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The relationship between citation-based metrics and Twitter in the area of age related macular degeneration research: Altmetric and bibliometric study

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Abstract

Purpose: The aim of this research is to analyze the bibliometric and altmetric scores of highly cited articles in the area of age related macular degeneration (AMD) research and to assess the correlations between them.

Material and methods: The data of publications in last decade were retrieved from the Web of Science Core Collection database using "age related macular degeneration" as a search term. The top 100 cited articles (T100) list was analyzed by author name, publication year, main topic, study type, journal name, journal impact factor (IF), H-index, total citation number (TCN), average citation per year (ACpY), Altmetric attention score (AAS), and number of tweets (NTs). VOSviewer software was utilized for visualization of bibliometric data.

Results: We discovered 16.984 articles in the last decade. The median values for TCN and AAS were 221 (IQR 178–380.75) and 13 (IQR 4-37.75), respectively in T100 list. The majority of the highly cited articles in AMD research have mainly focused on AMD treatment (n=34), especially anti-vascular endothelial growth factor therapy. However, social attention was primarily on the stem cell therapy. While AAS and NTs did not have significant correlation with TCN, they did show a significant positive correlation with ACpY. AAS and NTs showed significant positive correlation with journal IF and H-index.

Conclusion: Treatment for AMD is the most interested issue in the area. Stem cell therapies are popular on social media. The interest of social media is on articles that continue to be cited over the years rather than articles with high total citations.

Key words: altmetric attention score, altmetric, bibliometric, age related macular degeneration, Twitter

Introduction

Age related macular degeneration (AMD) is the main cause of blindness in persons over the age of 60 in developed countries [1]. The prevalence of AMD is 2% in people over the age of 50 and 25% in people over the age of 80 [2]. Early detection and follow-up of AMD, treatment planning, boosting public awareness, and enhancing communication between healthcare providers and patients are crucial.

Bibliometric analysis is a statistical tool for determining the worth and efficiency of a scientific article by counting the number of citations received since its publication [3]. Bibliometric analysis gives data on the most scientifically effective journals, authors, countries, important topics and keywords, as well as number of citations [4]. Map knowledge domain is a technique for graphing and visualizing bibliometric information in addition to doing co-occurrence assessment and identifying hotspots. It provides researchers information about research topics, new trends, and developing new study aspects [5]. While citation-based analyses are beneficial for determining the quality of articles, they have considerable limitations. A certain period of time must have passed since its publication that limits the rapid evaluation of an article's quality.

Altmetric, which has been using the effect of social media, has created a new score system for determining the impact of publications. Altmetric attention score (AAS) quantifies the impact value of articles shared, discussed, and viewed on Wikipedia, Mendeley, news, blogs, and social media platforms such as Twitter, Facebook, Pinterest [6-9].

By the beginning of 2021, the global number of daily active Twitter users reached 187 million, with an average of 500 million tweets every day [10]. Medical journals are also intending to boost the accessibility of their publications by posting them on their own Twitter accounts.

There have been no published research that investigate the relationships between altmetric analysis and bibliometric analysis including citation count, journal impact factor (IF), and H-index in the area of AMD research. The purpose of this study is to give bibliometric and altmetric summaries and visualizations of the AMD research. Additionally, we aimed to analyze the effect of Twitter on both metrics in terms of scientific information dissemination.

Material and methods

Study design

This retrospective clinical research has a level of evidence of three or group B under Scottish Intercollegiate Guidelines Network (SIGN) [11].

Compliance with ethical standards

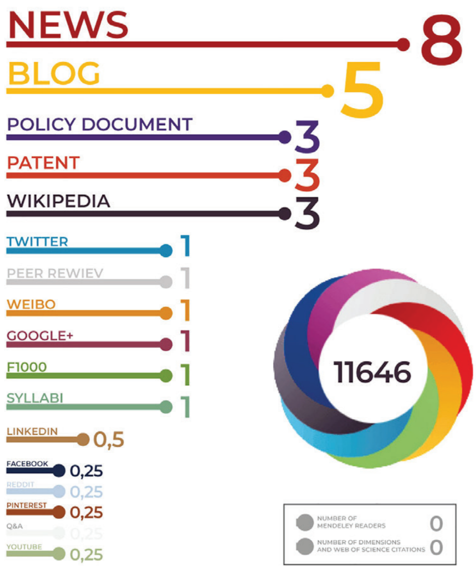
Each author confirms that the study was conducted in accordance with the Helsinki Declaration's Ethical Principles. There is no need for ethical approval for this investigation because it consists of existing publications related to AMD in the literature.

Data collection

The information was obtained from the Web of Science (WoS) Core Collection database (Philadelphia, Pennsylvania, United States) using "age related macular degeneration" as a search term (Date of access: April 3, 2021). The articles published between 2011 and 2021 years were selected. Full text articles were gathered and sorted according to the number of citations for each article [12]. All articles were thoroughly reviewed by each author and PubMed was used to obtain additional information about publications. The articles that were not relevant to AMD in the human health category were excluded. In the human health category, articles on the epidemiology, etiology, pathophysiology, histology, diagnosis, therapy, and prognosis of AMD were included. The articles were rated from top to lowest depending on the amount of citations, and the top-100 cited articles list (T100 list) was created with the agreement of all authors. The data was recorded into Microsoft Excel files and analyzed. The journals IF were registered based on the 2019 Clarivate Journal Citation Reports. The H-index and quartile (Q) scores of journals were determined using the 2020 Scimago Journal and Country Rank (SJCR). Study types and level of evidence were determined using SIGN [11]. All articles of T100 list were extensively evaluated and categorized by journal name, publication year, first author name, total citation number (TCN), average citation number per year (ACpY), study topic, study type, and level of evidence.

VOSviewer software version 1.6.16 was used to visualize the bibliometric statistics of T100 list (https://www.vosviewer.com). The data of top-100 cited articles was acquired from WoS in the “Full record and cited references” formats. A bibliometric coupling analysis was performed on all countries in the T100 list. Threshold value determined as 2 for co-occurrence keyword analysis. The findings of country coupling and keyword co-occurrence analyses were visualized on maps.

Figure 1-Altmetric donuts: Each color on the altmetric donut symbolizes a distinct source of attention. The weight score for posts of each social media platform is displayed.



The Altmetric.com website's "Altmetric it" tool was used to measure AAS of the T100 list. (https://www.altmetric.com/products/free-tools/bookmarklet/) (Date of access: April 3, 2021). AAS was computed by the process with a methodology defined as weighted average of all the attention that each paper received. Each color on the altmetric donut symbolizes a distinct area of attention (Figure 1). Additionally, the number of tweets (NTs) associated with each article was recorded.

Statistical analysis

IBM SPSS for windows version 23.0 (Statistical Package for Social Sciences, Chicago, Illinois, USA) was performed for the statistical analysis. Median and interquartile range (IQRs) were used to describe continuous variables, while percentages were used to define categorical variables. For intragroup and intergroup comparisons, the Mann-Whitney U and Kruskal Wallis tests were utilized. Sperman or Pearson correlation coefficients were used to analyze linear relationship between numerical variables. The correlation coefficients were assessed as follows: less than 0.4, weak; 0.4-0.6, moderate; 0.6-0.8, strong; and 0.81-1.00, very strong association [13]. A univariate linear regression analysis was performed to measure beta coefficients. When P was less than 0.05, statistical significance was assumed.

Results

We discovered 16.984 articles between 2011 and 2021 years using the phrase "age related macular degeneration" in our WoS search. The first author, publication year, TCN, and ACpY, AAS, and NTs for each article are displayed in T100 list, which was generated by sorting the top-100 articles based on TCN (Table 1). Although we did not specify the language option, all articles in the T100 list were written in English.

TCN and AAS analysis

The median values for TCN and AAS were 221 (IQR 178–380.75) and 13 (IQR 4-37.75), respectively in T100 list. The article with the highest TCN was Martin DF et al’s article entitled as "Ranibizumab and bevacizumab for neovascular age-related macular degeneration the CATT research group" and it

Table 1 Top-100 articles by metrics (T100 list)

Citation rank	Title	First author	Year	TCN	ACpY	AAS	NTs
1	Ranibizumab and bevacizumab for neovascular age-related macular degeneration the CATT research group	Martin D.F.	2011	1667	151.6	97	17
2	Global prevalence of age-related macular degeneration and disease burden projection for 2020 and 2040: a systematic review and meta-analysis	Wong W.L.	2014	1302	162.8	204	15
3	Intravitreal aflibercept (vegf trap-eye) in wet age-related macular degeneration	Heier J.S.	2012	1171	117.1	38	3
4	Ranibizumab and bevacizumab for treatment of neovascular age-related macular degeneration	Martin D. F.	2012	1090	109	49	15
5	Age-related macular degeneration	Lim L.S.	2012	899	89.9	56	9
6	Embryonic stem cell trials for macular degeneration: a preliminary report	Schwartz S.D.	2012	890	89	318	119
7	Global causes of blindness and distance vision impairment 1990-2020: a systematic review and meta-analysis	Flaxman S.R.	2017	659	131.8	614	81
8	Identifying medical diagnoses and treatable diseases by image-based deep learning	Kermany D.S.	2018	622	155.5	371	175
9	Human embryonic stem cell-derived retinal pigment epithelium in patients with age-related macular degeneration and Stargardt's macular dystrophy: follow-up of two open-label phase 1/2 studies	Schwartz S.D.	2015	613	87.57	423	92
10	Clinical classification of age-related macular degeneration	Ferris F.L.	2013	570	63.33	74	0
11	Lutein plus zeaxanthin and omega-3 fatty acids for age-related macular degeneration the age-related eye disease study 2 (AREDS2) randomized clinical trial	Chew E.Y.	2013	533	59.22	247	77
12	Ranibizumab versus bevacizumab to treat neovascular age-related macular degeneration	Chakravarthy U.	2012	522	52.2	21	8
13	Seven new loci associated with age-related macular degeneration	Fritsche L.G.	2013	514	57.11	89	28
14	Seven-year outcomes in ranibizumab-treated patients in ANCHOR, MARINA, and HORIZON	Rofagha S.	2013	512	56.89	8	2
15	Autologous ınduced stem-cell-derived retinal cells for macular degeneration	Mandai M.	2017	507	101.4	793	247
16	A large genome-wide association study of age-related macular degeneration highlights contributions of rare and common variants	Fritsche L.G.	2016	495	82.5	195	57
17	The pivotal role of the complement system in aging and age-related macular degeneration: hypothesis re-visited	Anderson D.H.	2010	472	39.33	15	0
18	Development and validation of a deep learning system for diabetic retinopathy and related eye diseases using retinal images from multiethnic populations with diabetes	Ting D.S.W.	2017	469	93.8	289	328
19	Understanding age-related macular degeneration (AMD): relationships between the photoreceptor/retinal pigment epithelium/bruch's membrane/choriocapillaris complex	Bhutto I.	2012	463	46.3	4	1
20	Quantitative optical coherence tomography angiography of choroidal neovascularization in age-related macular degeneration	Jia Y.	2014	456	57	16	1
21	Alternative treatments to inhibit vegf in age-related choroidal neovascularisation: 2-year findings of the IVAN randomised controlled trial	Chakravarthy U.	2013	440	48.89	115	34
22	Mechanisms of age-related macular degeneration	Ambati J.	2012	429	42.9	28	7
23	Intravitreal aflibercept injection for neovascular age-related macular degeneration ninety-six-week results of the VIEW studies	Schmidt-Erfurth U.	2014	425	53.13	14	0
24	Choroidal thickness in polypoidal choroidal vasculopathy and exudative age-related macular degeneration	Chung S.E.	2011	381	34.64	3	0
25	DICER1 deficit induces ALU RNA toxicity in age-related macular degeneration	Kaneko H.	2011	381	34.64	43	0
26	Clinical risk factors for age-related macular degeneration: a systematic review and meta-analysis	Chakravarthy U.	2010	380	31.67	3	0
27	Genetic variants near TIMP3 and high-density lipoprotein-associated loci influence susceptibility to age-related macular degeneration	Chen W.	2010	373	31.08	33	1
28	DICER1 loss and ALU RNA ınduce age-related macular degeneration via the NLRP3 inflammasome and MYD88	Tarallo V.	2012	348	34.8	23	15
29	Prevalence of age-related macular degeneration in the US population	Klein R.	2011	321	29.18	22	0
30	Risk of geographic atrophy in the comparison of age-related macular degeneration treatments trials	Grunwald J.E.	2014	311	38.88	4	0
31	Immunology of age-related macular degeneration	Ambati J.	2013	307	34.11	15	8
32	Genome-wide association study of advanced age-related macular degeneration identifies a role of the hepatic lipase gene (LIPC)	Neale B.M.	2010	307	25.58	18	0
33	Consequences of oxidative stress in age-related macular degeneration	Jarrett S.G.	2012	275	27.5	11	2

34	Five-year outcomes with anti-vascular endothelial growth factor treatment of neovascular age-related macular degeneration the comparison of age-related macular degeneration treatments trials	Maguire M.G.	2016	268	44.67	952	28
35	The prevalence of age-related macular degeneration in Asians a systematic review and meta-analysis	Kawasaki R.	2010	265	22.08	1	1
36	Twelve-month efficacy and safety of 0.5 mg or 2.0 mg ranibizumab in patients with subfoveal neovascular age-related macular degeneration	Busbee B.G.	2013	263	29.22	7	0
37	Safety and efficacy of a flexible dosing regimen of ranibizumab in neovascular age-related macular degeneration: the SUSTAIN study	Holz F.G.	2011	263	23.91	9	0
38	Reticular pseudodrusen are subretinal drusenoid deposits	Zweifel S.A.	2010	259	21.58	3	0
39	Regulation of angiogenesis and choroidal neovascularization by members of microrna-23 similar to 27 similar to 24 clusters	Zhou Q.	2011	254	23.09	13	1
40	Efficacy and safety of monthly versus quarterly ranibizumab treatment in neovascular age-related macular degeneration: the EXCITE study	Schmidt-Erfurth U.	2011	254	23.09	14	1
41	Multi-country real-life experience of anti-vascular endothelial growth factor therapy for wet age-related macular degeneration	Holz F.G.	2015	246	35.14	12	7
42	NLRP3 has a protective role in age-related macular degeneration through the induction of IL-18 by drusen components	Doyle S.L.	2012	243	24.3	12	7
43	Polypoidal choroidal vasculopathy and neovascular age-related macular degeneration: same or different disease?	Laude A.	2010	238	19.83	0	0
44	Spectral-domain optical coherence tomography angiography of choroidal neovascularization	de Carlo T.E.	2015	232	33.14	13	5
45	Do we need a new classification for choroidal neovascularization in age-related macular degeneration?	Freund K.B.	2010	230	19.17	1	0
46	Age-related macular degeneration: genetics and biology coming together	Fritsche L.G.	2014	226	28.25	31	2
47	HORIZON: an open-label extension trial of ranibizumab for choroidal neovascularization secondary to age-related macular degeneration	Singer M.A.	2012	226	22.6	16	2
48	Ranibizumab (lucentis) in neovascular age-related macular degeneration: evidence from clinical trials	Mitchell P.	2010	224	18.67	7	1
49	Inflammation and its role in age-related macular degeneration	Kauppinen A.	2016	223	37.17	7	4
50	Subfoveal choroidal thickness in typical age-related macular degeneration and polypoidal choroidal vasculopathy	Koizumi H.	2011	223	20.27	0	0
51	Guidelines for the management of neovascular age-related macular degeneration by the european society of retina specialists (EURETINA)	Schmidt-Erfurth U.	2014	219	27.38	124	21
52	Subretınal drusenoıd deposıts in non-neovascular age-related macular degeneratıon morphology, prevalence, topography, and biogenesis model	Curcio C.A.	2013	218	24.22	13	0
53	A rare penetrant mutation in CFH confers high risk of age-related macular degeneration	Raychaudhuri S.	2011	212	19.27	30	8
54	Automatic segmentation of nine retinal layer boundaries in OCT images of non-exudative AMD patients using deep learning and graph search	Fang L.	2017	211	42.2	4	1
55	Choriocapillaris vascular dropout related to density of drusen in human eyes with early age-related macular degeneration	Mullins R.E.	2011	203	18.45	0	0
56	Comparıson of choroıdal thıckness among patıents wıth healthy eyes, early age-related maculopathy, neovascular age-related macular degeneratıon, central serous chorıoretınopathy, and polypoıdal choroıdal vasculopathy	Kim S.W.	2011	199	18.09	3	0
57	Comparison of ranibizumab and bevacizumab for neovascular age-related macular degeneration according to lucas treat-and-extend protocol	Berg K.	2015	198	28.29	4	2
58	A treat and extend regimen using ranibizumab for neovascular age-related macular degeneration clinical and economic impact	Gupta O.P.	2010	197	16.42	1	0
59	Dysregulated autophagy in the RPE is associated with increased susceptibility to oxidative stress and AMD	Mitter S.K.	2014	194	24.25	0	0
60	Prevalence and significance of subretinal drusenoid deposits (reticular pseudodrusen) in age-related macular degeneration	Zweifel S.A.	2010	193	16.08	3	0
61	Optical coherence tomography angiography of type 1 neovascularization in age-related macular degeneration	Kuehlewein L.	2015	189	27	1	1
62	Rare variants in CFI. C3 and C9 are associated with high risk of advanced age-related macular degeneration	Seddon J.M.	2013	189	21	23	8
63	Secondary analyses of the effects of lutein/zeaxanthin on age-related macular degeneration progression AREDS2 report no. 3	Chew E.Y.	2014	188	23.5	37	17
64	Anti-vascular endothelial growth factor for neovascular age-related macular degeneration	Solomon S.D.	2014	188	23.5	14	5
65	The oil spill in ageing bruch membrane	Curcio C.A.	2011	187	17	8	2

66	Autophagy and heterophagy dysregulation leads to retinal pigment epithelium dysfunction and development of age-related macular degeneration	Kaarniranta K.	2013	186	20.67	1	2
67	Molecular pathogenesis of retinal and choroidal vascular diseases	Campochiaro P. A.	2015	182	26	7	1
68	Systemic pharmacokinetics following intravitreal injections of ranibizumab, bevacizumab or aflibercept in patients with neovascular AMD	Avery R.L.	2014	182	22.75	14	5
69	The prevalence of age-related macular degeneration and associated risk factors	Klein R.	2010	182	15.17	0	0
70	Geographic atrophy clinical features and potential therapeutic approaches	Holz F.G.	2014	181	22.63	13	1
71	Randomized, double-masked, sham-controlled trial of ranibizumab for neovascular age-related macular degeneration: PIER study year 2	Abraham P.	2010	181	15.08	3	0
72	The estimated prevalence and incidence of late stage age related macular degeneration in the UK	Owen C.G.	2012	180	18	24	2
73	Ciliary neurotrophic factor delivered by encapsulated cell intraocular implants for treatment of geographic atrophy in age-related macular degeneration	Zhang K.	2011	180	16.36	0	0
74	Treatment of macular degeneration using embryonic stem cell-derived retinal pigment epithelium: preliminary results in Asian patients	Song W.K.	2015	179	25.57	111	69
75	The impact of oxidative stress and inflammation on RPE degeneration in non-neovascular AMD	Datta S.	2017	178	35.6	3	0
76	Baseline predictors for one-year visual outcomes with ranibizumab or bevacizumab for neovascular age-related macular degeneration	Ying G.	2013	178	19.78	10	1
77	Animal models of age related macular degeneration	Pennesi M.E.	2012	178	17.8	6	0
78	Age-related macular degeneration	Mitchell P.	2018	177	44.25	50	84
79	Common variants near FRK/COL10A1 and vegfa are associated with advanced age-related macular degeneration	Yu Y.	2011	177	16.09	8	2
80	Dietary sources of lutein and zeaxanthin carotenoids and their role in eye health	Abdel A.	2013	176	19.56	189	14
81	Incidence of legal blindness from age-related macular degeneration in Denmark: year 2000 to 2010	Bloch S.B.	2012	176	17.6	30	23
82	Lutein, zeaxanthin, and meso-zeaxanthin: the basic and clinical science underlying carotenoid-based nutritional interventions against ocular disease	Bernstein P.	2016	175	29.17	158	10
83	Abundant lipid and protein components of drusen	Wang L.	2010	175	14.58	0	0
84	Aflibercept therapy for exudative age-related macular degeneration resistant to bevacizumab and ranibizumab	Bakall B.	2013	174	19.33	24	0
85	Lutein: more than just a filter for blue light	Kijlstra A.	2012	174	17.4	12	9
86	Analysis of choroidal thickness in age-related macular degeneration using spectral-domain optical coherence tomography	Manjunath V.	2011	174	15.82	1	1
87	Characteristics of patients losing vision after 2 years of monthly dosing in the phase III ranibizumab clinical trials	Rosenfeld P.J.	2011	174	15.82	0	0
88	Mechanisms of age-related macular degeneration and therapeutic opportunities	Campagne M.L.	2014	171	21.38	611	2
89	Blood-retinal barrier	Cunha-Vaz J.	2011	169	15.36	9	0
90	The prevalence of age-related eye diseases and visual İmpairment in aging: current estimates	Klein R.	2013	168	18.67	4	1
91	The neovascular age-related macular degeneration database: multicenter study of 92 976 ranibizumab injections	Tufail A.	2014	167	20.88	7	2
92	Phase 1 clinical study of an embryonic stem cell-derived retinal pigment epithelium patch in age-related macular degeneration	da Cruz L.	2018	166	41.5	1420	523
93	Age-related retinopathy in NRF2-deficient mice	Zhao Z.	2011	166	15.09	4	1
94	Parallel findings in age-related macular degeneration and Alzheimer's disease	Ohno-Matsui K.	2011	164	14.91	6	0
95	Stem cells in retinal regeneration: past. present and future	Ramsden C.M.	2013	162	18	30	16
96	Ranibizumab versus bevacizumab for neovascular age-related macular degeneration: results from the gefal noninferiority randomized trial	Kodjikian L.	2013	158	17.56	26	3
97	Laser-induced choroidal neovascularization model to study age-related macular degeneration in mice	Lambert V.	2013	158	17.56	6	0
98	Age and gender variations in age-related macular degeneration prevalence in populations of European ancestry: a meta-analysis	Rudnicka A.R.	2012	157	15.7	1	1
99	Twenty-four-month efficacy and safety of 0.5 mg or 2.0 mg ranibizumab in patients with subfoveal neovascular age-related macular degeneration	Ho A.C.	2014	156	19.5	20	2
100	Ultrahigh-speed swept-source OCT angiography in exudative AMD	Moult E.	2014	156	19.5	4	2

TCN: total citation number; ACpY: average citation per year; AAS: altmetric attention score; NTs: number of tweets.

Table 2 Journals of the Top-100 cited articles according to the number of articles

Journal name	Number of articles	IF*	Q category**	H Index**
Ophthalmology	27	8	1	229
Progress In Retinal And Eye Research	7	15	1	141
British Journal Of Ophthalmology	6	4	1	146
American Journal Of Ophthalmology	5	4	1	179
Lancet	5	60	1	747
Nature Genetics	4	28	1	550
Proceedings Of The National Academy Of Sciences Of The United States Of America	4	9	1	737
Molecular Aspects Of Medicine	3	10	1	128
Retina-The Journal Of Retinal And Vitreous Diseases	3	3	1	105
Jama Ophthalmology (Formerly Known As Archives Of Ophthalmology)	3	6	1	190
Autophagy	2	10	1	135
Cell	2	39	1	747
Investigative Ophthalmology & Visual Science	2	1	1	209
Jama-Journal Of The American Medical Association	2	46	1	654
Lancet Global Health	2	22	1	72
New England Journal Of Medicine	2	75	1	987
Plos One	2	3	1	300
Annual Review Of Genomics And Human Genetics	1	7	1	112
Biomedical Optics Express	1	4	1	76
Bmc Ophthalmology	1	1	2	39
Cellular And Molecular Life Sciences	1	6	1	210
Cochrane Database Of Systematic Reviews	1	8	1	261
Development	1	6	1	315
European Journal Of Ophthalmology	1	2	2	51
Graefes Archive For Clinical And Experimental Ophthalmology	1	2	1	96
Human Molecular Genetics	1	5	1	269
Journal Of Pathology	1	6	1	176
Nature	1	43	1	1159
Nature Biotechnology	1	37	1	426
Nature Medicine	1	36	1	524
Nature Protocols	1	10	1	230
Nature Reviews Immunology	1	40	1	371
Neuron	1	14	1	453
Nutrients	1	1	1	93
Ophthalmic Surgery Lasers & Imaging Retina	1	1	2	55
Stem Cell Reports	1	6	1	65

IF: Impact Factor
*: 2019 Clarivate Journal Citation Reports
**: 2020 Scimago Journal and Country Rank

Table 3 Comparison of AAS and TCN of the Top-100 cited articles according to the study types

Study Type-Subtype	Article Number	Level of Evidence**	AAS, median (IQR)	p*	TCN, median (IQR)	p*
Original Scientific Paper	**72**			0.278		0.549
Prospective Randomized Clinical Trial	20	1	20 (8-49)		254 (180-522)	
Meta-analysis	9					
Systematic Review	1					
Experimental Animal and/or Post-mortem Study	9	2	13 (4-89)		212 (174-469)	
Prospective Cohort Study	3					
Prospective Comparative Study	10					
Retrospective Comparative Study	5					
Prospective Descriptive Study	3	3	8 (2-19)		220,5 (191-290)	
Retrospective Descriptive Study	3					
Cross-Sectional Study	2					
Case Series	7					
Guideline and Advisory Documents	**1**	4	12 (6-30,5)		206,5 (176,5-291)	
Review	**25**					
Review-Seminar	**2**					

AAS: altmetric attention score; TCN: total citation number
*Kruskal-Wallis Test; p<0.05 significant
**Scottish Intercollegiate Guidelines Network (SIGN)

Table 4 Comparison of TCN and AAS of the Top-100 cited articles based on main topic categories

Main topic	Number of articles	TCN, median (IQR)	AAS, median (IQR)
The whole article	**100**	**221 (178-380,75)**	**13 (4-37,75)**
Treatment	**34**	**225 (179-577)**	**18 (8-97)**
Anti-VEGF injection	25		
Treatment outcome; efficacy and safety	4		
Treatment regimens and outcome; efficacy, safety	15		
Treatment outcome and prognostic features	3		
Switch protocol and treatment outcome	2		
Pharmacokinetics and systemic exposure	1		
Drug implant	*1*		
Retinal stem cell transplantation	*6*		
Dietary Supplements	*2*		
Diagnosis and image analyses	**13**	211 (189-381)	4 (3-13)
Medical image analyses	10		
OCT	4		
OCT-angiography	3		
OCT, FFA, FAF, fundus photo	3		
Artificial intelligence analyses	3		
OCT	2		
Fundus photo	1		
Pathophysiology	**12**	233 (186,5-368)	7,5 (3,5-13,5)
Immunological process	1		
Immunological and inflammatory process	4		
Oxidative stress	2		
Oxidative stress and inflammatory process	2		
Oxidative stress and immunological process	1		
Oxidative stress, inflammatory and immunological process	2		
Pathophysiology and genetics	**12**	**280,5 (205,5-377)**	**26,5 (15,5-38)**
Epidemiology	**10**	**210 (176-321)**	**13 (1-30)**
Histopathology	**6**	**189 (164-218)**	**4,5 (0-6)**
Molecular mechanisms of antioxidant molecules	**3**	**175 (174-176)**	**158 (12-189)**
Pathophysiology and treatment	**3**	**177 (171-899)**	**56 (50-611)**
Classification and staging	**2**	**400 (230-570)**	**37,5 (1-74)**
Prognostic features	**2**	**345,5 (311-380)**	**3,5 (3-4)**
Pathophysiology, diagnosis and image analyses	**1**	**169 (169-169)**	**9 (9-9)**
Histopathology and molecular mechanisms	**1**	**178 (178-178)**	**6 (6-6)**
Diagnosis and therapeutic management	**1**	**219 (219-219)**	**124 (124-124)**

TCN: total citation number, AAS: altmetric attention score, VEGF: vascular endothelial growth factor, OCT: optic coherence tomography, FFA: fundus fluorescein angiography, FAF: fundus autofloresans.

Table 5 Correlation analysis

		TCN	ACpY	NTs	IF	H-index	Q category
AAS	r	0.162	0.382**	0.779**	0.394**	0.238*	-0.066
	p	0.107	0.001	0.001	0.001	0.017	0.512
TCN	r	1	0.889**	0.131	0.516**	0.403**	-0.060
	p		0.001	0.195	0.001	0.001	0.552
ACpY	r		1	0.373**	0.602**	0.389**	-0.086
	p			0.001	0.001	0.001	0.394
NTs	r			1	0.497**	0.351**	-0.055
	p				0.001	0.001	0.585
IF	r				1	0.801**	-0.141
	p					0.001	0.162
H-index	r					1	-0.185
	p						0.065

AAS: altmetric attention score; TCN: total citation number; ACpY: average citation per year; NTs: number of tweets; IF: journal impact factor.
Impact factor: 2019 Clarivate Journal Citation Reports; H index: 2020 Scimago Journal and Country Rank.
**Correlation is significant at the 0.01 level
*Correlation is significant at the 0.05 level
r was obtained from Spearman rank or Pearson correlation coefficient.

was published in 2011 with a TCN of 1667 [14]. There were only eight articles in the T100 list that did not have AAS yet. The article with the highest AAS with 1420 in the T100 list was Cruz L et al's article, which was entitled as "Phase 1 clinical study of an embryonic stem cell-derived retinal pigment epithelium patch in age-related macular degeneration", and it was published in 2018 [15]. Also this article had the highest NTs in accordance with the highest AAS.

Twitter analysis

It was discovered that 68 articles of the T100 list were shared on Twitter. Five of the top-10 articles with the highest NTs dealt with stem cell treatment in AMD; two of them dealt with diagnostic image analyses using artificial intelligence techniques.

Journal perspective

The journal of Ophthalmology published most articles, with 27, among the T100 list's 36 journals (Table 2). The most cited article was from New England Journal of Medicine, which had the greatest IF among T100 journals. The second most cited article was from the journal of Lancet Global Health. The article with the highest AAS was published in the journal of Nature Biotechnology. According to SJCR, all journals received Q1 scores, with the exception of three journals which received Q2 scores.

Article types

According to SIGN, 72 articles of the T100 list represented original scientific research (Table 3). When all publications were categorized by their degree of evidence, there was no statistically significant difference in the median AAS of the four groups. (p=0.278). Similarly, there was no significant difference in the median TCN across the four groups (p=0.549). The level of evidence had no significant effect on the AAS and TCN of the articles, according to these results.

Research subjects

The bulk of publications on the T100 list were about treatment (n=34), followed by diagnosis and image analysis (n=13), pathophysiology (n=12), and pathophysiology and genetics (n=12) (Table 4). But the main subject with the greatest median AAS was molecular mechanisms of antioxidant molecules, with a value of 158 (12-189). The main subject with the greatest median TCN was classification and staging, with a value of 400 (230-570).

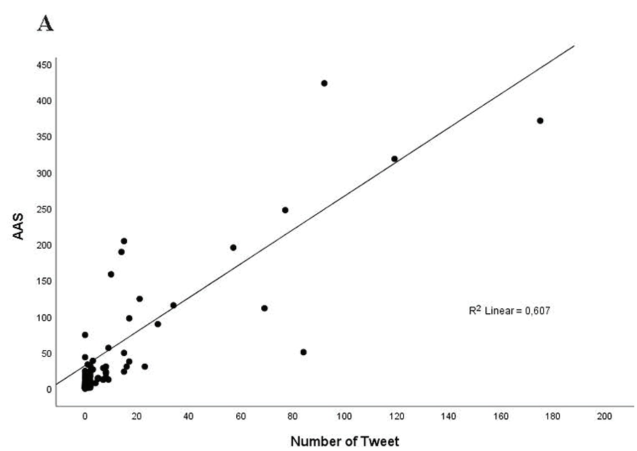
Correlation analysis

The correlation analysis findings are shown in Table 5 and Figure 2. While AAS and NTs did not have a significant correlation with TCN (r values were 0.162 and 0.131, p values were 0.107 and 0.195, respectively), they did show a weak positive correlation with ACpY (r values were 0.382 and 0.373, p values were 0.001 and 0.001, respectively). Notably, AAS had a weak positive correlation with journal IF, but NTs had a moderate positive correlation with journal IF (r values were 0.394 and 0.497, p values were 0.001 and 0.001, respectively). Additionally, both AAS and NTs showed weak positive correlation with H-index (r values were 0.238 and 0.351, p values were 0.017 and 0.001, respectively). It is worth noting that, although NTs did not correlate with TCN, they did have a moderate positive linkage with journal IF.

Visualization analysis

The total strength of bibliographic coupling relationships with other nations was estimated and presented for each of the 37 countries in the T100 list (Figure 3A). Countries with large nodes are more efficient and productive. The thickness and distance of links between nodes represent the level of communication and cooperation among countries. The United States was the most productive and impressive country regarding the total amount of documents (76 documents), TCN received (26758 citations), and international cooperation (24677 link strength).

Figure 2-Scatter plot of relationship between Altmetric Attention Score (AAS) and Number of tweets (Figure 2A), relationship between AAS and total citation number (Figure 2B) Figure 2A: There was strong positive correlation between Altmetrıc Attentıon Score and Number of Tweet (r=0.779; p=0.001). According to univariate linear regression analysis ~61% of variation in Altmetrıc Attentıon Score was explained by Number of Tweet. 1 unit increase in Tweet resulted in 2.36 increase in Altmetrıc Attentıon Score model to estimate Altmetrıc Attentıon Score was YAltmetrıc Attentıon Score = 31.40+2.36*X Number of Tweet Figure 2B: There was weak positive correlation between Altmetrıc Attentıon Score and Average citation pear year cite (r=0.382; p=0.001). According to univariate linear regression analysis ~15% of variation in Altmetrıc Attentıon Score was explained by Average citation pear year cite. 1 unit increase in Average citation pear year cite resulted in 2.51 increase in Altmetrıc Attentıon Score model to estimate Altmetrıc Attentıon Score was YAltmetrıc Attentıon Score = -10.54+2.51*X Average per Year Citation



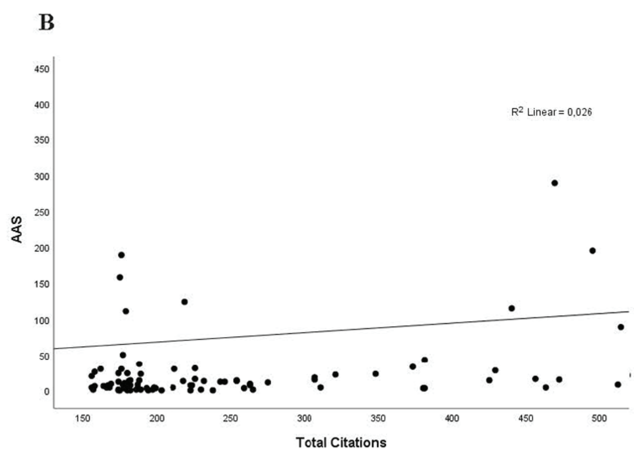
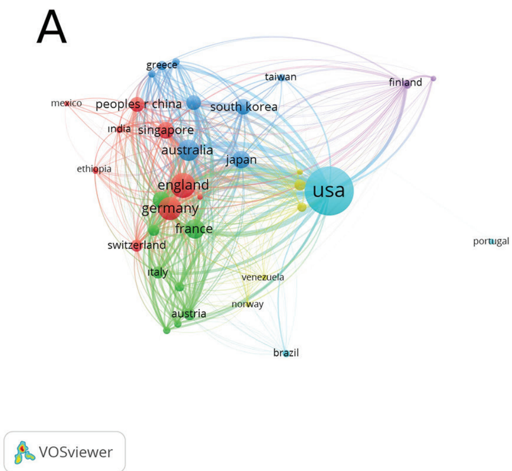
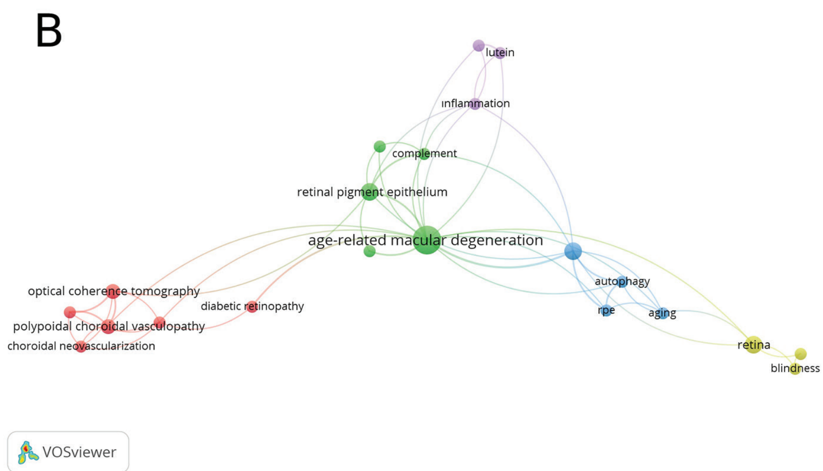


Figure 3-Network visualization maps of age related macular degeneration research The strength of bibliographic country coupling linkages is displayed in Figure 3A. The co-occurrence analysis of high-frequency keywords is displayed in Figure 3B.





The United States was followed by England, Germany, Australia, France, Japan, Singapore, Netherlands, South Korea, and North Ireland, respectively TCN of top-10 countries were 26758, 7882, 7549, 5360, 4379, 4214, 4903, 3001, 2762, and 3098, respectively.

The hotspots of AMD research were discovered with a co-occurrence analysis of frequently used keywords. The minimal number of keyword co-occurrences criteria was chosen to be 2.The criteria was met by 21 of the 129 retrieved keywords related to AMD. The system was used to cluster relevant keywords, and the five major clusters were represented by the colors red, green, blue, yellow, and purple, respectively (Figure 3B). The most prevalent keywords were "age-related macular degeneration" and "oxidative stress".

Discussion

We compared bibliometric analyses to altmetric analyses of the highly cited articles in the field of AMD research in the current study. While there was no relationship between AAS and TCN, a significant correlation between AAS and ACpY was discovered. Additionally, we found a significant correlation between AAS and journal IF and H-index. We noticed that the majority of the highly cited articles in the field of AMD research in the last decade have mainly focused on AMD treatment, especially anti-vascular endothelial growth factor (anti-VEGF) therapy.

While traditional bibliometric analyses are useful for assessing the impact value of scientific articles, they have significant disadvantages. A specific amount of time must pass before the measurement of citation metrics of the published article. Therefore it is not possible to evaluate the impact of a recently published article by bibliometric analysis in its earliest years. It causes difficulty for researchers to find impressive articles, keep track of fresh study subjects, and come up with new research areas. Additionally, the reason of citing the articles is unclear. The possibility of referring highly cited articles is usually raised [6]. Furthermore, citation quantities may be influenced unfairly because of self-citation or citation of relevant authors' articles. Therefore a new technique to quickly evaluate the quality and impact value of articles is needed. This is the first research that we are aware of that evaluated articles with both bibliometric and altmetric analysis in the field of AMD research. While AAS and NTs had no significant correlation with TCN (r values of 0,162 and 0,132, respectively), they did have weak positive correlation with ACpY (r values of 0,382 and 0,373, respectively). This indicates that articles which have been cited regularly over the years and remain actual are more valuable on social media and Twitter. NTs can be used as a valuable indicator for predicting the early period impact values of articles.

While AAS and NTs did not correlate with TCN, AAS did show a weak positive correlation with journal IF, and also TCN showed a moderate positive correlation with journal IF as well. This issue may be explained by the fact that AAS and NTs were positively correlated with ACpY. Journal IF is influenced by citations received in recent years. Articles which continue to be debated receive a greater amount of attention on Twitter. Another explanation could be that journals which have had their own Twitter accounts for a long time have more followers. As the number of social media followers increases, the awareness of the journals and accessing their articles also increase. It was revealed that tweeting about recently published articles increases the number of citations in following years [16-18]. It was found that medical journals with Twitter profiles have greater IF, and that there is a positive association between journal IF and the amount of Twitter account followers [19-21].

Kolahi et al. discovered a statistically significant positive correlation between AAS and TCN in their study [22]. He added that the intensity of this association will rise in the future due to the growth of social media. Gargovich et al. found an increasing positive correlation between AAS and TCN in their altmetric study in the field of pediatric dentistry investigation between 2014 and 2017 [23]. Suzan et al. also revealed a statistically significant positive correlation between AAS and TCN, ACpY, journal IF, and H-index in their altmetric study on malnutrition research [24]. However, Haustein et al. discovered relatively weak correlation between NTs and TCN [25]. Thelwall, a social media analyst with more than a hundred researches on metrics, claimed that there is a negative correlation between NTs and TCN because of long duration which is needed for citation, unlike quick sharing on Twitter [26]. We found both AAS and NTs to have positive correlation with ACpY, journal IF, and H-index. These findings reveal that altmetric and bibliometric parameters are generally compatible and correlated with each other. In accordance with Thelwall, AAS and NTs were not correlated with TCN in our study. We discovered that ACpY is a more important indication than TCN for AAS and NTs. Social media users pay more attention to the articles which continue to be discussed and are current. In addition to this, articles with older publication years usually have higher TCN because of the accumulation of citations. Due to the fact that social media usage was not widespread in the early years of the last decade, AAS of articles with older publication years may be low. This could also explain why there was no significant association between AAS and TCN in our study.

Seventy two articles of the T100 list articles were original scientific research. Twenty of these articles were randomized clinical trials, and ten of these articles were meta-analyses and systematic reviews with a level of evidence of 1 according to SIGN criteria. Suzan et al. discovered a statistically significant differences between TCN but no statistically significant differences between AAS in terms of study types [24]. We found that the level of evidence did not make a significant difference in TCN and AAS when we classified and compared the articles according to the study types and level of evidence. However, it was notable that both articles with highest TCN and AAS were randomized clinical trials with a level of evidence 1.

It is important to classify the T100 list according to the main subject areas in order to determine which subjects get far more interest from scholars and social media users. The main topics of the articles with the highest TCN median value were classification and staging (400) and prognostic features (345.5). The main topics of the articles with the highest AAS median value were molecular mechanisms of antioxidant molecules (158) and diagnostic and therapeutic management (124). According to the main topic analysis of T100 list, we found out that majority of articles were about treatment, particularly anti-VEGF therapy. In accordance with this, Martin et al.'s article entitled as "Ranibizumab and Bevacizumab for Neovascular Age-Related Macular Degeneration The CATT Research Group" received the highest TCN [14]. However, the article entitled as "Phase 1 clinical study of an embryonic stem cell-derived retinal pigment epithelium patch in age-related macular degeneration" by Cruz et al. had both the greatest AAS and NTs in the T100 list [15]. The academic community made the highest citations to the article which is evaluating the treatment protocols, efficacy, and safety of anti-VEGF therapies, which are currently used to treat AMD. On the other hand, anti-VEGF medications are a kind of medication that reduces and suppresses the progression of neovascular AMD but cannot provide a complete cure in advanced AMD. Social media users were most interested in the article about embryonic stem cell therapy, which had the potential to be a more dramatic therapeutic option for AMD than symptomatic anti-VEGF medications. The top ten articles with the highest AAS had the following topics: embryonic stem cell treatment (n=4), anti-VEGF treatment (n=2), diagnostic image analysis using artificial intelligence techniques (n=2), dietary supplement treatment (n=1), and epidemiology (n=1). It was remarkable that social media users showed great interest in newly developed techniques such as embryonic stem cell therapy and artificial intelligence. It was notable that six of the ten articles with the highest AAS were produced in the United States, which was also the most productive country according to the bibliometric visualization analysis.

As a consequence of increasing use of Twitter for professional reasons, scholars and clinicians have begun to frequently utilize Twitter for academic knowledge transfer in recent years. Twitter dismantles academic hierarchy and enables scientists and clinicians from across the globe to interact and debate research topics. According to the report, 71.9 percent of 160 ophthalmologists use social media in 2020 [27]. Additionally, Alfaris et al. reported that 35 percent of medical students use Twitter for vocational training in their study on the effect of social media use on academic achievement in medical students [28]. Numerous medical journals also have their own Twitter accounts. Over 20% of all published articles are announced at least once on Twitter [29]. In our study, 68 articles in the T100 list were shared on Twitter. It is worth noting that the journals of Nature Bıotechnology, Jama-Journal Of The American Medical Association, New England Journal Of Medicine, Cell, And Lancet, which published the first five articles with the highest AAS in the T100 list, have their own Twitter accounts. Furthermore, journal of Ophthalmology, which has the most number of articles in the T100 list with 27 articles, also has a Twitter account. On the other hand, it is noteworthy to see that the journals which published the first and second articles with highest TCN (New England Journal of Medicine and Lancet Global Health, respectively) and the journal which published the article with the highest AAS (Nature Biotechnology) were general medicine journals which were not specialized in ophthalmology field.

The limitation of our study is that we used NTs in our altmetric analysis, but we did not define detailed Twitter demographics. The amount of Twitter followers might be used to estimate the amount of individuals contacted and the spread of the content. It might be useful to evaluate the occupations, ages, genders, and geographical regions of Twitter users to determine the hot topics for different target groups. Further altmetric researches are needed to conduct detailed Twitter analyses, involving user classifications, amount of followers, and geography.

Conclusion

This study carried out both detailed altmetric and bibliometric analyses in the field of AMD research. AAS and NTs had significant positive correlation with ACpY, journal IF, and H-index. Therefore, altmetric analysis was found to be a useful option for rapid assessment of the impact of articles whose citation analysis period has not yet completed. Furthermore, AAS and NTs had a significant positive correlation with ACpY, implying that social media users are more interested in articles that continue to be cited over time and remain actual. Additionally, it is worth noting that NTs have a greater impact on journal IF than AAS. The majority of the mostly cited articles in the field of AMD research were about treatment, especially anti-VEGF medication. However social media users paid more attention to embryonic stem cell therapy as a treatment option for AMD. Performing altmetric analyses in the evaluation of articles, in addition to the bibliometric analyses, offers scholars a wealth of information about trending topics in AMD research.

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