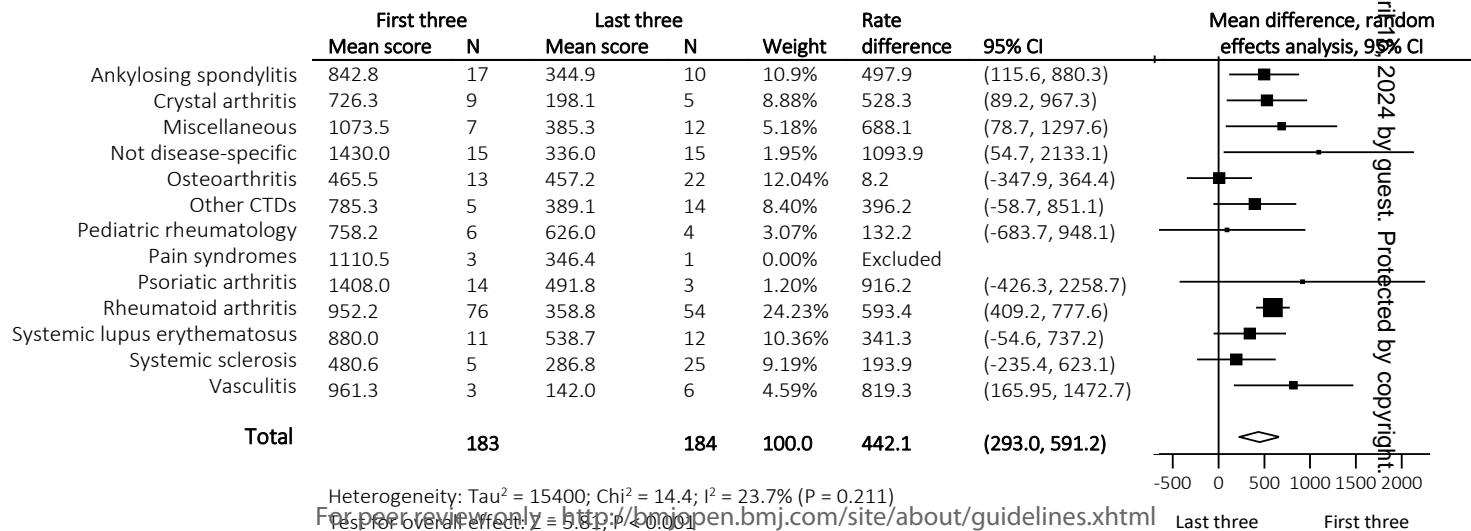
- Ankylosing spondylitis
- Crystal arthritis
- Miscellaneous
- Not disease-specific
- Osteoarthritis
- Pediatric rheumatology
- Pain syndromes
- Psoriatic arthritis
- Rheumatoid arthritis
- Systemic lupus erythematosus
- Systemic sclerosis
- Other connective tissue disease
- Vasculitis

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A. Differences in Altmetric scores between articles in first and last three places of an issue



B. Differences in download rates between articles in first and last three places of an issue



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3 **SUPPLEMENTARY MATERIAL**
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8 **Supplementary Table 1. Journal characteristics**

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	Publisher	Country of publication	2016 Impact Factor	Relevant affiliated society	Issues per year	Contents grouped by disease	Total number of articles included, n	Number of included articles per issue, mean (SD)
10	Annals of the Rheumatic Diseases	United Kingdom	12.811	European League Against Rheumatism	12	0	1374	13.2 (9.4)
11	Arthritis & Rheumatology	United States	6.918	American College of Rheumatology	12	es	1367	12.5 (7.6)
12	Rheumatology	United Kingdom	4.818	British Society for Rheumatology	12	0	1158	10.2 (5.7)
13	Seminars in Arthritis and Rheumatism	United States	4.498	None	6	es	403	7.3 (4.1)
14	Joint Bone Spine	United States	3.329	French Society of Rheumatology	6	0	239	4.6 (2.6)
15	Arthritis Care & Research	United States	3.319	American College of Rheumatology, Association of Rheumatology Health Professionals	12	es	1098	9.6 (5.4)
16	The Journal of Rheumatology	Canada	3.150	Canadian Rheumatology Association	12	es	1148	10.3 (6.1)

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Supplementary Table 2. Number of articles within each disease category for crystal arthritis, miscellaneous and other connective tissue diseases

	Frequency	Percent
<i>Crystal arthritis (n = 269)</i>		
Gout	260	96.7
Calcium crystal diseases	9	3.3
<i>Miscellaneous Disease (n = 277 articles)</i>		
Regional musculoskeletal syndromes	48	17.3
Osteoporosis	22	7.9
IgG4-related disease	20	7.2
FMF	20	7.2
Polymyalgia rheumatica	19	6.9
CAPS	16	5.8
Still's disease	10	3.6
Septic arthritis	8	2.9
Fibrosis	8	2.9
Sarcoidosis	7	2.5
Chikungunya Virus	7	2.5
SAPHO syndrome	6	2.2
TRAPS	5	1.8
Polychondritis	5	1.8
Ehlers-Danlos Syndrome	4	1.4
Lyme disease	4	1.4
Alkaptonuria	4	1.4
Hemophagocytic syndromes	3	1.1
Vertebral fractures	2	0.7
Uveitis	2	0.7
Undifferentiated arthritis	2	0.7
Tuberculosis	2	0.7
Periodic fever syndrome	2	0.7
Löfgren syndrome	2	0.7
Erdheim-Chester disease	2	0.7
Dupuytren's disease	2	0.7
ACPA-negative undifferentiated arthritis	1	0.4
Yellow fever	1	0.4
Whipple disease	1	0.4
Vertebral endplate lesions	1	0.4
Tumoral calcinosis	1	0.4
Tenosynovial giant cell tumor	1	0.4
Systemic autoinflammatory disease (SAID)	1	0.4
Schnitzler's syndrome	1	0.4
Ribbing disease	1	0.4
Receptor-associated periodic syndrome	1	0.4
Pyogenic sterile arthritis pyoderma gangrenosum and acne (PAPA) syndrome	1	0.4
Pyogenic arthritis	1	0.4
Primary angiitis of the CNS	1	0.4
Preeclampsia	1	0.4
Pigmented villonodular synovitis	1	0.4
Periodic fever, aphthous stomatitis, pharyngitis, and cervical adenitis (PFAPA) syndrome	1	0.4

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3	Paraneoplastic rheumatic syndrome	1	0.4
4	Palindromic rheumatism	1	0.4
5	Paget's disease	1	0.4
6	Osteonecrosis	1	0.4
7	Osteomyelitis	1	0.4
8	NOD2-associated autoinflammatory diseases	1	0.4
9	Muckle-wells syndrome	1	0.4
10	Mikulicz's disease	1	0.4
11	Mevalonate kinase deficiency	1	0.4
12	Medial meniscal tears	1	0.4
13	Macrophage activation syndrome	1	0.4
14	Leri's pleonosteosis	1	0.4
15	Kikuchi-Fujimoto disease	1	0.4
16	Joint hypermobility syndrome	1	0.4
17	Immune reconstitution inflammatory syndrome	1	0.4
18	Hereditary recurrent fever syndromes	1	0.4
19	Hereditary haemochromatosis	1	0.4
20	Haploinsufficiency of A20	1	0.4
21	Glomerulonephritis	1	0.4
22	Gaucher disease	1	0.4
23	Femoral fractures	1	0.4
24	Fabry disease	1	0.4
25	Ebola virus	1	0.4
26	Discitis	1	0.4
27	Chronic graft-versus-host disease	1	0.4
28	Blau syndrome	1	0.4
29	Biphosphate trochanteric fracture	1	0.4
30	Amyloidosis	1	0.4
31	Aicardi-Goutières syndrome	1	0.4
32	Other connective tissue disease (n = 339 articles)		
33	Sjogren's syndrome	174	51.3
34	Inflammatory myositis	115	33.9
35	Antiphospholipid syndrome	41	12.1
36	Mixed connective tissue disease	7	2.1
37	CTD-associated interstitial lung disease	1	0.3
38	Undifferentiated connective tissue disease	1	0.3
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Supplementary Table 3. Difference in distribution of standard article placement indices (SAPI) for each author gender, geographical region, industry finding category and research design

	N (%)	SAPI, mean (SD)	Two-sample Kolmogorov-Smirnov Z test Effect size (KS D)	FDR-adjusted P
First author gender				
Female	3517 (52.0%)	0.53 (0.29)	0.03	0.19
Male	3250 (48.0%)	0.52 (0.29)		
Last author gender				
Female	2359 (34.8%)	0.52 (0.28)	0.04	0.017
Male	4412 (65.2%)	0.53 (0.29)		
Geographical region				
Europe	3486 (51.4%)	0.53 (0.29)	(reference)	-
North America	2177 (32.1%)	0.52 (0.29)	0.02	0.57
Other	1124 (16.6%)	0.52 (0.29)	0.03	0.93
Industry funding				
Industry funded and initiated	640 (9.4%)	0.42 (0.28)	0.19	<0.001
Industry funded and investigator initiated	596 (8.8%)	0.45 (0.29)	0.17	<0.001
Not industry funded	5551 (82.0%)	0.55 (0.29)	(reference)	-
Research design				
Basic science	1395 (20.6%)	0.64 (0.28)	(reference)	-
Other clinical research	4466 (65.8%)	0.51 (0.28)	0.22	<0.001
Randomised controlled trials	488 (7.2%)	0.41 (0.29)	0.34	<0.001
Systematic literature reviews/meta-analyses	438 (6.4%)	0.49 (0.29)	0.24	<0.001

SAPI = standard articles placement index. Lower SAPI scores equate to articles ordered at the front of issues, while higher SAPI scores equate to articles ordered at the end of issues.

Supplementary Table 4. Number of articles appearing in at least one article in first and last three articles of an issue for author gender, geographical region of affiliated institution, industry funding category, and disease category

	Total articles	First three N	% of total	Last three N	% of total	Odds ratio (OR) ^a	95% CI for OR	P ^b
First author gender								
Female	3517	537	15.3%	586	16.7%	0.90	0.79, 1.02	0.17
Male	3250	557	17.1%	509	15.7%	1.11	0.98, 1.27	0.17
Last author gender								
Female	2359	393	16.7%	355	15.0%	1.13	0.97, 1.32	0.17
Male	4412	705	16.0%	737	16.7%	0.95	0.85, 1.01	0.37
Geographical region								
Europe	3486	573	16.4%	556	16.0%	1.04	0.91, 1.18	0.68
North America	2177	362	16.6%	352	16.2%	1.03	0.88, 1.21	0.68
Other	1124	163	14.5%	190	16.9%	0.83	0.66, 1.05	0.35
Industry funding								
Industry-funded and initiated	640	104	16.3%	109	17.0%	0.95	0.70, 1.27	0.71
Industry-funded and investigator-initiated	596	87	14.6%	111	18.6%	0.75	0.55, 1.01	0.09
Not industry-funded	5551	907	16.3%	878	15.8%	1.04	0.94, 1.15	0.09
Research type								
Basic science	1395	106	7.6%	366	26.2%	0.23	0.18, 0.29	<0.001
Other clinical research	4466	757	17.0%	606	13.6%	1.30	1.16, 1.46	<0.001
Randomised controlled trials	488	129	26.4%	53	10.9%	2.95	2.08, 4.18	<0.001
Systematic literature reviews / meta-analyses	438	106	24.2%	73	16.7%	1.60	1.14, 2.23	0.003
Disease category								
Ankylosing spondylitis	496	47	9.5%	40	8.1%	1.19	0.77, 1.86	0.51
Crystal arthritis ^c	269	29	10.8%	72	26.8%	0.33	0.21, 0.53	<0.001
Miscellaneous	277	28	10.1%	103	37.2%	0.19	0.12, 0.30	<0.001
Not disease-specific	422	52	12.3%	121	28.7%	0.35	0.24, 0.50	<0.001
Osteoarthritis	773	81	10.5%	82	10.6%	0.99	0.71, 1.37	0.934
Other connective tissue diseases	339	23	6.8%	56	16.5%	0.37	0.22, 0.61	<0.001
Pediatric rheumatology	443	37	8.4%	172	38.8%	0.14	0.10, 0.21	<0.001
Pain syndromes	143	12	8.4%	53	37.1%	0.16	0.08, 0.31	<0.001
Psoriatic arthritis ^c	242	26	10.7%	23	9.5%	1.15	0.63, 2.07	0.71
Rheumatoid arthritis	1946	692	35.6%	170	8.7%	5.77	4.80, 6.92	<0.001
Systemic lupus erythematosus	642	30	4.7%	62	9.7%	0.46	0.29, 0.72	0.001
Systemic sclerosis	433	18	4.4%	79	18.2%	0.19	0.11, 0.33	<0.001
Vasculitis	362	23	6.4%	65	18.0%	0.31	0.19, 0.51	<0.001

^aThe odds of being in at least one article in the first three places of an issue; ^bFDR-adjusted Mid-P exact P-value; ^cOne article in each of 'Crystal arthritis' and 'Psoriatic arthritis' came from issues which included 5 articles and were therefore counted in both the 'first' and 'last' three categories.

Supplementary Table 5. Difference in cumulative density function distribution of standard article placement indices (SAPI) between journals with and without contents grouped by disease for articles with related editorials and for each disease category

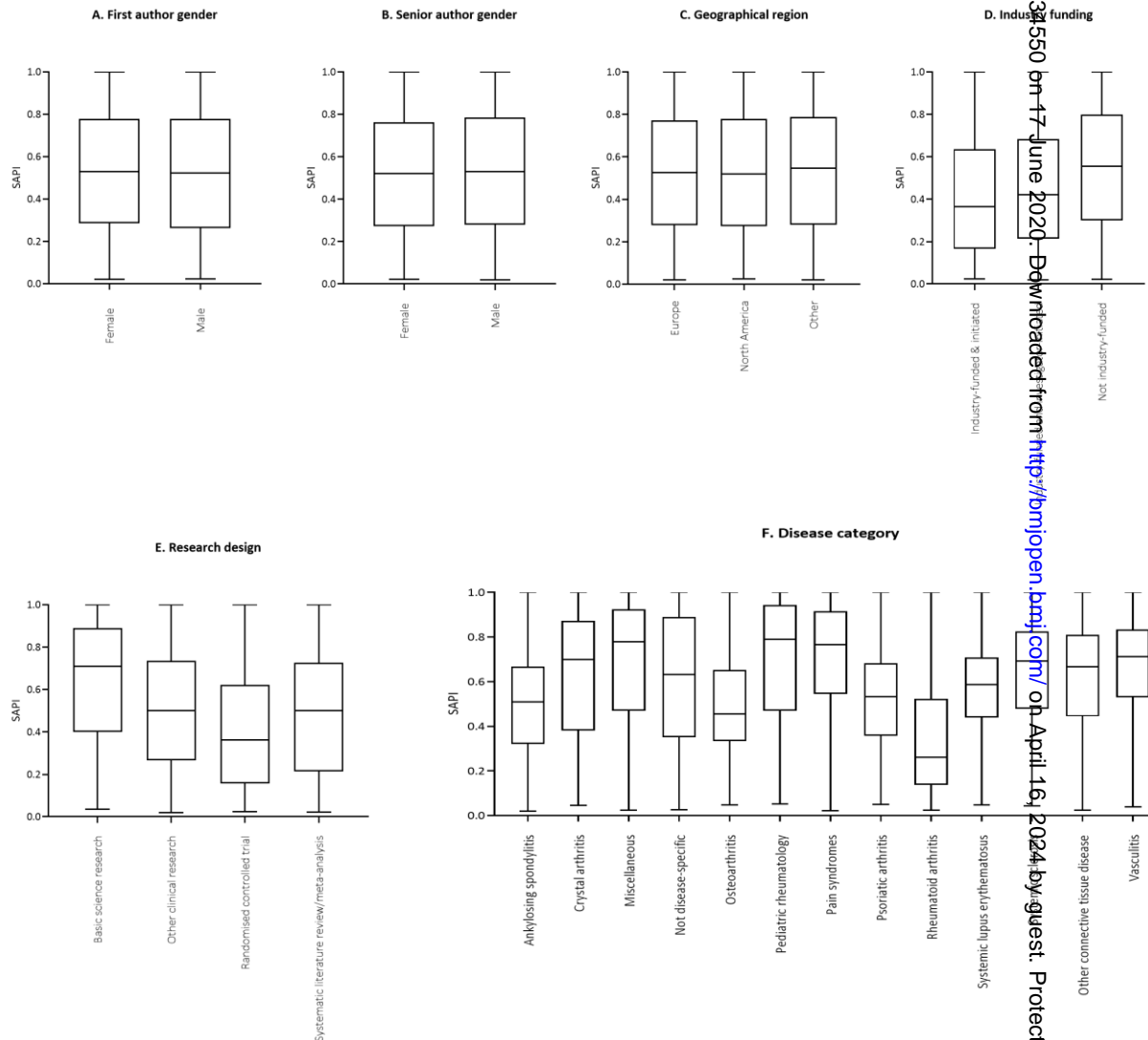
	Journals with contents not grouped by disease			Journals with contents grouped by disease			Two-sample Kolmogorov-Smirnov Z test ^b	
	N (%)	SAPI ^a		N (%)	SAPI ^a		Effect size (KS D)	FDR-adjusted P
		Mean	SD		Mean	SD		
Ankylosing spondylitis	228 (8.2%)	0.49	0.28	268 (6.7%)	0.52	0.19	0.20	<0.001
Crystal arthritis	137 (4.9%)	0.49	0.28	132 (3.3%)	0.78	0.20	0.50	<0.001
Miscellaneous	152 (5.5%)	0.62	0.30	125 (3.1%)	0.76	0.26	0.29	<0.001
Not disease-specific	178 (6.4%)	0.53	0.30	244 (6.1%)	0.66	0.29	0.22	<0.001
Osteoarthritis	231 (8.3%)	0.55	0.27	542 (13.5%)	0.47	0.22	0.20	<0.001
Other connective tissue diseases	167 (6.0%)	0.49	0.29	172 (4.3%)	0.70	0.17	0.36	<0.001
Pediatric rheumatology	121 (4.4%)	0.48	0.26	322 (8.0%)	0.77	0.25	0.50	<0.001
Pain syndromes	41 (1.5%)	0.54	0.35	102 (2.5%)	0.75	0.21	0.36	0.001
Psoriatic arthritis	109 (3.9%)	0.48	0.27	133 (3.3%)	0.56	0.20	0.22	0.005
Rheumatoid arthritis	881 (31.8%)	0.51	0.29	1065 (26.5%)	0.23	0.20	0.49	<0.001
Systemic lupus erythematosus	193 (7.0%)	0.56	0.28	449 (11.2%)	0.58	0.17	0.19	<0.001
Systemic sclerosis	182 (6.6%)	0.60	0.30	251 (6.3%)	0.68	0.18	0.26	<0.001
Vasculitis	151 (5.4%)	0.51	0.28	211 (5.3%)	0.75	0.14	0.50	<0.001

^aLower SAPI scores equate to articles ordered at the front of issues, while higher SAPI scores equate to articles ordered at the end of issues. ^bTest of difference in distribution of SAPI between journals with and without contents grouped by disease sections.

Supplementary Table 6. Comparison of median standardised article placement index (SAPI) between genders of first and last authors, geographical regions, industry funding categories and disease categories.

	N of articles	SAPI ^a Median (IQR)	Min-max	Difference in median SAPI Effect size (Cohen's d)	FDR-adjusted P- value
First author gender					
Female	3517	0.53 (0.49)	0.02-1.00	0.04	0.11
Male	3250	0.52 (0.51)	0.02-1.00		
Last author gender					
Female	2359	0.52 (0.49)	0.02-1.00	0.05	0.07
Male	4412	0.23 (0.51)	0.02-1.00		
Geographical region					
Europe	3486	0.53 (0.50)	0.02-1.00	0.02	0.26
North America	2177	0.51 (0.51)	0.02-1.00		
Other	1124	0.56 (0.51)	0.02-1.00		
Industry funding					
Industry funded and initiated	640	0.36 (0.47)	0.02-1.00	0.30	<0.001
Industry funded and investigator initiated	596	0.42 (0.47)	0.02-1.00		
Not industry funded	5551	0.56 (0.49)	0.02-1.00		
Research type					
Basic science	1395	0.71 (0.28)	0.03-1.00	0.19	<0.001
Other clinical research	4466	0.50 (0.47)	0.02-1.00		
Randomised controlled trials	488	0.36 (0.46)	0.02-1.00		
Systematic literature reviews/meta-analyses	438	0.50 (0.51)	0.02-1.00		
Disease category					
Ankylosing spondylitis	496	0.50 (0.35)	0.02-1.00	0.53	<0.001
Crystal arthritis	269	0.70 (0.50)	0.05-1.00	0.59	<0.001
Miscellaneous	277	0.78 (0.45)	0.02-1.00	0.68	<0.001
Not disease-specific	422	0.63 (0.54)	0.03-1.00	0.64	<0.001
Osteoarthritis	773	0.45 (0.32)	0.05-1.00	0.58	<0.001
Other connective tissue diseases	339	0.67 (0.37)	0.02-1.00	0.66	<0.001
Pediatric rheumatology	443	0.79 (0.47)	0.05-1.00	0.86	<0.001
Pain syndromes	143	0.75 (0.37)	0.02-1.00	0.51	<0.001
Psoriatic arthritis	242	0.53 (0.33)	0.05-1.00	0.43	<0.001
Rheumatoid arthritis	1946	0.26 (0.39)	0.02-1.00	(reference category)	-
Systemic lupus erythematosus	642	0.58 (0.27)	0.05-1.00	0.78	<0.001
Systemic sclerosis	433	0.69 (0.35)	0.04-1.00	0.79	<0.001
Vasculitis	362	0.71 (0.30)	0.04-1.00	0.74	<0.001

^aLower SAPI scores equate to articles ordered at the front of issues, while higher SAPI scores equate to articles ordered at the end of issues.



Supplementary Figure 1. Box plots showing differences in standardised article placement indices (SAPI) for first author gender (A.), senior author gender (B.), industry funding (C.), first author's geographical region of affiliated institution (D.), research design (E) and disease category (F.)