RESEARCH

Top 100 articles on vitamin D: Bibliometric versus altmetric analysis

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ABSTRACT

OBJECTIVE: To analyse the main features of the top 100 (T100) most cited articles in academia and 100 most discussed articles on social media about vitamin D from 1975 to 2021 and compare bibliometric and altmetric analysis.

METHODS: 'Vitamin D' was searched from the Web of Science database and Altmetric.com website, and T100 citation and altmetric lists were created, respectively. Articles in both lists were analysed in terms of study type, topic, first author, publication year, citation number and altmetric attention score (AAS). Impact factor (IF) and quartile of journal, in which the articles were published was also examined.

RESULTS: The article "Vitamin D Deficiency" by Holick MF, published in the *New England Journal of Medicine* was the most cited article (n=8492), original scientific paper was the most frequent study type in both lists. No correlation was found between AAS and citation number in both lists (r=0.176, p=0.081; r=0.157, p=0.119, respectively). The journals on the T100 citation list had a statistically significantly higher IF than the journals in the T100 altmetric list (p<0.001).

CONCLUSION: Altmetric analysis of vitamin D is currently insufficient to replace traditional bibliometric analysis but can provide valuable information about the society's interest. As social media gains more importance every day in our lives, high altmetric score could affect future interests and direct studies *(Tab. 6, Fig. 3, Ref. 21)*. Text in PDF *www.elis.sk*

KEY WORDS: vitamin D, deficiency, fractures, COVID-19, bibliometric, altmetric.

Introduction

Vitamin D is a unique hormone that can be produced mostly in the skin by exposure to direct sunlight but also through dietary sources. Vitamin D receptors are present in most tissues and cells in the body (1). The relationship of vitamin D with many diseases has been investigated over the years. In addition to the risk of metabolic bone diseases, the risk of many common chronic diseases, including cancers, cardiovascular disease and autoimmune diseases may increase in the presence of vitamin D deficiency (2). Because of the popularity of vitamin D in many fields of health, including COVID-19, it is not surprising that there has been a significant number of studies about this topic over the past several decades.

Bibliometric and altmetric analyses provide important and different perspectives for research articles in both scientific world and community. The term "bibliometrics" was first used in 1969 and it was reported that bibliometric analysis could highly sensitively and

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quantitatively measure scientific outputs based on geometrical and statistical methods (3). Today, bibliometric analysis is frequently used by academicians in different scientific disciplines including medicine to identify impactful papers in their fields (4, 5).

Altmetrics are non-traditional bibliometrics that was first proposed in year 2010 (6). As a result of the increase in the popularity of social media recently, researchers had the opportunity to present their academic studies to public more easily, so a concept called "altmetric analysis" was created. Altmetric attention score (AAS) obtained by altmetric analysis symbolizes the effect of articles on social media. Although it is a new analysis technique, there are many studies using this non-traditional method (7).

The number of citations is frequently used to determine the quality of articles. Similarly, the average number of citations of the publications in a journal is used to calculate the impact factor (IF) of a journal which is considered as an indicator of journal quality in academia (8). The term impact factor is generally used for journals, but can rarely be used for articles, too.

Although there are many studies about vitamin D, no prior studies to evaluate the relationship between traditional and non-traditional publication metrics in the field of vitamin D were conducted. In this study, we evaluated 100 most cited articles in academia and 100 most shared articles in social media about vitamin D and we aimed to analyse the relationship between bibliometrics and altmetrics on this topic. In addition, bibliometric mapping and

Tab. 1. Top 100 Citation List.

Rank and title	Year	First Author	Times Cited	Average Citations Per Year	Altmetric Score
1. Vitamin D Deficiency	2007	Holick MF	8492	566,13	**643**
2. Evaluation, Treatment, and Prevention of Vitamin D Deficiency: an Endocrine Society Clinical Practice Guideline	2011	Holick MF	4746	431,45	**1124**
3. Toll-like receptor triggering of a vitamin D-mediated human antimicrobial response	2006	Liu PT	2406	150,38	**59**
4. The 2011 Report on Dietary Reference Intakes for Calcium and Vitamin D from the Institute of Medicine: What Clinicians Need to Know	2011	Ross AC	2263	205,73	**172**
5. Vitamin-D(3) and calcium to prevent hip-fractures in elderly women	1992	Chapuy MC	2167	72,23	**95**
6. Decreased bioavailability of vitamin D in obesity	2000	Wortsman J	1891	85,95	**129**
7. Estimation of optimal serum concentrations of 25-hydroxyvitamin D for multiple health outcomes	2006	Bischoff-Ferrari HA	1626	101,63	**-**
8. Prediction of bone-density from vitamin-D receptor alleles	1994	Morrison NA	1609	57,46	**12**
9. Vitamin D deficiency and risk of cardiovascular disease	2008	Wang TJ	1593	113,79	**141**
10. Sunlight and vitamin D for bone health and prevention of autoimmune diseases, cancers, and cardiovascular disease	2004	Holick MF	1559	86,61	**168**
11. Effect of calcium and vitamin D supplementation on bone density in men and women 65 years of age or older	1997	DawsonHughes B	1498	59,92	**-**
12. 1,25-Dihydroxyvitamin D-3 is a negative endocrine regulator of the renin-angiotensin system	2002	Li YC	1417	70,85	**11**
13. Vitamin D deficiency: a worldwide problem with health consequences	2008	Holick MF	1376	98,29	**245**
14. Vitamin D deficiency and secondary hyperparathyroidism in the elderly: Consequences for bone loss and fractures and therapeutic implications	2001	Lips P	1321	62,9	**9**
15. Overview of general physiologic features and functions of vitamin D	2004	DeLuca HF	1258	69,89	**3**
16. Intake of vitamin D and risk of type 1 diabetes: a birth-cohort study	2001	Hypponen E	1257	59,86	**162**
17. Estimates of optimal vitamin D status	2005	Dawson-Hughes B	1229	72,29	**10**
18. RXR-BETA - A Coregulator that enhances binding of retinoic acid, thyroid-hormone, and vitamin-D receptors to their cognate response elements	1991	Yu VC	1228	39,61	**12**
19. The role of vitamin D and calcium in type 2 diabetes. A systematic review and meta-analysis	2007	Pittas AG	1205	80,33	**40**
20. Structure-function-relationships in the vitamin-D endocrine system	1995	Bouillon R	1202	44,52	**-**
21. Hypovitaminosis D is associated with insulin resistance and beta cell dysfunction	2004	Chiu KC	1181	65,61	**-**
22. Serum 25-hydroxyvitamin D levels and risk of multiple sclerosis	2006	Munger KL	1159	72,44	**-**
23. Calcium plus vitamin D supplementation and the risk of fractures	2006	Jackson RD	1149	71,81	**117**
24. High prevalence of vitamin D inadequacy and implications for health	2006	Holick MF	1145	71,56	**51**
25. Vitamin D: importance in the prevention of cancers, type 1 diabetes, heart disease, and osteoporosis	2004	Holick MF	1077	59,83	**195**
26. Hypovitaminosis D in medical inpatients	1998	Thomas MK	1064	44,33	**-**
27. Prevalence of vitamin D insufficiency in an adult normal population	1997	Chapuy MC	1061	42,44	**22**
28. The nuclear vitamin D receptor: Biological and molecular regulatory properties revealed	1998	Haussler MR	1059	44,13	**7**
29. FGF-23 is a potent regulator of vitamin D metabolism and phosphate homeostasis	2004	Shimada T	1056	58,67	**10**
30. Vitamin D and Human Health: Lessons from Vitamin D Receptor Null Mice	2008	Bouillon R	1026	73,29	**28**
31. Common genetic determinants of vitamin D insufficiency: a genome-wide association study	2010	Wang TJ	1019	84,92	**32**
32. Targeted ablation of Fgf23 demonstrates an essential physiological role of FGF23 in phosphate and vitamin D metabolism	2004	Shimada T	999	55,5	**17**
33. Vitamin D and calcium supplementation reduces cancer risk: results of a randomized trial	2007	Lappe Joan M	992	66,13	**464**
34. Vitamin D supplementation, 25-hydroxyvitamin D concentrations, and safety	1999	Vieth R	986	42,87	**81**
35. Cutting edge: 1,25-dihydroxyvitamin D-3 is a direct inducer of antimicrobial peptide gene expression	2004	Wang TT	981	54,5	**-**
36. Fracture prevention with vitamin D supplementation - A meta-analysis of randomized controlled trials	2005	Bischoff-Ferrari HA	939	55,24	**95**
37. The role of the vitamin-D endocrine system in health and disease	1989	Reichel H	933	28,27	**15**
38. Genetics and biology of vitamin D receptor polymorphisms	2004	Uitterlinden AG	932	51,78	**4**
39. Vitamin D signalling pathways in cancer: potential for anticancer therapeutics	2007	Deeb Kristin K	928	61,87	**43**
40. Prevalence of abnormal serum vitamin D, PTH, calcium, and phosphorus in patients with chronic kidney disease: Results of the study to evaluate early kidney disease	2007	Levin A	927	61,8	**10**
41. Human serum 25-hydroxycholecalciferol response to extended oral dosing with cholecalciferol	2003	Heaney RP	920	48,42	**-**
42. Current understanding of the molecular actions of vitamin D	1998	Jones G	920	38,33	**13**

Rank and title	Year	First Author	Times Cited	Average Citations Per Year	Altmetric Score
43. 1 alpha,25-dihydroxyvitamin D-3 inhibits differentiation, maturation, activation, and survival of dendritic cells leading to impaired alloreactive T cell activation	2000	Penna G	919	41,77	-
44. Vitamin D	2005	Dusso AS	909	53,47	1
45. 25-hydroxyvitamin D levels and the risk of mortality in the general population	2008	Melamed Michal L	907	64,79	-
46. Global vitamin D status and determinants of hypovitaminosis D	2009	Mithal A	898	69,08	48
47. Effect of vitamin D on falls - A meta-analysis	2004	Bischoff-Ferrari HA	883	49,06	35
48. Independent association of low serum 25-hydroxyvitamin D and 1,25-dihydroxyvitamin D levels with all-cause and cardiovascular mortality	2008	Dobnig H	876	62,57	-
49. Prevention of Rickets and Vitamin D Deficiency in Infants, Children, and Adolescents	2008	Wagner CL	870	62,14	84
50. Vitamin D supplementation and total mortality - A meta-analysis of randomized controlled trials	2007	Autier P	856	57,07	73
51. Cloning and expression of full-length CDNA-encoding human vitamin-D receptor	1988	Baker AR	844	24,82	9
52. 25-hydroxyvitamin D and risk of myocardial infarction in men - A prospective study	2008	Giovannucci E	833	59,5	-
53. Vitamin effects on the immune system: vitamins A and D take centre stage	2008	Mora JR	831	59,36	195
54. Vitamin D: A millenium perspective	2003	Holick MF	829	43,63	49
55. Vitamin D Status: Measurement, Interpretation, and Clinical Application	2009	Holick MF	826	63,54	25
56. Effect of four monthly oral vitamin D-3 (cholecalciferol) supplementation on fractures and mortality in men and women living in the community: randomised double blind controlled trial	2003	Trivedi DP	826	43,47	49
57. Distribution of the Vitamin D receptor and 1 alpha-hydroxylase in human brain	2005	Eyles DW	816	48	88
58. Resurrection of vitamin D deficiency and rickets	2006	Holick MF	807	50,44	372
59. Mice lacking the vitamin D receptor exhibit impaired bone formation, uterine hypoplasia and growth retardation after weaning	1997	Yoshizawa T	806	32,24	8
60. Circulating 25-hydroxyvitamin D levels indicative of vitamin D sufficiency: Implications for establishing a new effective dietary intake recommendation for vitamin D	2005	Hollis BW	791	46,53	-
61. Annual High-Dose Oral Vitamin D and Falls and Fractures in Older Women A Randomized Controlled Trial	2010	Sanders KM	789	65,75	271
62. Use of calcium or calcium in combination with vitamin D supplementation to prevent fractures and bone loss in people aged 50 years and older: a meta-analysis	2007	Tang BMP	787	52,47	81
63. Transcriptional activation of the Cdk inhibitor p21 by vitamin D-3 leads to the induced differentiation of the myelomonocytic cell line U937	1996	Liu M	786	30,23	-
64. Redefining vitamin D insufficiency	1998	Malabanan A	780	32,5	19
65. Vitamin D receptor as an intestinal bile acid sensor	2002	Makishima M	760	38	-
66. Prospective study of predictors of vitamin D status and cancer incidence and mortality in men	2006	Giovannucci E	752	47	-
67. Demographic Differences and Trends of Vitamin D Insufficiency in the US Population, 1988-2004	2009	Ginde AA.	739	56,85	228
68. Vitamin D deficiency in children and its management: Review of current knowledge and recommendations	2008	Misra M	727	51,93	-
69. Vitamin D-2 is much less effective than vitamin D-3 in humans	2004	Armas LAG	723	40,17	108
70. 1 alpha,25-dihydroxyvitamin D3 has a direct effect on naive CD4(+) T cells to enhance the development of Th2 cells	2001	Boonstra A	721	34,33	-
71. An endocytic pathway essential for renal uptake and activation of the steroid 25-(OH) vitamin D-3	1999	Nykjaer A	702	30,52	-
72. Hypovitaminosis D prevalence and determinants among African American and white women of reproductive age: third National Health and Nutrition Examination Survey, 1988-1994	2002	Nesby-O'DS	696	34,8	-
73. Extrarenal expression of 25-hydroxyvitamin D-3-1 alpha-hydroxylase	2001	Zehnder D	696	33,14	-
74. Vitamin D physiology	2006	Lips P	692	43,25	40
75. Calcium plus vitamin D supplementation and the risk of colorectal cancer	2006	Wactawski-Wende J	691	43,19	50
76. Vitamin D intake and incidence of multiple sclerosis	2004	Munger KL	688	38,22	53
77. Low vitamin D and high parathyroid hormone levels as determinants of loss of muscle strength and muscle mass (Sarcopenia): The Longitudinal Aging Study Amsterdam	2003	Visser M	688	36,21	83
78. Human cathelicidin antimicrobial peptide (CAMP) gene is a direct target of the vitamin D receptor and is strongly up-regulated in myeloid cells by 1,25-dihydroxyvitamin D-3	2005	Gombart AF	680	40	1
79. The vitamin-D endocrine system – Steroid metabolism, hormone receptors, and biological response (calcium-binding proteins)	1982	Norman AW	675	16,88	3
80. Vitamin D supplementation improves cytokine profiles in patients with congestive heart failure: a double-blind, randomized, placebo-controlled trial	2006	Schleithoff SS	671	41,94	25

Rank and title	Year	First Author	Times Cited	Average Citations Per Year	Altmetric Score
81. The role of vitamin D in cancer prevention	2006	Garland CF	668	41,75	**141**
82. Targeted ablation of the vitamin D receptor: An animal model of vitamin D-dependent rickets type II with alopecia	1997	Li YC	667	26,68	**6**
83. Serum 25-hydroxyvitamin D, diabetes, and ethnicity in the Third National Health and Nutrition Examination Survey	2004	Scragg R	662	36,78	-
84. Activated injectable vitamin D and hemodialysis survival: A historical cohort study	2005	Teng M	653	38,41	-
85. The crystal structure of the nuclear receptor for vitamin D bound to its natural ligand	2000	Rochel N	653	29,68	**12**
86. Fall prevention with supplemental and active forms of vitamin D: a meta-analysis of randomised controlled trials	2009	Bischoff-Ferrari HA	647	49,77	**35**
87. Vitamin D-Binding Protein and Vitamin D Status of Black Americans and White Americans	2013	Powe CE	645	71,67	**297**
88. Vitamin D: modulator of the immune system	2010	Baeke F	645	53,75	**25**
89. Higher 25-hydroxyvitamin D concentrations are associated with better lower-extremity function in both active and inactive persons aged > = 60 y	2004	Bischoff-Ferrari HA	644	35,78	-
90. Modulatory effects of 1,25-dihydroxyvitamin D-3 on human B cell differentiation	2007	Chen S	640	42,67	-
91. Noncalcemic actions of vitamin D receptor ligands	2005	Nagpal S	637	37,47	**19**
92. Do sunlight and vitamin-D reduce the likelihood of colon cancer?	1980	Garland CF	636	15,14	**50**
93. Plasma 25-hydroxyvitamin D levels and risk of incident hypertension	2007	FormanJP	634	42,27	-
94. The role of vitamin D in reducing cancer risk and progression	2014	Feldman D	632	79	**227**
95. Oral vitamin D3 and calcium for secondary prevention of low-trauma fractures in elderly people (Randomised Evaluation of Calcium Or vitamin D, RECORD): a randomised placebo-controlled trial	2005	Grant AM	629	37	**15**
96. Effects of vitamin D and calcium supplementation on falls: A randomized controlled trial	2003	Bischoff-Ferrari HA	628	33,05	**12**
97. Dietary vitamin-D and calcium and risk of colorectal cancer-A 19 year prospective study in men	1985	Garland C	627	16,95	**18**
98. Calcium absorption varies within the reference range for serum 25-hydroxyvitamin D	2003	Heaney RP	625	32,89	-
99. Vitamin D status and ill health: a systematic review	2014	Autier P	620	77,5	**371**
100. Prevalence of cardiovascular risk factors and the serum levels of 25-hydroxyvitamin D in the United States - Data from the Third National Health and Nutrition Examination Survey	2007	Martins D	614	40,93	-

text mining were performed to determine and display the keywords of the articles in T100 citation list, words in the abstract and the authors' countries.

Methods

Data collection and inclusion criteria

Citation information for vitamin D was obtained from Thomson Reuters Web of Science (WoS) database. All of the articles, published between the years 1975–2021, related to the keyword "vitamin D" were searched in English on March 4, 2021 and 104.796 articles were obtained. Since WoS database lists all the articles containing vitamin D in any of the title, abstract, keywords, keywords plus; the articles not primarily related to vitamin D were excluded to create the T100 citation list with the consensus of the authors. PubMed was also utilized to find data about the articles. All the top 100 citation and altmetric articles were analysed and information on topic of the articles, types of research methods, journal of publication, first author, year of publication, citation counts and also average number of citations per year was extracted. IF and Quartile (Q) rankings of the journals in which the articles were published, for the year 2019 were

used. IF is calculated by dividing the current year citation score to the total number of articles published in that journal during the previous two years and is calculated yearly for journals listed in the Journal Citation Reports (8). Q index describes the rank of a journal in a specific field and scores of the same journal may vary according to the scientific categories. Each subject category of journals is divided into four quartiles and Q1 indicates the top 25 % journals in the same field. The ranking of the journals that had 2 or more articles in the T100 lists were given in detail with IF values and Q categories.

Similarly, the keyword "vitamin D" was searched on the Altmetric.com website on March 4, 2021 and the T100 altmetric list was created by excluding unrelated articles (9). The Altmetric Attention Score (AAS) is a weighted count of the online attention received by a scholarly article. Online attention comes from non-traditional sources, including mainstream media, social media (Facebook, Twitter, LinkedIn, Google+, Sin Weibo and Pinterest), public policy documents, post-publication peer-review platforms, Open Syllabus Project, blogs, citations, research highlights, multimedia and other online platforms (YouTube, Reddit, Q&A), patents, online reference managers and Wikipedia (10). AAS is derived from three main factors including volume, sources and

Tab. 2. Top 100 Altmetric List.

Rank and title	Year	First Author	Altmetric Score	Times Cited
1. Vitamin D supplementation to prevent acute respiratory tract infections: systematic review and meta-analysis of individual participant data	2017	Martineau AR	**6444**	492
2. Effects of vitamin D supplementation on musculoskeletal health: a systematic review, meta-analysis, and trial sequential analysis	2018	Bolland MJ	**2973**	141
3. Association Between Calcium or Vitamin D Supplementation and Fracture Incidence in Community-Dwelling Older Adults: A Systematic Review and Meta-analysis	2017	Zhao JG	**2812**	197
4. Association of Vitamin D Status and Other Clinical Characteristics With COVID-19 Test Results	2020	Meltzer DO	**2716**	47
5. Evidence that Vitamin D Supplementation Could Reduce Risk of Influenza and COVID-19 Infections and Deaths	2020	Grant WB	**2601**	416
6. Vitamin D Supplements and Prevention of Cancer and Cardiovascular Disease	2019	Manson JE	**2292**	411
7. Analysis of vitamin D level among asymptomatic and critically ill COVID-19 patients and its correlation with inflammatory markers	2020	Jain A	**2164**	16
8. The role of Vitamin D in the prevention of Coronavirus Disease 2019 infection and mortality	2020	Ilie PC	**1819**	159
9. Autumn COVID-19 surge dates in Europe correlated to latitudes, not to temperature-humidity, pointing to vitamin D as contributing factor	2021	Walrand S	**1719**	0
10. Vitamin D Deficiency Is There Really a Pandemic?	2016	Manson JE	**1602**	133
11. Vitamin D Insufficiency May Account for Almost Nine of Ten COVID-19 Deaths: Time to Act. Comment on: Vitamin D Deficiency and Outcome of COVID-19 Patient. Nutrients 2020, 12, 25	2020	Brenner H	**1551**	2
12. Vitamin D sufficiency, a serum 25-hydroxyvitamin D at least 30 ng/mL reduced risk for adverse clinical outcomes in patients with COVID-19 infection	2020	Maghbooli Z	**1456**	28
13. Vitamin D Deficiency, Its Role in Health and Disease, and Current Supplementation Recommendations	2017	Pfotenhauer KM	**1422**	18
14. Vitamin D and COVID-19: evidence and recommendations for supplementation	2020	Griffin G	**1360**	0
15. Vitamin D and the Immune System	2015	Aranow C	**1322**	350
16. Effect of Monthly High-Dose Vitamin D Supplementation on Cardiovascular Disease in the Vitamin D Assessment Study	2017	Scragg R	**1170**	159
17. Evaluation, Treatment, and Prevention of Vitamin D Deficiency: an Endocrine Society Clinical Practice Guideline	2011	Holick MF	**1124**	4746
18. Impact of Serum 25(OH) Vitamin D Level on Mortality in Patients with COVID-19 in Turkey	2020	Karahan S	**1117**	0
19. Vitamin D deficiency as a predictor of poor prognosis in patients with acute respiratory failure due to COVID-19	2020	Carpagnano GE	**1024**	28
20. Do vitamin D supplements help prevent respiratory tract infections?	2017	Bolland MJ	**1020**	3
21. Effect of High-Dose Vitamin D Supplementation on Volumetric Bone Density and Bone Strength	2019	Burt LA	**1015**	71
22. Vitamin D and the risk of dementia and Alzheimer disease	2014	Littlejohns TJ	**1005**	232
23. Epidemic influenza and vitamin D	2007	Aloia JF	**983**	180
24. Prevalence and correlates of vitamin D deficiency in US adults	2011	Forrest KY	**977**	481
25. Randomized trial of vitamin D supplementation to prevent seasonal influenza A in schoolchildren	2010	Urashima M	**943**	509
26. Vitamin D for COVID-19: a case to answer?	2020	Martineau AR	**915**	30
27. Maternal gestational vitamin D supplementation and offspring bone health (MAVIDOS): a multicentre, double-blind, randomised placebo-controlled trial	2016	Cooper C	**887**	103
28. Circulating Vitamin D and Colorectal Cancer Risk: An International Pooling Project of 17 Cohorts	2018	McCullough ML	**832**	75
29. The economic case for prevention of population vitamin D deficiency: a modelling study using data from England and Wales	2019	Aguiar M	**825**	7
30. Determinants of the Maternal 25-Hydroxyvitamin D Response to Vitamin D Supplementation During Pregnancy	2016	Moon RJ	**794**	19
31. Vitamin D for the management of asthma	2016	Martineau AR	**791**	106
32. Vitamin D and survival in COVID-19 patients: A quasi-experimental study	2020	Annweile C	**787**	16
33. Relation between milk-fat percentage, vitamin D, and BMI z score in early childhood	2016	Vanderhout SM	**770**	20
34. Role of Magnesium in Vitamin D Activation and Function	2018	Uwitonze AM	**750**	70
35. Vitamin D Supplementation and Cardiovascular Disease Risks in More Than 83000 Individuals in 21 Randomized Clinical Trials	2019	Barbarawi M	**745**	54
36. Dose responses of vitamin D3 supplementation on arterial stiffness in overweight African Americans with vitamin D deficiency: A placebo controlled randomized trial	2017	Raed A	**743**	25
37. Relationships between hyperinsulinaemia, magnesium, vitamin D, thrombosis and COVID-19: rationale for clinical management	2020	Cooper ID	**742**	3
38. Gestational vitamin D deficiency and autism-related traits: the Generation R Study	2016	Vinkhuyzen AAE	**737**	54
39. Vitamin D concentrations and COVID-19 infection in UK Biobank	2020	Hastie CE	**735**	8
40. Vitamin D Supplementation and Prevention of Type 2 Diabetes	2019	Pittas AG	**733**	137

Rank and title	Year	First Author	Altmetric Score	Times Cited
41. Effect of Vitamin D3 Supplements on Development of Advanced Cancer	2020	Chandler PD	**732**	0
42. Vitamin D, Calcium, or Combined Supplementation for the Primary Prevention of Fractures in Community-Dwelling Adults	2018	Kahwati LC	**706**	64
43. Low plasma 25(OH) vitamin D level is associated with increased risk of COVID-19 infection: an Israeli population-based study	2020	Merzon E	**702**	41
44. Cohort study to evaluate the effect of combination vitamin D, magnesium and vitamin B-12 (DMB) on progression to severe outcome in older patients with coronavirus (COVID-19)	2020	Tan CW	**666**	10
45. Association of Serum Level of Vitamin D at Diagnosis With Breast Cancer Survival	2017	Yao S	**662**	57
46. Sunlight and Vitamin D: Necessary for Public Health	2015	Baggerly CA	**659**	57
47. Monthly High-Dose Vitamin D Treatment for the Prevention of Functional Decline	2016	Bischoff-F	**657**	251
48. A Statistical Error in the Estimation of the Recommended Dietary Allowance for Vitamin D	2014	Veugelers PJ	**655**	36
49. Effects of vitamin D supplements on bone mineral density: a systematic review and meta-analysis	2014	Reid IR	**647**	295
50. Vitamin D Deficiency	2007	Holick MF	**643**	8492
51. Vitamin D deficiency contributes directly to the acute respiratory distress syndrome (ARDS)	2015	Dancer RCA	**641**	94
52. Vitamin D and Health Outcomes: Then Came the Randomized Clinical Trials	2019	Lucas A	**592**	5
53. Use of vitamin D drops leading to kidney failure in a 54-year-old man	2019	Auguste BL	**590**	4
54. Vitamin D associates with improved quality of life in participants with irritable bowel syndrome: outcomes from a pilot trial	2015	Tazzyman S	**581**	17
55. Effect of Vitamin D and Calcium Supplementation on Cancer Incidence in Older Women	2017	Lappe J	**577**	119
56. Vitamin D Status and Rates of Cognitive Decline in a Multiethnic Cohort of Older Adults	2015	Miller JW	**577**	97
57. New Approach to Develop Optimized Sunscreens that Enable Cutaneous Vitamin D Formation with Minimal Erythema Risk	2016	Kockott D	**573**	9
58. Latitude, urbanization, age, and sex as risk factors for vitamin D deficiency disease in the Roman Empire	2018	Mays S	**573**	8
59. Vitamin D supplementation to the older adult population in Germany has the cost-saving potential of preventing almost 30000 cancer deaths per year	2021	Niedermaier T	**558**	0
60. Vitamin D and multiple health outcomes: umbrella review of systematic reviews and meta-analyses of observational studies and randomised trials	2014	Theodoratou E	**557**	497
61. Vitamin D Supplementation Improves Cognitive Function Through Reducing Oxidative Stress Regulated by Telomere Length in Older Adults with Mild Cognitive Impairment: A 12-Month Randomized Controlled Trial	2020	Yang T	**540**	0
62. Effect of Vitamin D Supplementation, Omega-3 Fatty Acid Supplementation, or a Strength-Training Exercise Program on Clinical Outcomes in Older Adults	2020	Bischoff-F	**537**	9
63. A Trial of Calcium and Vitamin D for the Prevention of Colorectal Adenomas	2015	Baron JA	**535**	160
64. Trends in Use of High-Dose Vitamin D Supplements Exceeding 1000 or 4000 International Units Daily, 1999-2014	2017	Rooney MR	**528**	53
65. Vitamin D and Calcium Supplementation to Prevent Fractures in Adults: U.S. Preventive Services Task Force Recommendation Statement	2013	Moyer VA	**527**	155
66. Vitamin D deficiency aggravates COVID-19: systematic review and meta-analysis	2020	Pereira M	**525**	15
67. Vitamin D metabolites and the gut microbiome in older men	2020	Thomas RL	**516**	1
68. Vitamin D and risk of pregnancy related hypertensive disorders: mendelian randomisation study	2018	Magnus MC	**512**	10
69. Editorial: low population mortality from COVID-19 in countries south of latitude 35 degrees North supports vitamin D as a factor determining severity	2020	Rhodes JM	**499**	69
70. Relationship Between Neonatal Vitamin D at Birth and Risk of Autism Spectrum Disorders: the NBSIB Study	2017	Wu DM	**499**	28
71. Vitamin D for Health: A Global Perspective	2013	Hossein-nezhad A	**491**	558
72. Vitamin D and African Americans	2006	Harris SS	**476**	210
73. Vitamin D deficiency and depression in adults: systematic review and meta-analysis	2018	Anglin RES	**475**	347
74. Assessment of vitamin D concentration in non-supplemented professional athletes and healthy adults during the winter months in the UK: implications for skeletal muscle function	2013	Close GL	**466**	130
75. Exercise and Vitamin D in Fall Prevention Among Older Women	2015	Uusi-Rasi K	**464**	
76. High-Dose Monthly Vitamin D for Prevention of Acute Respiratory Infection in Older Long-Term Care Residents: A Randomized Clinical Trial	2016	Ginde AA	**464**	45
77. Vitamin D and calcium supplementation reduces cancer risk: results of a randomized trial	2007	Lappe JM.	**464**	992
78. Vitamin D is Not Associated With Severity in NAFLD: Results of a Paired Clinical and Gene Expression Profile Analysis	2016	Patel YA	**455**	25
79. Should adults take vitamin D supplements to prevent disease?	2016	Bolland MJ	**451**	11
80. Athletic Performance and Vitamin D	2009	Cannell JJ	**446**	153
81. Prevention of benign paroxysmal positional vertigo with vitamin D supplementation	2020	Jeong SH	**444**	3
82. Effect of Vitamin D Supplementation on Testosterone Levels in Men	2011	Pilz S	**440**	132
83. Vitamin D and the omega-3 fatty acids control serotonin synthesis and action, part 2: relevance for ADHD, bipolar disorder, schizophrenia, and impulsive behavior	2015	Patrick RP	**438**	163

Rank and title	Year	First Author	Altmetric Score	Times Cited
84. Predisposing role of vitamin D receptor (VDR) polymorphisms in the development of multiple sclerosis: A case-control study	2016	Abdollahzadeh R	**436**	18
85. Should healthy people take a vitamin D supplement in winter months?	2016	Spector TD	**432**	4
86. Sorting Out Whether Vitamin D Deficiency Raises COVID-19 Risk	2021	Rubin R	**430**	1
87. Vitamin D supplementation to prevent asthma exacerbations: a systematic review and meta-analysis of individual participant data	2017	Jolliffe DA	**427**	117
88. Folate and vitamin B12 concentrations are associated with plasma DHA and EPA fatty acids in European adolescents: the Healthy Lifestyle in Europe by Nutrition in Adolescence (HELENA) study	2017	Iglesia I	**427**	9
89. Estimation of Total Usual Calcium and Vitamin D Intakes in the United States	2010	Bailey RL	**424**	354
90. Treatment of Vitamin D Insufficiency in Postmenopausal Women: A Randomized Clinical Trial	2015	Hansen KE	**417**	84
91. Vitamin D status in pediatric irritable bowel syndrome	2017	Nwosu BU	**416**	11
92. The Relationship between 25 (OH) D Levels (Vitamin D) and Bone Mineral Density (BMD) in a Saudi Population in a Community-Based Setting	2017	Alkhenizan A	**415**	11
93. Association between vitamin D supplementation and mortality: systematic review and meta-analysis	2019	Zhang Y	**409**	49
94. Vitamin D and Calcium for the Prevention of Fracture	2019	Yao P	**406**	32
95. Association Between Myopia, Ultraviolet B Radiation Exposure, Serum Vitamin D Concentrations, and Genetic Polymorphisms in Vitamin D Metabolic Pathways in a Multicountry European Study	2017	Williams KM	**402**	29
96. Vitamin D Insufficiency and Deficiency and Mortality from Respiratory Diseases in a Cohort of Older Adults: Potential for Limiting the Death Toll during and beyond the COVID-19 Pandemic?	2020	Brenner H	**402**	7
97. Understanding vitamin D deficiency	2014	Sahota O	**401**	25
98. The association between neonatal vitamin D status and risk of schizophrenia	2018	Eyles DW	**400**	21
99. Serum 25-hydroxyvitamin D, vitamin D binding protein, and prostate cancer risk in black men	2017	Layne TM	**395**	12
100. Effects of Vitamin D on Cardiac Function in Patients With Chronic HF: The VINDICATE Study	2016	Witte KK	**393**	96

Tab. 3. Journals in the top 100 Citation List.

Rank and Journal	The Number of Articles	Impact Factor*	Quartile in Category**
1. American Journal of Clinical Nutrition	13	6,77	Q1
2. New England Journal of Medicine	8	74,70	Q1
3. Lancet	6	60,39	Q1
4. Archives of Internal Medicine	6	17,33	Q1
5. Journal of Clinical Endocrinology & Metabolism	6	5,40	Q1
6. Endocrine Reviews	5	14,66	Q1
7. Journal of the American Medical Association	4	45,54	Q1
8. Journal of Immunology	4	4,89	Q2
9. Journal of Clinical Investigation	3	11,86	Q1
10. Journal of Bone and Mineral Research	3	5,95	Q1
11. Osteoporosis International	3	3,86	Q2
12. Nature Reviews Cancer	2	53,03	Q1
13. Cell	2	38,64	Q1
14. British Medical Journal	2	30,31	Q1
15. Proceedings of the National Academy of Sciences of the United States of America	2	9,41	Q1

* 2019 Journal Citation Reports (Clarivate Analytics), ** 2019 Scimago Journal and Country Rank, ***Journals with 2 or more articles in the top 100 citation list is given.

100 altmetric articles were obtained from the WoS website on the same date.

Countries of the authors were recorded. Among the authors of the article, those of the same geographic origin were registered only once. VOSviewer was used to visualize the keywords of the articles in the T100 citation list, countries of the authors, and words in the abstract section and also to display bibliometric maps.

Statistical analysis

Categorical variables were defined as the median (minimum – maximum). Since the data was not normally distributed, Mann-Whitney U test was used to compare the differences between the 2 groups; and Kruskal-Wallis test was used to compare 3 or more groups. Spearman correlation analysis was performed to evaluate the correlation between citation count and AAS in both lists. We performed statistical analyses using IBM SPSS-20 (Statistical Package for Social Sciences, Chicago, Illinois, USA).

Results

Top cited 100 articles about vitamin D are given in the Table 1; with the number of citations, AAS, altmetric score donut, ave-

authors and represented in the donut-shaped graphic. AAS appears in the middle of altmetric donut and colours of the donut represent different sources of attention. Area occupied by the source in donut indicates the source's contribution to AAS. Mendeley readers and Citeulike bookmarks do not contribute to the donut or score (11). In addition, the AAS of the top 100 cited articles was obtained from the Altmetric.com website, and the citation counts of the top

Tab. 4. Journals in the top 100 Altmetric List.

Rank and Journal	The Number of Articles	Impact Factor*	Quartile in Category**
1. Journal of the American Medical Association	8	45,54	Q1
2. British Medical Journal	7	30,31	Q1
3. New England Journal of Medicine	5	74,70	Q1
4. PLoS ONE	5	2,74	Q2
5. Nutrients	4	4,55	Q1
6. Lancet Diabetes & Endocrinology	3	25,34	Q1
7. JAMA Internal Medicine	3	18,65	Q1
8. American Journal of Clinical Nutrition	3	6,77	Q1
9. JAMA Network Open	3	5,03	Q1
10. Scientific Reports	3	4,00	Q1
11. JAMA Cardiology	2	12,79	Q1
12. Neurology	2	8,77	Q1
13. Journal of Clinical Endocrinology & Metabolism	2	5,40	Q1
14. Journal of Nutrition	2	4,28	Q1

* 2019 Journal Citation Reports (Clarivate Analytics), ** 2019 Scimago Journal and Country Rank, ***Journals with 2 or more articles in the top 100 altmetric list is given
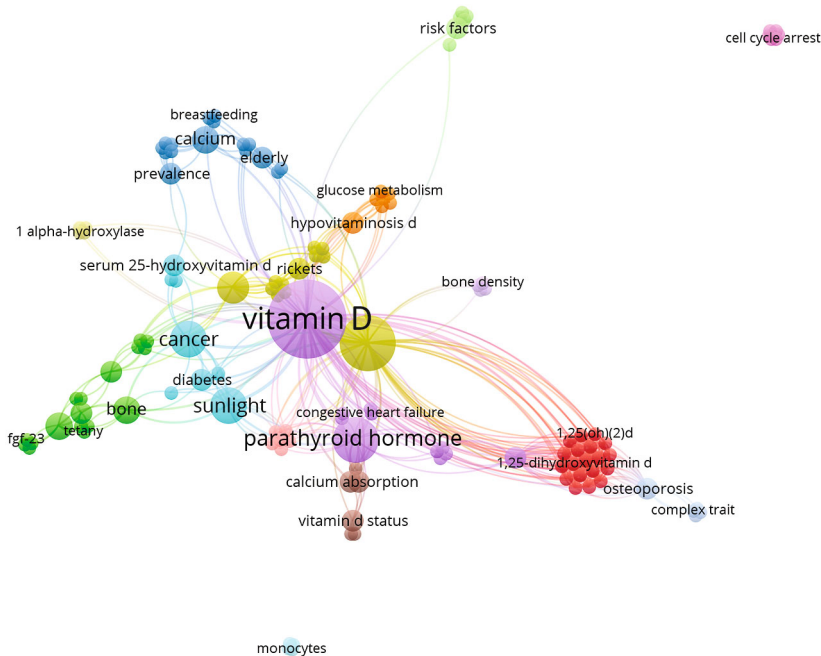
Fig. 1. The most common keywords in the T100 citation list.

rage citations per year, first author and year of publication. The median of the citation count of the top 100 cited articles was 850 (IQR, 614–8,492), while the median for AAS was 17,5 (IQR, 0–1124). The article entitled "Vitamin D Deficiency" by Holick MF published in the *New England Journal of Medicine* in 2007 was the most cited article on both lists (n = 8492) (rank 1 in table 1) (1). The highest altmetric score (n = 1124) in the T100 citation list belonged to the second most cited article (n = 4746) entitled "Evaluation, Treatment, and Prevention of Vitamin D Deficiency: an Endocrine Society Clinical Practice Guideline" again by Holick MF et al, published in the *Journal of Clinical Endocrinology & Metabolism* in 2011 (rank 2 in table 1) (12). Time period since

publication median was 16 years (range: 7–31). The Spearman correlation analysis was used to define the correlation between the citation number and AAS of the T100 citation articles, but no statistically significant correlation was found between the citation number and AAS (r=0.176; p=0.081).

Table 2 (T100 altmetric list) includes 100 articles about vitamin D with the highest AAS, as well as the number of citations, altmetric score donut, first author and year of publication of the articles. The median AAS of the top 100 altmetric articles was 642 (IQR, 393–6444) and the citation number median for the same list was 46 (IQR, 0–8492). The article entitled "Vitamin D supplementation to prevent acute respiratory tract infections: systematic review and meta-analysis of individual participant data" written by Martineau AR et al. and published in the *British Medical Journal* in 2017, had the highest altmetric score (n= 6444) in the top 100 altmetric list while the citation count of the article was 492 (rank 1 in table 2) (13). Time period since publication median was 4 years (range: 0–15). There was no correlation between the citation number and AAS of the T100 altmetric articles according to Spearman correlation analysis (r=0.157; p=0.119).

There were only three common articles in both lists (rank 1, rank 2 and rank 33 in table 1). One of the common articles was "Vitamin D and calcium supplementation reduces cancer risk: results of a randomized trial" by Lappe JM published in the *American Journal of Clinical Nutrition* in 2007 (rank 33 in table 1) (14). The other common articles were the first two articles in T100 citation list, as mentioned before (rank 1 and rank 2 in table 1).

Journals with the most published articles in the T100 citation list was the *American Journal of Clinical Nutrition* (n = 13), *New England Journal of Medicine* (n=8) and Archives of Internal Medicine (n=6) respectively, while the most frequently encountered journal in the T100 altmetric list was the *Journal of the American Medical Association* (n=8). The median IF of the journals in T100 citation list was 9.46 (IQR, 2.18–74.69) and for the T100 altmetric list it was 6.76 (IQR, 1.21–74.69). In our study, 79.5 % (n=35) of the journals in the T100 citation list and 45.9 % (n=39) of the journals in the T100 altmetric list were Q1 according to the Scimago Journal and Country Rank category. IF values of the journals, in which the articles in both lists were published, were summed up for each list and divided by the number of articles. While the
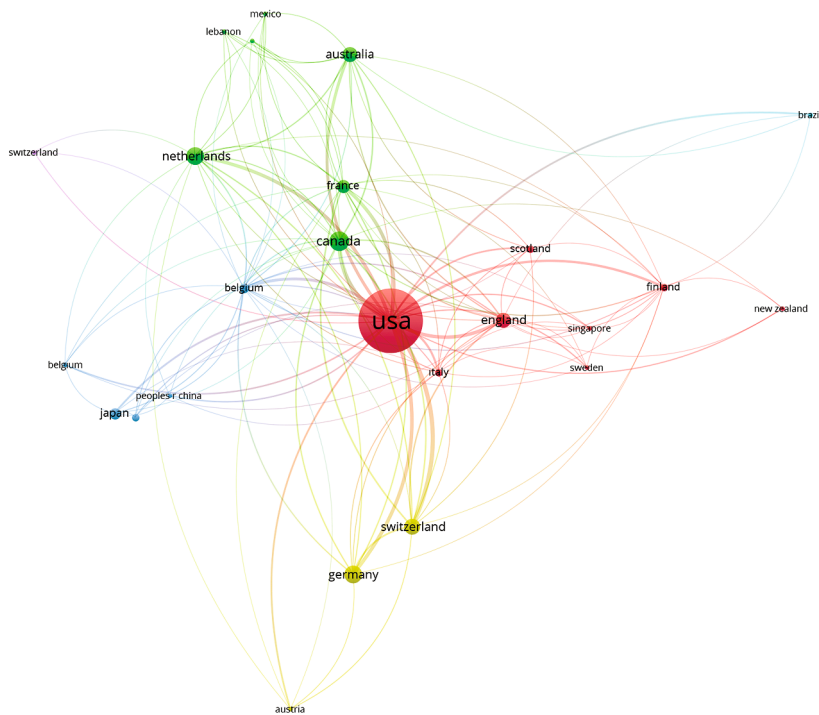
Fig. 2. Countries of the authors and network of countries.

The most common keywords in the T100 citation list were vitamin D, 25-hydroxyvitamin D, parathyroid hormone and sunlight as shown in Figure 1 with the link strength relationship in a network visualization cluster map. USA had the distinction of being the country of most of the authors that had articles in T100 citation list. Countries of the authors and network of countries are given in Figure 2. Figure 3 shows the words exceeding 5 or more times in the abstract sections of the articles with connections. The most prominent word in the red coloured cluster, one of the 3 clusters, was vitamin D receptor. In the green coloured cluster d level; and in the blue cluster fracture and trial was foremost and had the most link strength.

Study types were categorized into the 3 groups as original scientific paper, review, and others. Original scientific paper was the most frequent study type followed by review in both lists. According to article types; while there was no difference between altmetric scores in the T100 altmetric list (p=0.492), there was a significant difference between the number of citations (p=0.028). On the other hand, while there was no significant difference between the number of citations according to article types in the T100 citation list (p=0.158), there was a statistically significant difference between the altmetric scores (p=0.001). Study types of the two lists and statistical analysis according to study types are given in Table 5. Top 100 cited articles were divided into 4 groups as pathophysio-
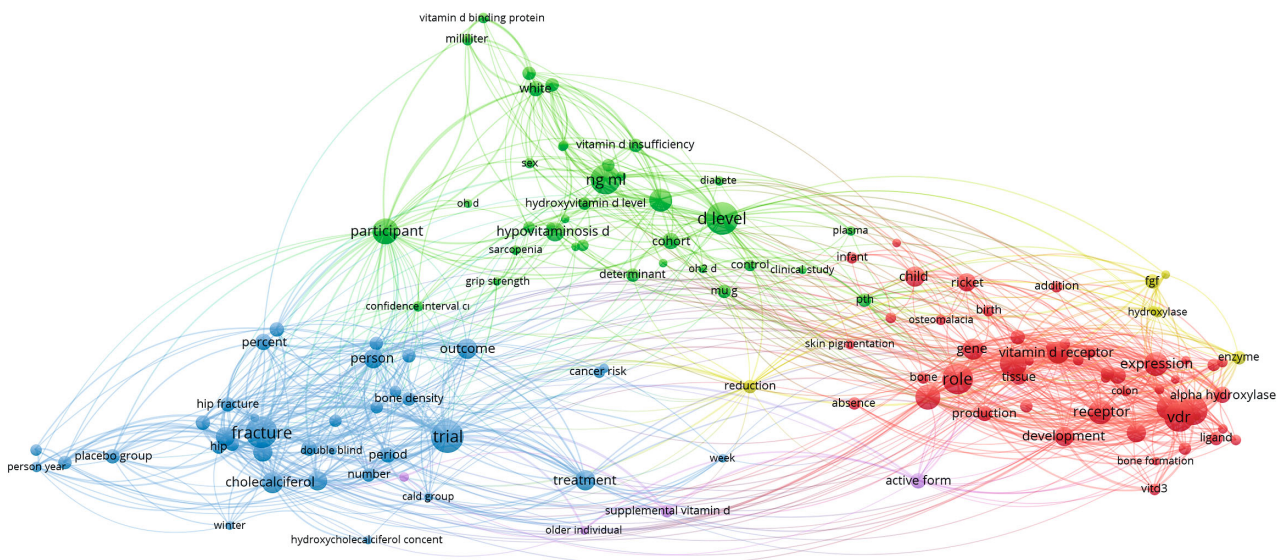
journals of the articles on the T100 citation list had a statistically significantly higher IF value than the journals in the T100 altmetric list (p<0.001), there was no statistically significant difference between Q categories in both lists (p=0.058). The publication language was English for all articles. Journals with two or more articles in both lists, published article counts of the journals, IF values and Q categories are given in Tables 3 and 4, respectively.

Fig. 3. Correlation and clusters of words exceeding 5 or more times in the abstract sections of the most cited 100 articles.

logy, aetiology-risk factors, prevention and others in terms of topic. In the T100 citation list, most publications were on pathophysiology (n = 33) while there were only a few articles (n=4) on this topic in the altmetric list. The number of articles on aetiology and risk factors was similar between the two lists (n=24, n=25, respectively). In the T100 citation list, according to the article topics; there was no difference between the groups in terms of the citation counts (p=0.857), but there was a statistically significant difference in AAS (p=0.019). When the articles in the T100 altmetric list were evaluated according to topics, no statistically significant difference was found in terms of both AAS and citation count (p =0.475, p=0.135, respectively). Table 6 shows the topics of articles in both lists and statistical analysis according to the topics.

Evaluating the first authors of the top 100 cited articles, the leading first authors were Holick MF with 9 articles and Bischoff-Ferrari HA with 6 articles. Holick MF has also the distinction of being the author of the first two top cited articles on the list (Tab. 1). The years, in which most of the top 100 cited articles were published, were 2004 with 13 articles and for the top 100 altmetric articles it was 2020 with 23 articles, 18 of which was about COVID-19 (Tabs 1 and 2).

Discussion

There are many studies about Vitamin D in literature, but only a few bibliometric or altmetric studies were performed. As far as we know, our study is the first comparative study of bibliometric and altmetric analyses of the top 100 most cited articles in academia and top 100 most discussed articles on social media on the topic vitamin D. In 2019, Caballero-Villarraso J et al wrote a

Tab. 5. Study types of the articles in top 100 Altmetric and Citation List.

Study Type	Number of articles	Citations, median (minimum–maximum)	p	AAS, median (minimum–maximum)	p
Top 100 citation list	100	850 (614–8492)		17 (0–1124)	
Original scientific paper	57	806 (614–2167)		10 (0–464)	
Review	34	924 (632–8492)		45 (0–643)	
Others	9		0.158		0.001
Systematic reviews and meta-analyses	7	856 (620–4746)		73 (0–1124)	
Guidelines and advisory documents	2				
Top 100 altmetric list	100	46 (0–8492)		642 (393–6444)	
Original scientific paper	57	28 (0–992)		581 (393–2716)	
Review	31	53 (0–8492)		659 (401–2601)	
Others	12				
Systematic reviews and meta-analyses	6		0.028		0.492
Editorial	3	148 (15–4746)		587 (406–6444)	
Guidelines and advisory documents	2				
Case report	1				

AAS – Altmetric Attention Score

Tab. 6. Topics of the articles in top 100 Citation and Altmetric List.

Topic	Number of articles	Citations, median (minimum–maximum)	p	AAS, median (minimum–maximum)	p
Top 100 citation list	100	850 (614–8492)		17 (0–1124)	
Pathophysiology	33	844 (637–2406)		8 (0–195)	
Etiology and risk factors	24	844 (620–1891)		30 (0–464)	
Prevention	11	870 (629–2167)		81 (0–141)	
Others	32		0.857		0.019
Combination	23				
Epidemiology, Policy	6	863 (614– 8492)		45 (0–1124)	
Treatment	3				
Top 100 altmetric list	100	46 (0–8492)		642 (393–6444)	
Etiology and risk factors	25	28 (0–350)		577 (395–1551)	
Prevention	23	119 (0–992)		706 (406–6444)	
Treatment	15	30 (5–509)		666 (417–943)	
Others	37		0.135		0.475
Combination	32				
Pathophysiology	4	25 (0–8492)		573 (393–2716)	
Epidemiology, Policy	1				

AAS – Altmetric Attention Score

systematic review that evaluates the effects of vitamin D on neu-rodegeneration using bibliometric analysis and drew attention to the growing evolution of research about vitamin D over the last decade (15). Brüggmann et al presented an analysis of the global research productivity on vitamin D and emphasized that high-income countries such as the USA has written most of the high-impact articles and led numerous collaborations (16). Similarly, in our study, the country with the highest number of articles in the T100 citation list was the USA.

The fact that there are 31 articles with more than 1000 cita-tions in the T100 citation list and 68 articles with an altmetric score over 500 in the T100 altmetric list shows that both the academic community and social media are closely interested in this topic. We found no correlation between citation count and AAS in both T100 citation and T100 altmetric list. Contrary to our study, Huang W et al found a significant positive correlation between citation count and AAS in their studies (17).

In the T100 citation list **"Vitamin D deficiency"** by Holick MF published in *New England Journal Of Medicine* in 2007 was the most cited article with 8492 citation (1). It was one of the com-mon articles in both T100 citation and altmetric lists and had 643 AAS. The article was a review about the role of vitamin D in health and makes recommendations for the prevention and treatment of vitamin D deficiency. The second most cited article **"Evaluation, Treatment, and Prevention of Vitamin D Deficiency: an Endocrine Society Clinical Practice Guideline"** by (again) Holick MF et al, published in *Journal Of Clinical Endocrinology & Metabolism* in 2011, was a comprehensive guide for vitamin D deficiency and cited 4746 times (10). The article took place in both of the T100 lists and was very popular with 1124 AAS on social media as well. The third most cited article, with 2406 citation score, **"Toll-like receptor triggering of a vitamin D-mediated human antimicrobial response"** written by Liu PT et al. and published in *Science* in 2006 was a genome study, in which the link between Toll-like re-ceptors and vitamin D-mediated innate immunity was found (18).

When we examined the top 3 articles of the T100 altmetric list, we come across vitamin D supplementation. In the T100 altmet-ric list "Vitamin D supplementation to prevent acute respiratory infections: systematic review and meta-analysis of individual par-ticipant data", by Martineau AR published in the *British Medical Journal* in 2017, had the highest AAS with 6444 (13). 25 eligible randomised controlled studies were evaluated in the article and vitamin D supplementation was found to be safe and protective against acute respiratory tract infections. The reason for having such high AAS may be the COVID-19 pandemic that has affected the whole world since December 2019 and the significant atten-tion of social media users to COVID-19. "Effects of vitamin D supplementation on musculoskeletal health: a systematic review, meta-analysis, and trial sequential analysis" by Bolland MJ et al, published in the *Lancet Diabetes & Endocrinology* in 2018, had the second highest AAS with 2973 (19). 81 randomised controlled trials, reporting fracture, falls or bone mineral density were identi-fied, and it was concluded that vitamin D supplementation did not prevent fractures or falls, nor had clinically meaningful effects on bone mineral density. The article with the third highest AAS (n =

2812) was "Association Between Calcium or Vitamin D Supple-mentation and Fracture Incidence in Community-Dwelling Older Adults : A Systematic Review and Meta-analysis" written by Zhao JG et al. and published in the *Journal of the American Medical Association* in 2017 (20). Randomized clinical trials comparing calcium, vitamin D, or combined calcium and vitamin D supple-ments with a placebo or no treatment for fracture incidence in community-dwelling adults older than 50 years was selected and as the result the use of supplements was not found to be associated with a lower risk of fractures, thus the routine use of the supple-ments in this population were not supported.

When we evaluated the topics of articles in both lists, we found differences. The number of articles on pathophysiology was higher in the T100 citation list (n = 33) than the T100 altmetric list (n = 4). This result shows the curiosity of the academic com-munity to pathophysiology, a specific subject, unlike the general public. Interest in vitamin D, vitamin D deficiency and vitamin D-related diseases grows more and more every year both in the scientific world and social media. Confirming this, in our study, the topic with the highest number of articles in the altmetric list and the second highest number of articles in the citation list was aetiology and risk factors (n = 25, n = 24, respectively). In a quan-titative and co-word analysis, which aims to predict the future research topic trend by evaluating 4625 articles on vitamin D in 2019, the epidemiological study of vitamin D deficiency and vi-tamin D-related diseases are found to be popular research topics similar to ours (21).

The number of articles about COVID-19 in the T100 altmetric list was 20 while no article on this topic was found in T100 citation list. Although it has not been long since the emergence of the CO-VID-19 pandemic, the fact that there are so many articles on this subject in the altmetric list shows how important social media is in our lives. Vitamin D, an inexpensive, easily available and well-known vitamin, has become a hope for people in the prevention and treatment of COVID-19, about which there are still unknown.

The most frequently determined journal, in which the articles on the T100 citation list were published was the *American Jour-nal of Clinical Nutrition* (n = 13) with a 74.69 IF value, while the most frequently encountered journal in the T100 altmetric list was the *Journal of the American Medical Association* (n = 8) with a 45.54 IF. IF of the journals of the articles on the T100 citation list was statistically significantly higher than the journals in the altmetric list (p < 0.001). This can be attributed to the fact that citation count and AAS are different parameters and do not cor-relate with each other.

Our study has limitations. One of the limitations is the evalu-ation of the number of citations over the total number of citations; cited article analysis or self-citation analysis was not performed. The other limitation is that citation counts of the articles in both of the lists were obtained from the WoS database and articles not found in the database were not included in the lists.

Vitamin D is a hot topic in both academia and social media. Altmetric analysis of vitamin D is currently insufficient to replace traditional bibliometric analysis, but it can provide valuable in-formation about the society's interest in this issue. As social me-

dia gains more importance every day in our lives, high altmetric score could affect future interests and direct studies. As well as the number of citations, increasing the altmetric score, which shows the public awareness of the articles is an issue that should be considered important by academicians.

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