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Original article

Looking Beyond Traditional Metrics in Orthodontics: An Altmetric Study on the Most Discussed Articles on the Web

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Summary

Objective: To evaluate the online visibility of the most popular orthodontic articles in Web platforms in relation to publication details and citations.

Materials and Methods: Altmetric Explorer (Altmetric LLP, London, UK) was searched for articles published in 11 orthodontic journals without time limits in publication and citation on social media. The 200 articles with the highest Altmetric Attention Score (AAS) were collected and screened for data related to publication (date, journal, access), authorship (number of authors, affiliation and origin of the corresponding author), and research (type, subject, funding). Citation counts were harvested from Scopus.

Results: The top 200 articles presented a median AAS of 8.0 (range: 5.0–196.0), and were mostly bookmarked in Mendeley (median: 16.6 references; range: 0–199.0). American Journal of Orthodontics & Dentofacial Orthopedics, European Journal of Orthodontics and The Angle Orthodontist contributed 86 per cent of the total number of research outputs. Studies investigating socio-demographics had significantly higher AAS compared to diagnostic studies (median AAS: 19.0; range: 7.0–34.0; versus median AAS: 6.0; range: 5.0–10.0. No other study parameter was found to be statistically significant. AAS did not correlate to the number of citations as reported in Scopus.

Limitations: The early stage of altmetrics and their complementary role in assessing together with the citation-based metrics the research impact need to be acknowledged in the interpretation of the results.

Conclusions: Visibility of orthodontic articles on the Web is not significantly correlated with citations. Studies on socio-demographics had significantly higher number of online mentions. More constructive online presence of orthodontic journals is needed to reinforce dissemination of research data among scholars and non-scholars.

Introduction

Over 7 million researchers around the world are daily reshaping the landscape for science and innovation by publishing their work in around 25 000 scientific journals (1). Research impact can be defined as 'the demonstrable contribution that excellent research makes to society and the economy' (2). Citation counting measures have long been used by researchers, publishers and funding bodies to assess research quality and impact. However, due to inherent flaws, citation-based metrics alone may fail to capture the today's booming digital publishing activity. Citations can be heavily manipulated,

slow to accumulate, and overlook impact outside the academic sphere (3, 4).

A new class of metrics (3), viz. 'Web-based metrics for the impact of scholarly material with an emphasis on social media outlets as source of data' (5), has been recently developed to appraise scientific literature from a broader perspective. The main advantage of the so called altmetrics is that they can rapidly accrue, even during the first few hours or days after publication, measuring the real-time reach and influence of published research data. Altmetric services like Altmetric (www.altmetric.com), Impactstory (https://impactstory.org/) and Plum Analytics (http://www.plumanalytics.com) aggregate and analyse on demand mentions (i.e. views, likes, shares, comments, tweets, blog posts, bookmarks, saves, recommendations, etc.) of scientific outputs in social Web networks such as Facebook, Twitter, Wikipedia, blogs, news media, and reference management tools. By relating research impact and social skill (6), the implications of the scholarly work can be made apparent to the larger society, and not restricted to the academia.

The significance of the new metrics in capturing the online activity around scholarly literature is reflected on the inclusion of Altmetric badges in the electronic journals of leading academic publishers like BMJ, Elsevier, Oxford University Press, SAGE, Springer, Taylor & Francis Group and Wiley. In this way, readers are empowered to quickly filter the emerging scientific literature and identify articles that are receiving digital attention in a multitude of online sources (7). Moreover, these indicators offer research funders greater insight into the use and reuse of research both among academics and laypersons (8).

The growing reputation of altmetrics in recent years prompted several researchers to study traditional metrics in combination with altmetrics. Nonetheless, the results of these investigations have been so far inconclusive and conflicting. Whereas weak positive correlations between altmetric scores and citations were demonstrated in emergency medicine and organ transplantation (9, 10), other authors (11) reported no correlation. In this context, Thelwall and colleagues (12) found some evidence that mentions in specific Web platforms were associated with citation counts but could not further determine the size of correlation effect.

To date, the coverage of altmetrics in orthodontics, in other words, the online discussion triggered by articles published in specialty journals, has not been investigated. With respect to the dental literature, there have been merely two altmetric studies that reviewed articles published within 1-year period (13, 14). Therefore, the aims of this study were to identify the top altmetric orthodontic articles of all time, and to investigate altmetric scores in relation to publication details and citation counts.

Materials and methods

Search engine

Altmetric Explorer (Altmetric LLP, London, UK), a Web screening tool programmed to run altmetric analyses, was engaged for the purposes of the study. Compared to other concurrent providers, Altmetric database monitors more comprehensively online discussions surrounding research articles (15). It tracks the digital attention that research outputs receive by compiling data from three main sources: social media like Twitter, Facebook, Google+, Pinterest and blogs; traditional media—both mainstream (e.g. The Guardian, New York Times etc.) and science specific (e.g. New Scientist, Scientific American); and online reference managers like Mendeley and CiteULike (16). The Altmetric algorithm produces a weighted score, the Altmetric Attention Score (AAS), within a coloured wreath (Altmetric donut), which illustrates the type and amount of immediate attention received (Figure 1).

Search strategy

A systematic search was conducted on Altmetric Explorer on Friday, 27 January 2017, and was updated on 27 April 2017, for articles published in 11 orthodontic journals. The eight journals listed in 2015 Journal Citation Reports® (American Journal of Orthodontics & Dentofacial Orthopedics, Orthodontics & Craniofacial Research, The Angle Orthodontist, European Journal of Orthodontics, The Korean Journal of Orthodontics, Journal of Orofacial Orthopedics/Fortschritte der Kieferorthopädie, Australian Orthodontic Journal, Seminars in Orthodontics) were entered together with three other popular journals (Journal of Clinical Orthodontics, Journal of

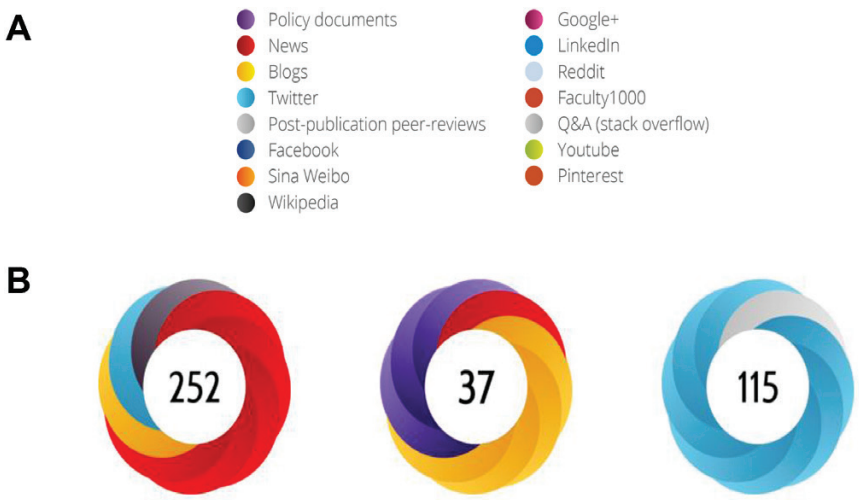

Figure 1. (A) Sources tracked by Altmetric Explorer. (B) Altmetric donut examples. The prevalence of red, yellow and light blue colors in the Altmetric donuts indicates that the research outputs received the most online attention from mainstream media, blogs and Twitter, respectively (starting from the left to the right). AAS is displayed in the center of each badge.

Orthodontics, and Progress in Orthodontics) in the 'Journal or Collection' filter of the 'Advanced Search' page (https://www.altmetric.com/explorer/outputs). To prevent possible data loss, former journal titles, e.g. American Journal of Orthodontics and British Journal of Orthodontics, were also typed. No time filters regarding publication and citation dates were activated to expand search results.

Data collection

Altmetric Explorer automatically generated a .csv file displaying AAS of orthodontic research outputs in descending order as well as the distribution of mentions in social media, traditional and science specific media and online reference managers. The data of the 200 articles with the highest AAS were transferred to an Excel spreadsheet (Microsoft, Richmond, Virginia, USA) and analyzed. Two researchers (CL and KD) screened simultaneously and extracted by consensus information regarding: (i) article title; (ii) journal title; (iii) time interval since publication, i.e. up to 1 year, >1 and ≤2 years, >2 and ≤5 years, >5 and ≤10 years, more than 10 years; (iv) number of authors and affiliations; (v) type of the affiliation of the corresponding author, i.e. university or other; (vi) origin of the article (as defined by the corresponding author), i.e. North America, Europe, Asia, South America, Africa, Oceania; (vii) article subject, i.e. oral health related quality of life (OHRQOL), biomaterials, diagnosis, treatment, growth, esthetics, practice management, socio-demographics, new technologies, periodontics/caries prevention, side effects, other; (viii) study type, i.e. original research, review or other; (ix) full text availability, i.e. free full text or subscription required; (x) funding, i.e. study funded or not. All reviewed articles were classified according to the abovementioned subcategories for each area of interest. Additionally, citation counts were harvested from Scopus (https://www.scopus.com/).

Statistical analysis

Statistical analysis was performed with IBM SPSS Statistics 20 (SPSS, Chicago, Illinois, USA). The Kruskal–Wallis H test was used to compare differences in AAS between the different research outputs as classified by journal, time since publication, number of authors and affiliations, affiliation of the corresponding author, origin, subject, study type, full text availability and funding. Spearman correlation coefficient (r) <0.3 was interpreted as poor, 0.3–0.5 as low, 0.5–0.7 as moderate, 0.7–0.9 as high and >0.9 as very high (16, 17). P <0.05 were considered statistically significant.

Results

Descriptive statistics (median, range) for AAS and distribution of articles per journal are summarized in Table 1. The reviewed orthodontic articles presented a median AAS of 8.0 (range: 5.0–196.0), and were mostly discussed by Mendeley readers (median: 16.6 references; range: 0–199.0). The best performing article (AAS: 196.0) drew attention mainly to news outlets and Mendeley users, as illustrated by the red coloured stripes in Figure 2. The top 200 orthodontic articles of all time according to altmetric.com are displayed in Supplementary Table 1.

American Journal of Orthodontics & Dentofacial Orthopedics appeared more frequently in the 200-article list (i.e. 73 articles), and together with European Journal of Orthodontics (60 articles) and The Angle Orthodontist (39 articles) contributed 86 per cent of the total number of publications (Table 1). One hundred eight-seven out of 200 articles derived from universities. Four authors (range: 1–21) and 2 departments (range: 1–21) were involved in the authorship of the articles. Regarding the origin of the corresponding author, Europe accounted for the 52 per cent of the analysed articles, followed by North America (49 articles), Asia (18 articles), and the rest of the world (19 articles). Free full-text was available in 92 articles, whereas subscription was required in 108 articles. Original research represented the most common article type (58%), while funding was reported in 73 articles. The most popular subjects were evaluation of treatment outcome, growth, side effects, and QHRQOL. Studies investigating socio-demographics had significantly higher AAS compared to diagnostic studies (median AAS: 19.0; range: 7.0–34.0; versus median AAS: 6.0; range: 5.0–10.0; Table 2, Figure 3). No significant differences were observed in AAS between articles regarding publication (date, journal, access), authorship (number of authors, affiliation and origin of the first author), and research (type, funding) (Figure 4). No correlation was observed between AAS and citations in Scopus (r = 0.09, P = 0.42).

Table 1. Summary statistics for Altmetric Attention Score (median, range) and number (N) of articles per journal.

		AAS	
Journal	N	Median	Range
AJODO/Am J Orthod	73	8.0	5.0–54.0
Angle Orthod	39	8.0	5.0–196.0
Eur J Orthod	60	8.0	5.0–34.0
J Orthod	12	8.0	5.0–15.0
Orthod Craniofac Res	10	7.5	5.0–15.0
Prog Orthod	5	9.0	6.0–13.0
Semin Orthod	1	46.0	—

AAS, Altmetric attention Score; AJODO/Am J Orthod, American Journal of Orthodontics & Dentofacial Orthopedics/American Journal of Orthodontics; Angle Orthod, The Angle Orthodontist; Eur J Orthod, European Journal of Orthodontics; J Orthod, Journal of Orthodontics; Orthod Craniofac Res, Orthod Craniofac Res; Prog Orthod, Progress in Orthodontics; Semin Orthod, Seminars in Orthodontics.

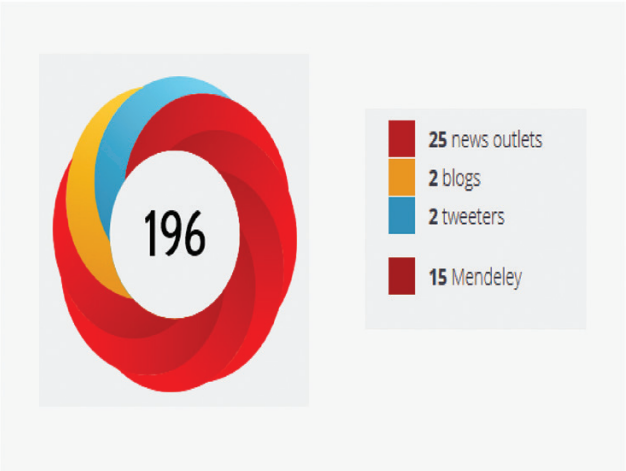

Figure 2. Altmetric donut of the highest scoring article illustrating the achieved Altmetric Attention Score and type and amount of online visibility.

Discussion

To the best knowledge of the authors, this is the first study to report on altmetrics in the orthodontic literature. So far, the only available

Table 2. Summary statistics for Altmetric Attention Score and number (*N*) of articles per subject.

		AAS	
Subject	*N*	Median	Range
OHRQOL	16	10.0	5.0–24.0
Biomaterials	14	7.0	5.0–24.0
Diagnosis	14	6.0	5.0–10.0
Treatment outcome	57	8.0	5.0–19.0
Growth	23	6.0	5.0–53.0
Esthetics	8	7.0	5.0–20.0
Practice management	12	8.5	5.0–25.0
Socio-demographics	8	19.0	7.0–34.0
New technologies	14	10.5	5.0–196.0
Periodontics/Caries prevention	15	8.0	5.0–19.0
Side-effects	16	8.0	5.0–41.0
Other	3	6.0	5.0–8.0

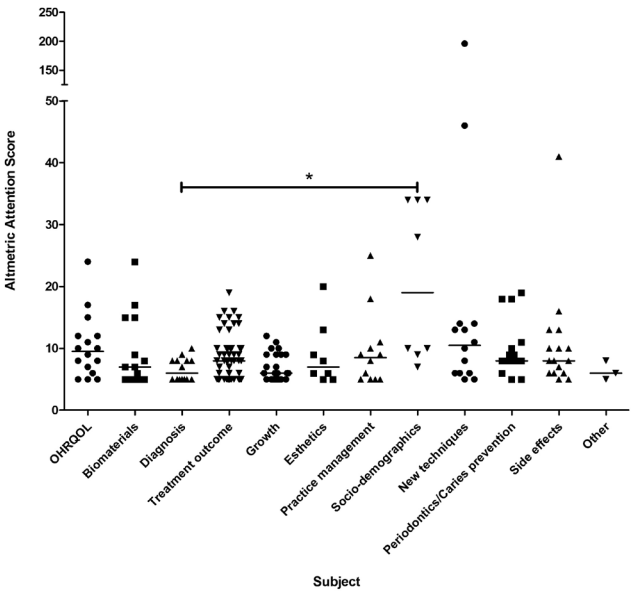

Figure 3. Distribution of Altmetric Attention Score in relation to article subjects. Horizontal lines indicate medians. $*P < 0.05$.

dental studies, published by the same group of authors (13, 14) described the characteristics of the top 50 articles according to Altmetric in 2014 and analysed the total of the 2015 literature without further investigating the association between publication details, traditional and new metrics.

The results of the present study showed that there was no significant correlation between AAS and Scopus citations. This is in agreement with the results of a large-scale study that processed research data that had been published during the last six decades (11). Contrary to our findings, others reported weak to moderate positive correlations between traditional and alternative metrics (9, 10, 12). However, there is mounting evidence to warn against the low coverage of altmetrics (11, 12). Additional variables like altmetric provider, publication year (6), number of analysed articles, and type of Web source (6, 18) need to be considered in translating the results. Differences in altmetric scores have been also described among disciplines (6, 11), and between specialty and non-specialty journals (10), and should be therefore taken into account when assessing new metrics. After all, it is essential to realize that altmetrics do not serve, at least currently, as a direct substitute for traditional bibliometric markers of scientific importance but as a complementary (7, 14, 19).

Articles dealing with topics of interest for both orthodontists and laypersons like treatment outcome, growth, OHRQOL and side effects were the most repeated but the corresponding AAS was not significantly higher than the rest topics. Research of the influence of socio-demographic variables on the prevalence of treatment need and uptake of orthodontic services had significantly higher visibility on Web networks. It is well established that malocclusion remains highly untreated in socially handicapped groups (for example, racial/ethnic minorities, immigrants from lower-income families and inhabitants of rural areas), resulting in a substantial oral health burden (20, 21). The social significance of studies on access to orthodontic care for minorities as well as government policymakers and healthcare administrators may account for the extensive online discussion around socio-demographics.

The highest AAS was ascribed to a randomized clinical trial that reported significantly less pain symptoms for orthodontic patients using a micropulse vibration device for 20 min daily for a 4-month period (22). The same device (AcceleDent®) was also clinically tested in the third-ranking study (23), which reported significantly increased tooth movement when vibration had been applied as an adjunct to orthodontic treatment. Interestingly enough, according to a third article on AcceleDent® (No 49 in the list, AAS: 10.0), no significant effects were observed on increasing anterior arch perimeter, or reducing irregularity or perceived discomfort during initial alignment with fixed appliances (24). Whereas the first two of the abovementioned articles were broadcasted through various news agencies (29 and 5 times, respectively), the last of the studies did not make a single news story. The eagerness of news channels to disseminate research reporting significant results resembles the previously reported preference of journals to publish statistically significant findings (25), and can be also explained by their perception of the importance of study observations.

Although time elapsed since publication appeared not to affect AAS, a widespread presence of relatively new literature was evident. Only seven per cent of the top 200 articles were published earlier than 20 years with the oldest one, dated from 1951, reviewing experimental studies on the effects of the physical consistency of food on the growth and development of jaws in rats (26). Despite 'classic' papers, like the 1983 article of Björk and Skieller (27) that had been cited so far 477 times, were also included, it can be assumed that users of social media tend to discuss and recommend online more recently published articles.

Another interesting finding of this study was the limited availability of the reviewed orthodontic journals in total in the top-200 ranking. Excluding American Journal of Orthodontics & Dentofacial Orthopedics, European Journal of Orthodontics and The Angle Orthodontist that supplied the 172 out of 200 research outputs, the rest of the journals either appeared occasionally or were completely unsuccessful to publish an article that triggered debate on social media. This lack of online interest for published research may point toward the need for the journals to adjust into the new digital publishing era or the need for the readership to be more active in spreading articles of interest. Interactive interfaces featured with social bookmarking tools, already embedded in the electronic pages of some journals (28), and broader involvement of online visitors, can change the way scholars communicate research data inside and outside the scientific community. Moreover, a more constructive online presence of orthodontic journals with public pages, accounts

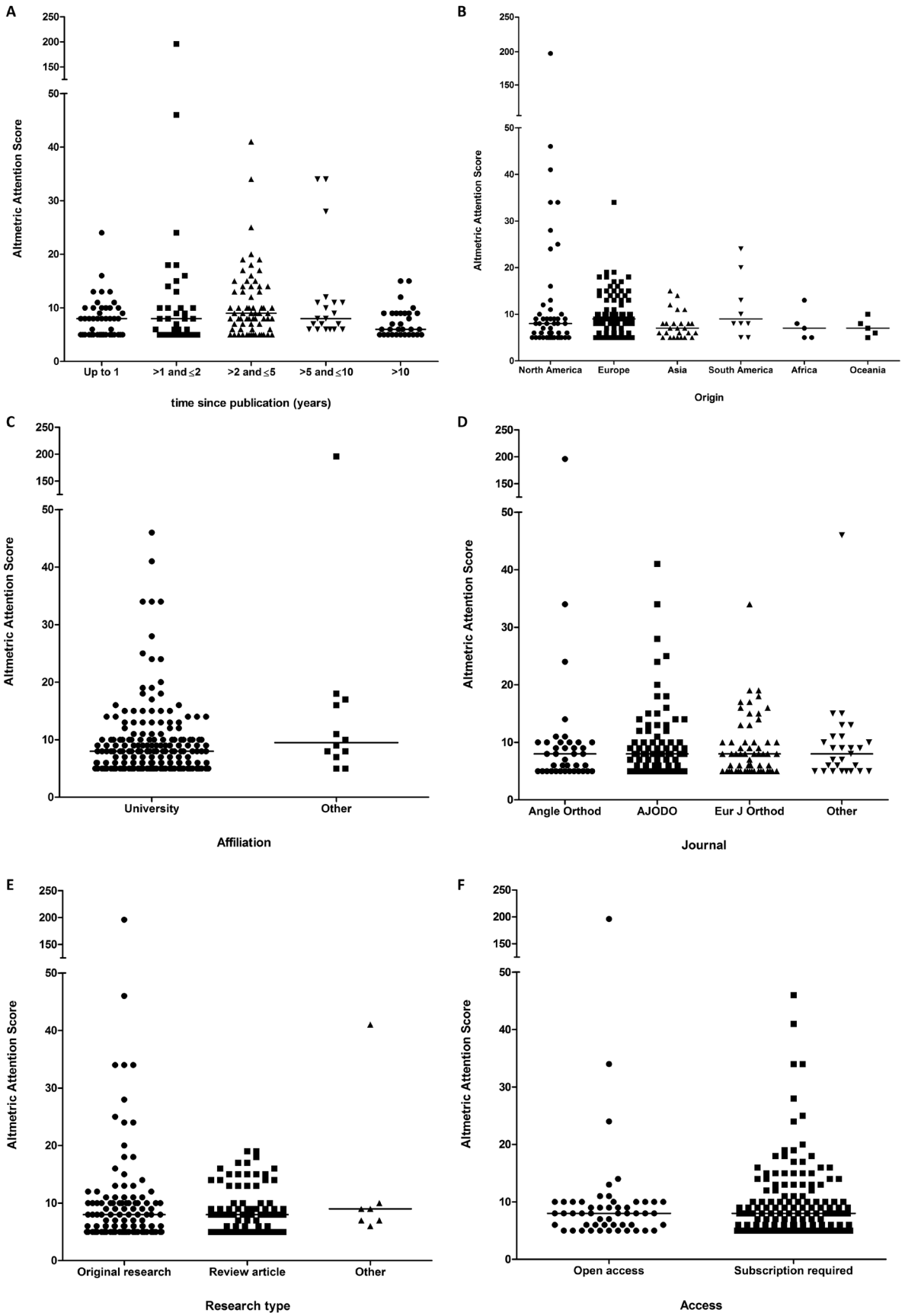

Figure 4. Distribution of Altmetric Attention Score in relation to (A) time since publication, (B) article origin, (C) author affiliation, (D) journal, (E) research type, and (F) full text availability. Horizontal lines indicate medians.

or channels in popular social networking sites, which will promote a more digestible explanation of research for the non-expert reader (29), can further facilitate the speed and ease of sharing information among non-scholars through the Web.

This study presents certain limitations related to the literature search, altmetric system and social media behaviours, and altmetrics as a whole. Given a considerable volume of orthodontic research work is published in non-specialty journals (30, 31), a number of published studies remained unexplored, and thus conclusions regarding the whole orthodontic literature cannot be made. Fluctuation of AAS over time as well as the ever-changing nature of social media need also to be acknowledged while comparing traditional and alternative metrics (12, 14). In addition, Altmetric Explorer cannot differentiate between positive and negative publicity in the score generation process. For example, a retracted article on grounds of dual publication (No 70 in the list, AAS: 9.0), had been bookmarked by 7 Mendeley readers and discussed negatively in a blog that tracks retractions (32). Even though the Altmetric algorithm controls score manipulation by disambiguating links to outputs and counting only one mention from each person per source (33), the initiatives of social media users that drive online discussions remain unclear. Differences in users' groups and attitudes between social media and disciplines (12, 34) should not be ignored when carrying out research on altmetrics. Last but not least, the relatively early stage of altmetrics calls for careful interpretation of the results. Most importantly, the new metrics should not be viewed as an indicator of research quality or replacement for informed peer review and citation-based metrics but as an additional tool for understanding the full impact of the research on the society.

Conclusions

- Online popularity is not significantly different between orthodontic articles that differ by publication, authorship and research characteristics other than subject.
- Socio-demographics studies appear to have significantly higher visibility on Web media.
- The online profile of orthodontic journals should be edited to facilitate spread of research information in non-scholar audiences.
- Despite their low coverage in orthodontics, altmetrics have the potential to measure the social impact of articles published in specialty journals, and should be therefore combined with traditional metrics for a more comprehensive assessment of research effects.

Supplementary material

Supplementary material is available at *European Journal of Orthodontics* online.

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Conflict of Interest

None declared.

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