

Bibliometric Analysis of 100 Most Cited Articles in Middle East and North Africa (MENA) Region on Implant Prosthodontics

Raj Kiran Chitumalla¹, Faris Z. Jamjoom¹, Ikram Ul Haq², Pillai Arun Gopinathan³, Sulthan Raja Khan¹, Swapna Munaga¹

¹Department of Restorative and Prosthetic Dental Sciences, College of Dentistry, King Saud Bin Abdulaziz University for Health Sciences, Ministry of National Guard Health Affairs, King Abdullah International Medical Research Center, Riyadh, Saudi Arabia, ²College of Dentistry, Academic affairs, King Saud Bin Abdulaziz University for Health Sciences, Riyadh, Saudi Arabia, ³Department of Maxillofacial Surgery and Diagnostic Sciences, College of Dentistry, King Saud Bin Abdulaziz University for Health Sciences Ministry of National Guard Health Affairs King Abdullah International Medical Research Centre, Riyadh, Saudi Arabia

Received : 06-Mar-2024
Revised : 29-Jun-2024
Accepted : 16-Jul-2024
Published : 27-Aug-2024

INTRODUCTION

Brånemark's pioneering discovery of osseointegration has transformed the profession

ABSTRACT

Aim: This study aims to conduct a comprehensive analysis and scientometric evaluation of the top 100 most cited publications in the field of implant prosthodontics, authored by individuals affiliated with nations of the Middle East and North Africa (MENA) region. **Materials and Methods:** In October 2023, the 100 most cited articles were gathered from the Web of Science database using the bibliometric research technique. The analysis was conducted on bibliometric indicators, including the distribution of articles over time, authorship, design of study, field of study, nature of research, contribution from various countries in MENA, international research collaboration, and most frequently used keywords by authors. Chi-square and one-way analysis of variance were used for statistical analysis. VOSviewer software was used to analyze the bibliometric network for co-occurrence among countries, coauthors, and common keywords. **Results:** The results revealed that the top 100 most cited articles from MENA countries on the topic of implant prosthodontics, published between 1995 and 2020, had received an average of 73.31 citations each. About one-third of the papers were published in the top 4 journals. The journal with the most published articles was *Clinical Oral Implant Research*, followed by the *International Journal of Oral & Maxillofacial Implants*, the *International Journal of Prosthodontics*, and the *Journal of Oral and Maxillofacial Surgery*. Saudi Arabia had the distinction of producing the greatest number of highly cited papers. The co-occurrence network analysis using VOSviewer software identified 10–15 related clusters. Research studies with multiple authors received significantly more citations ($P < 0.05$). Significant relationships were observed between the number of citations and journal type (open access vs. non-open access; $P < 0.05$), and also articles published in dental journals received the most citations and were statistically significant ($P = 0.001$). **Conclusion:** Over the last decade, there has been a significant surge in research related to implant prosthodontics. Among the countries in the MENA region, Saudi Arabia has distinguished itself by leading in terms of overall research output. This resource would benefit academicians, clinicians, and researchers in prosthodontics, oral surgery, and periodontic specialties of dentistry.

KEYWORDS: Bibliometrics, citations, dental implants, Middle East and North Africa

Address for correspondence: Dr. Pillai Arun Gopinathan, Department of Maxillofacial Surgery and Diagnostic Sciences, College of Dentistry, King Saud Bin Abdulaziz University for Health Sciences, Ministry of National Guard Health Affairs, King Abdullah International Medical Research Centre, Riyadh 11481, Saudi Arabia. E-mail: arunaswbds007@gmail.com

This is an open access journal, and articles are distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.

For reprints contact: reprints@medknow.com

How to cite this article: Chitumalla RK, Jamjoom FZ, Haq IU, Gopinathan PA, Khan SR, Munaga S. Bibliometric analysis of 100 most cited articles in middle east and North Africa (MENA) region on implant prosthodontics. *J Int Soc Prevent Communit Dent* 2024;14:261-77.

Access this article online	
Quick Response Code: 	Website: https://journals.lww.com/jpcd
	DOI: 10.4103/jispcd.jispcd_34_24

of dentistry by giving an innovative method of replacing missing teeth with dental implants. The clinical utilization of dental implants in oral rehabilitation has already been proven effective in the literature, further known for its long-lasting durability and superior results in terms of both functionality and esthetics.^[1] Extensive literature has been documented about notable advancements in the field of implant dentistry, which has witnessed a rapid evolution of research.^[2-4] Bibliometrics is a field in the quantitative sciences that employs mathematical and statistical methods, including citation analysis, to evaluate the scientific content and influence of a research paper in the scientific world. The surge in scientific literature necessitates scrutiny by the scholarly community to assess both research findings and the impact of research.^[5] A multitude of studies have focused on top-cited articles in dental literature,^[6,7] as well as in other sub-specialties of dentistry, including prosthodontics,^[8] oral and maxillofacial surgery,^[9] periodontics,^[10,11] orthodontics,^[12] endodontics,^[13] and implant dentistry.^[14-16]

A study examining the research production on endodontics conducted by the six Arab nations provided a substantial contribution of 2.82% of the overall global endodontic research, of which 80% of the literature in this field has been published by Saudi Arabia.^[17] A retrospective descriptive analysis was conducted on the most frequently cited papers in Scopus-listed dental journals, which were associated with the Middle East and North Africa (MENA) region, spanning from the years 2011 to 2021. Four journal publications attained top scores in different bibliometric measures and secured the highest positions in the “SCImago Journal Rankings.”^[18]

Numerous have made significant contributions to the progress of implant dentistry,^[2-4,14,15] however, to date, the articles cited in indexed implant-related journals from the MENA region have not been either ranked nor descriptively examined. The MENA region includes nineteen countries and accounts for around 6% of the world’s population.^[19,20] This is the first bibliometric study from the MENA region, which provides insight into the characteristics of the most cited articles that have been published in implant dentistry journals.

The objectives of the study were:

- (1) To examine overall research growth and contribution by the MENA region in implant prosthodontics at a global level.
- (2) To identify the most productive country, author, and research institution concerning average citation per publication.
- (3) To recognize co-authorship and co-occurrence networks among different countries, authors, and common keywords using VOSviewer software (version 1.6.8; Leiden University, Leiden, Netherlands).
- (4) To investigate the characteristics of 100 most cited published papers.

MATERIALS AND METHODS

The Institutional Review Board of the King Abdullah International Medical Research Center approved the study, as indicated by the reference number NRC23R/681/11; as it was the retrospective assessment of public data, ethical approval was not required. The present review methodology was grounded on the Expanded Science Citation Index database, which was accessed through the Web of Science (WoS) Core Collection on October 19, 2023. Boolean operator “OR” was used to enter the search phrases “peri-implant bone resorption,” “implant-supported restorations,” and “dental implants.” The inclusion criteria were original articles, reviews, and case reports, whereas exclusion criteria were classification, conference papers, notes, thesis, short survey, comments, books, and letters. The flow chart for the selection criteria of articles is shown in Figure 1.

The first phase involved using certain bibliometric features to measure the increase in global publications on implant prostheses. Following that, the percentage of the MENA region was calculated, and the significant characteristics of publications were emphasized. Later, two independent investigators assessed the findings and chose the top 100 most cited papers related to dental implant studies. If there was a disagreement, a third investigator was brought in, to achieve a consensus. The full records of the final articles were obtained and sorted by the number of citations in the Excel file and Plain Text file for data analysis.

The articles were additionally scrutinized concerning the name of the publication, the count of citations, the year of publication, the number of contributing authors, and the authors' country (for the research if any author was from the MENA region it was included). Moreover, the average number of citations per year (considering 2023 as the reference year) for all the publications was computed to adjust for the time bias typically present in bibliometric studies. The basic evaluation of the total number of citations tends to favor older papers and poses risks while potentially overlooking more recent impactful publications. Each article was further analyzed based on different study designs. Ultimately, the papers were classified based on their research field into subject areas pertinent to

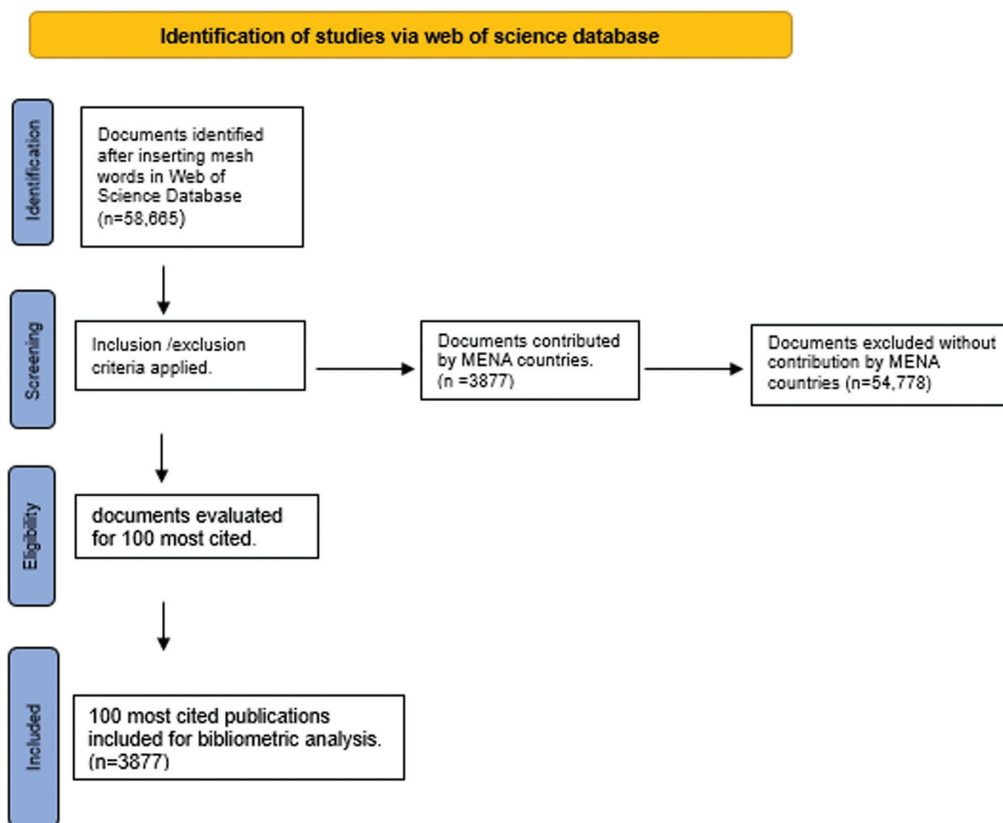


Figure 1: Selection criteria for 100 most cited articles

dental implant studies. For data visualization, text format was interwoven with the VOSviewer software (version 1.6.8; Leiden University, Leiden, The Netherlands).

STATISTICAL ANALYSIS

The top 100 cited papers were statistically tested to compare articles published in dental and nondental journals, clinical versus nonclinical research, open and closed access journals, and authorship patterns were evaluated using the Chi-square test. The research designs of most cited papers were assessed using a one-way analysis of variance (ANOVA). The analysis of the data was performed using Statistical Package for the Social Sciences Statistics for Windows, version 27 (a product of IBM Corp., Armonk, NY, USA). A P value of <0.05 was considered to signify statistical significance.

RESULTS

MEASURING THE PUBLICATION GROWTH AT THE GLOBAL LEVEL ON IMPLANT PROSTHESIS

A total of 58,665 records of publications were identified about implant prostheses indexed in the Wos Core Collection database on October 19, 2023, whereas the first record was found in 1970. Slow

progress was recorded in the first four decades, followed by an exponential increase ($n = 34,092$; 58%) in the last 10 years (2014 to October 2023). The United States submitted the most papers (23.76%), followed by Italy (8.91%), Brazil ($n = 8.06\%$), Germany (8.05%), and Japan (7.97%). The authors from the University of Bern produced the greatest number of documents ($n = 1316$), followed by the Universidade de Sao Paulo ($n = 1282$), Universidade Estadual Paulista ($n = 1275$), University of Michigan ($n = 1172$), and University of Gothenburg ($n = 1148$). Clinical oral implant research was found to be the most preferred source of publication sources, with 3623 documents, followed by *International Journal of Oral Maxillofacial Implant* ($n = 3238$), *Journal of Dental Research* ($n = 2515$), *Journal of Prosthetic Dentistry* ($n = 2241$), and *Clinical Implant Dentistry and Related Research* ($n = 1493$). The bulk of documents (98.71%) were published in English, with just 372, 88, 77, and 54 published in German, French, Italian, and Spanish, respectively. With 507 papers, Hom-Lay Wang was the most productive author, followed by Adriano Piattelli ($n = 446$), Niklaus Peter Lang ($n = 283$), and Christoph H. F. Hammerle ($n = 280$) documents, respectively.

THE SHARE OF THE MENA REGION ON THE PUBLICATION OF IMPLANT PROSTHESIS

The authors from the MENA area contributed 3877 documents, accounting for 6.60% of global document productivity on implant prostheses. Only 33 records were discovered between 1976 and 2000, with around 85% ($n = 3298$) of the documents published in the last decade (2014 to October 2023). Saudi Arabia contributed slightly more than one-third of all documents ($n = 1329$; 34.27%), followed by Iran, Egypt, the United Arab Emirates, and Iraq, which contributed 29%, 19.16%, 5.72%, and 4.56%, respectively. The authors from MENA predominantly collaborated with the United States (15.86%), followed by India (4.87%), and Canada (4.41%). Egyptian country submitted the most documents to the evaluation of institutional productivity, followed by King Saud University and Tehran University of Medical Sciences. The *International Journal of Oral Maxillofacial Implant* was the most preferred source of publications, followed by *Clinical Implant Dentistry and Related Research*, *Journal of Oral Implantology*, *Journal of Prosthetic Dentistry*, and *Journal of Prosthodontics-Implant Esthetic and Reconstructive Dentistry*. Fahim Vohra was the most productive author, with 73 documents, followed by Tariq Abduljabbar ($n = 68$), Fawad Javed ($n = 67$), and Moustaf Abdou Elsayad ($n = 64$), respectively. All 3,877 documents were cited 51,992 times, with an average of 13.41 citations per document, and approximately 39% ($n = 1518$) were open access. Table 1 demonstrates the share of the MENA region in Implant prosthodontics during the last 10 years. The

data revealed authors affiliated with the MENA region contributed 9.65% of global research.

DISTRIBUTION OF 100 MOST CITED ARTICLES AND CITATION METRICS BY YEAR

The authors linked with the MENA region contributed to the 100 most cited articles on implant prosthesis during a span of 24 years, from 1997 to 2020. Figure 2 shows timeline distribution of articles. The year 2018 had the most papers published ($n = 14$), followed by 2017 and 2020 with 11 articles each. The majority of cited articles ($n = 52$) were published between the 5 years of 2016 and 2020. The articles were divided into three equal sections, each covering around 8 years. The most recent interval (2013–2020) had the most articles published ($n = 75$), followed by the intermediate interval (2005–2012) with 20 articles, and the initial interval (1997–2004) with 5 articles that were the most cited. The top 100 articles were cited 7331 times, for an average of 73.31 citations per article. The maximum citation impact was achieved by a single article published in 2005 (208 cites/article), which was followed by four papers published in 2008 (148.75 cites/article) and eight articles published in 2016 (101.63 cites/article). (Note. The appendix at the end section of the article contains the list of the 100 articles that have been cited the most).

The Chi-square analysis revealed a significant statistical association between journal types (open vs. closed access) and number of citations [Table 2]. In addition, the type of authorship (single/multiple) had a statistically significant ($P = 0.001$) effect on citations comparing single and multiple authors [Table 3] that is, research publications with multiple authors received much more citations than single authors.

Table 1: Distribution of global research productivity with the share of MENA region, with annual growth rate by years

Year	Total global research productivity	Share of MENA region (%)	Annual growth rate
2014	2568	161 (6.26%)	
2015	2728	165 (6.04%)	2.48
2016	2716	165 (6.07%)	0.00
2017	2846	222 (7.80%)	34.55
2018	3341	349 (10.44%)	57.21
2019	3758	335 (8.91%)	-4.01
2020	4029	386 (9.58%)	15.22
2021	4440	482 (10.85%)	24.87
2022	4556	594 (13.03%)	23.24
2023**	3110	433 (13.92%)	-27.10
Total	34,092	3292 (9.65%*)	14.05*

*Average citations per article and average annual growth rate.

**The Dataset of 2023 was limited from January 1, 2023, to October 19, 2023

PREFERRED SOURCES OF PUBLICATIONS

Out of the 100 articles with the most citations, 43 journals have published them, and 27 out of these journals have each published one article. One-third of the total articles ($n = 34$) were published in the top four journals and the highest number of articles were published in *Clinical Oral Implant Research*, followed by *International Journal of Oral & Maxillofacial Implants*. Articles published in the *International Journal of Prosthodontics* received the most citations, followed by the *Journal of Oral and Maxillofacial Surgery*. The impact factor ratio varies from a minimum of 1.6 to a maximum of 7.9 and most of the journals ($n = 10$) fall in the top quartile (Q1) rank [Table 4]. Most articles ($n = 61$) published in the journals were included in the category of *Dentistry, Oral Surgery & Medicine* and

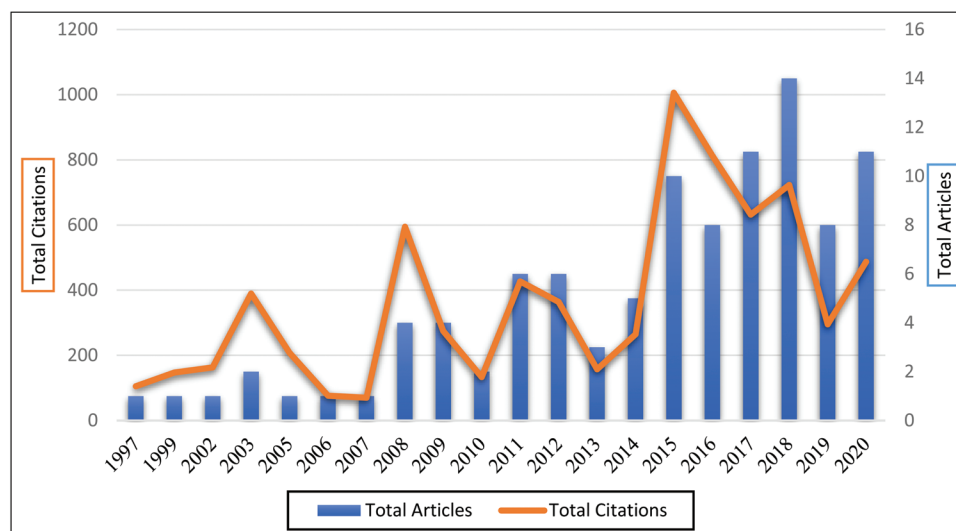


Figure 2: Distribution of most cited articles and citations by year

Table 2: Distribution of open and closed access journals among 100 most cited articles (statistically significant * $P < 0.05$)

S. no.	Type of publication	Total articles	Total citation	Citation impact	Chi-square test
1	Open access	24	1373	57.2	0.001
2	Closed access (subscription-based)	76	5958	78.39	

Table 3: Distribution of articles based on single and multiple authors among 100 most cited articles (statistically significant * $P < 0.05$)

S. no.	Authors	Total articles	Total citation	Citation impact	Chi-square test
1	Single	5	359	71.8	0.001
2	Multiple	95	6972	73.38	

these articles gained the highest citation ratio (78.11 cites/article).

There were 76 articles published in dental and 24 in nondental journals, totaling around 7331 citations. The Chi-square test found a significant ($P = 0.001$) difference in citation impact for articles published in dental journals when compared with nondental journals [Table 5]. Among the top 100 most cited articles, 38 were clinical studies, whereas 62 were nonclinical studies, and the total number of citations was 7331. However, there was no statistically significant difference ($P = 0.06$) in the citation impact of clinical and nonclinical publications [Table 6].

The analysis of journals with the country of origin showed that 72 articles were published in the journals

published from the United States, followed by England ($n = 9$), the Netherlands ($n = 7$), Switzerland ($n = 5$), and Ireland ($n = 2$). One article each was published in the five journals of five different countries (Canada, France, India, Scotland, and Spain). No articles from the list of the most cited ones were published in journals originating from the MENA region.

RATIO OF CONTRIBUTION BY COUNTRIES OF THE MENA REGION

The most cited articles were written by authors from 15 different MENA nations. Saudi Arabia provided the most articles ($n = 40$), followed by Iran, Egypt, and the United Arab Emirates, with 19, 17, and 9 articles, respectively. Iraq, Kuwait, Libya, Morocco, Palestine, Syria, and Yemen each contributed one article. In 68 articles, MENA region authors cooperated with authors from 22 countries. The United States had the most collaborations ($n = 26$), followed by Canada, England, and Germany, each with nine publications. Ten countries collaborated on a single article. Figure 3 shows a bar graph distribution among MENA nations.

Approximately one-third of the publications ($n = 32$) were the outcome of research collaboration among MENA authors, whereas most of the collaboration ($n = 68$) was undertaken with other regions of the world. The citation impact of research collaboration with other regions was larger ($n = 5347$; 78.63 cites/article) than collaboration within the MENA region ($n = 1984$; 62 cites/article).

CO-AUTHORSHIP NETWORK OF COUNTRIES

The co-authorship network of nations consisted of 10 clusters, generated with the VOSviewer program [Figure 4]. The first cluster included six nations (Belgium, Canada, Iran, Malta, Spain, and Yemen), with Iran

Table 4: Top-16 frequently used sources of publications

S. no.	Name of journal	Impact Factor (Q)	Total articles	Total citations	Citation impact
1.	<i>Clinical Oral Implants Research</i>	4.3 (Q1)	11	604	54.91
2.	<i>International Journal of Oral & Maxillofacial Implants</i>	2.0 (Q3)	9	844	93.78
3.	<i>Journal of Prosthodontics-Implant Esthetic and Reconstructive Dentistry</i>	4.0 (Q1)	7	353	50.43
4.	<i>Clinical Implant Dentistry and Related Research</i>	3.6 (Q1)	7	312	44.57
5.	<i>Journal of Oral Implantology</i>	1.6 (Q4)	6	415	69.17
6.	<i>Journal of Periodontology</i>	4.3 (Q1)	6	360	60.00
7.	<i>Journal of Prosthetic Dentistry</i>	4.6 (Q1)	5	419	83.80
8.	<i>Implant Dentistry</i>	3.0 (Q2)	4	198	49.50
9.	<i>International Journal of Prosthodontics</i>	2.3 (Q3)	3	395	131.67
10.	<i>Journal of Clinical Periodontology</i>	6.7 (Q1)	3	137	45.67
11.	<i>Journal of Oral and Maxillofacial Surgery</i>	1.9 (Q4)	2	235	117.50
12.	<i>Dental Materials</i>	5.0 (Q1)	2	188	94.00
13.	<i>Journal of the Mechanical Behavior of Biomedical Materials</i>	3.9 (Q2)	2	145	72.50
14.	<i>Materials Science & Engineering C-Materials for Biological Applications</i>	7.9 (Q1)	2	135	67.50
15.	<i>Cochrane Database of Systematic Reviews</i>	8.4 (Q1)	2	117	58.50
16.	<i>Journal of Dentistry</i>	4.4 (Q1)	2	110	55.00

being the most active, with 19 articles. There were five countries (England, Finland, Iraq, Scotland, and Syria) in the second cluster, and England emerged most

Table 5: Distribution of articles based on dental and nondental journals among 100 most cited articles (statistically significant * $P < 0.05$)

S. no.	Type of journals	Total articles	Total citation	Citation impact	Chi-square test
1	Dental journals	76	5679	74.72	0.001
2	Nondentalj	24	1652	68.83	

Table 6: Distribution of articles based on clinical significance among 100 most cited articles (statistically significant * $P < 0.05$)

S. no.	Format of study	Total articles	Total citation	Citation impact	Chi-square test
1	Clinical studies	38	2643	69.55	0.06
2	Nonclinical studies	62	4688	75.61	

productive with nine articles. Saudi Arabia emerged as the most prolific nation with 40 articles in a different cluster that included the Netherlands, Sweden, India, and Saudi Arabia.

TOP-10 MOST PRODUCTIVE AUTHORS

A total of 381 authors contributed to the top 100 most referenced articles, with 334 (87.66%) contributing to a single article each. Table 7 depicts 10 authors who contributed between three and five articles each. Fawad Javed and Panos Paraspyridakos shared first place with five papers each, however, Fawad Javed's citation impact was slightly higher than Panos Papaspyridakos'. Zohaib Khurshid only published three works, with the largest citation impact.

The co-authorship network of authors, consisting of five clusters showed 30 authors related to each other [Figure 5]. There were nine authors in the first cluster, Panos Papaspyridakos and Konstantinos Chochlidakis were identified as the most active with five and four articles, respectively. There are seven authors in the second cluster, Zuhair S. Natto and Hom-Lay Wang had been the most connected with three articles each. Interestingly, Fawad Javed, the most productive author, has not been listed among the top 30 authors that were related to each other.

FREQUENTLY USED KEYWORDS

VOSviewer found 317 author-used terms, of which 267 (84.22%) and 35 (11%), respectively, have appeared one and two times. The recurrence rate of the top 15 keywords ranges from 3 to 23. Figure 6 shows commonly used keywords. Dental implants ($n = 23$) is the most frequently occurring keyword, followed by osseointegration and titanium (eight times each). Figure 7 depicts the

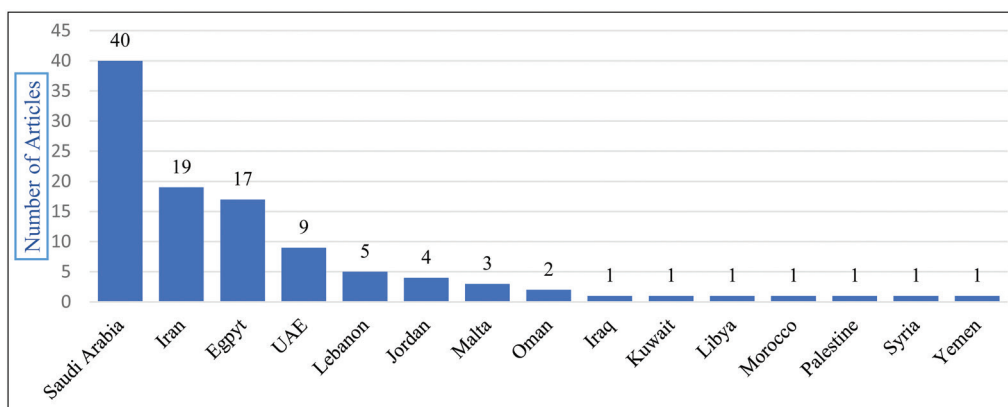


Figure 3: Article distribution among countries belonging to the MENA region

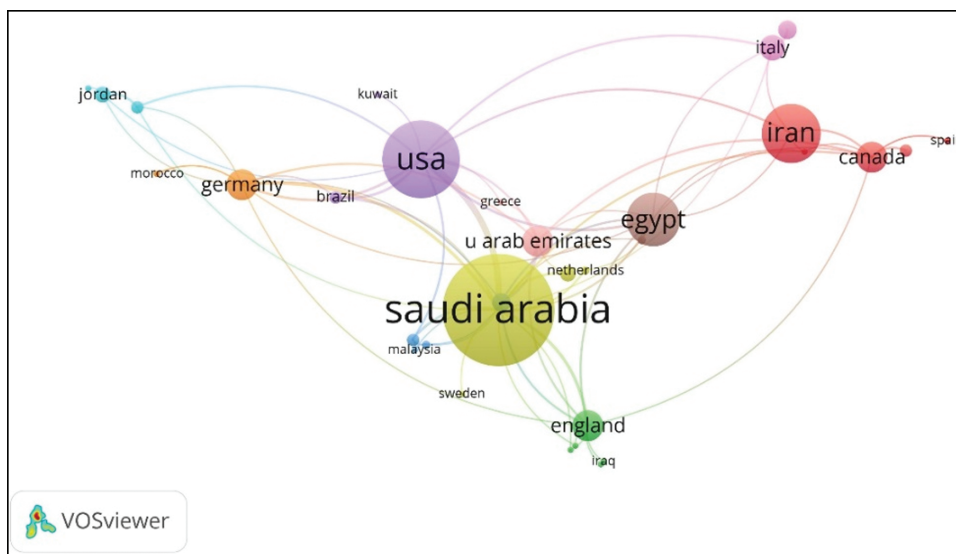


Figure 4: Co-authorship network of countries

Table 7: Top-10 most productive authors

S. no.	Name of author	Total articles	Total citations	Citation impact
1	Fawad Javed	5	271	54.20
2	Panos	5	245	49.00
3	Papaspyridakos Konstantinos Chochlidakis	4	178	44.50
4	Zohaib Khurshid	3	568	189.33
5	Hom-Lay Wang	3	183	61.00
6	Momen A. Atieh	3	159	53.00
7	Marzieh Alikhasi	3	153	51.00
8	Hans-Peter Weber	3	141	47.00
9	Abdulaziz A. Al-Kheraif	3	140	46.67
10	Zuhair S. Natto	3	109	36.33

co-occurrence network of keywords, with 272 keywords connecting in 26 clusters out of 317. The first and the most rich cluster consisted of 24 keywords (AISI 316L stainless steel, biomaterials, ceramic, corrosion, HA coating, immediate implants, implant survival, infection control,

ion release, laser, lasers, oral cancer, peri-implant bone loss, peri-implant mucositis, periimplantitis, periodontology, photodynamic therapy, platform-switching, radiation therapy, surface chemistry, surface roughness, systematic review, TI coating, and zirconium).

DISTRIBUTION OF ARTICLES BY STUDY DESIGNS

Although *in vitro* studies had the greatest number of articles ($n = 26$), they had a lower citation impact, whereas analytical studies ($n = 22$) received the highest citation impact (IF). Finally, the least cited was the descriptive study. The statistical analysis of one-way ANOVA was applied for the total citation and citation impact among different types of study designs and revealed a statistical significance ($P = 0.000$) [Table 8 shows different study designs].

DISCUSSION

The current study sought to explore the patterns and characteristics of the 100 most cited publications on implant prosthodontics published by authors from the

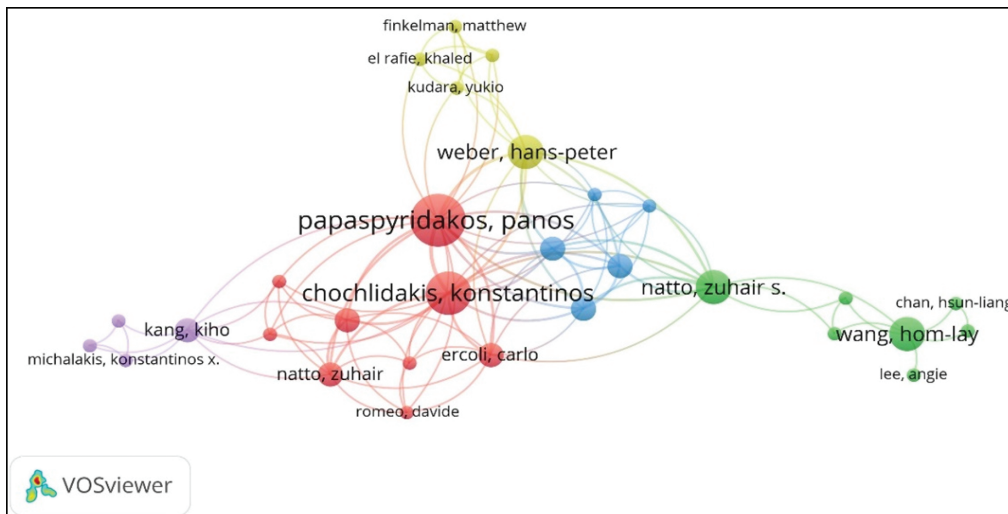


Figure 5: Co-authorship network of authors

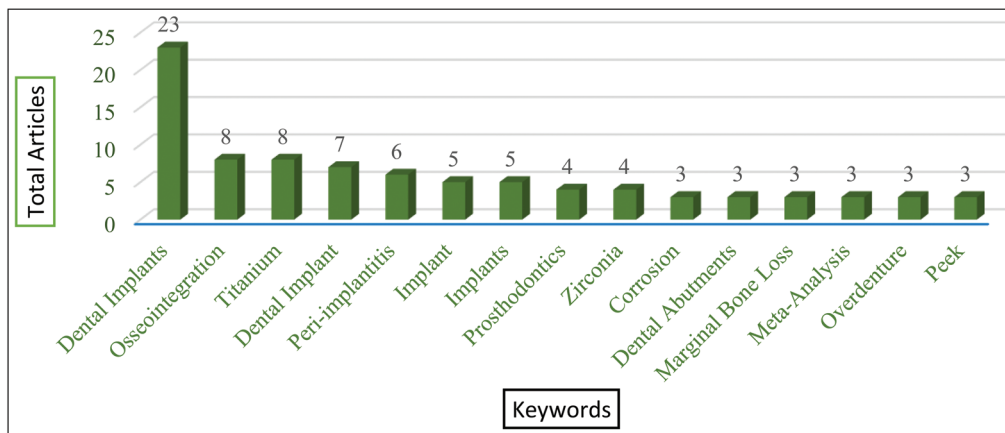


Figure 6: Top 15 most occurred keywords

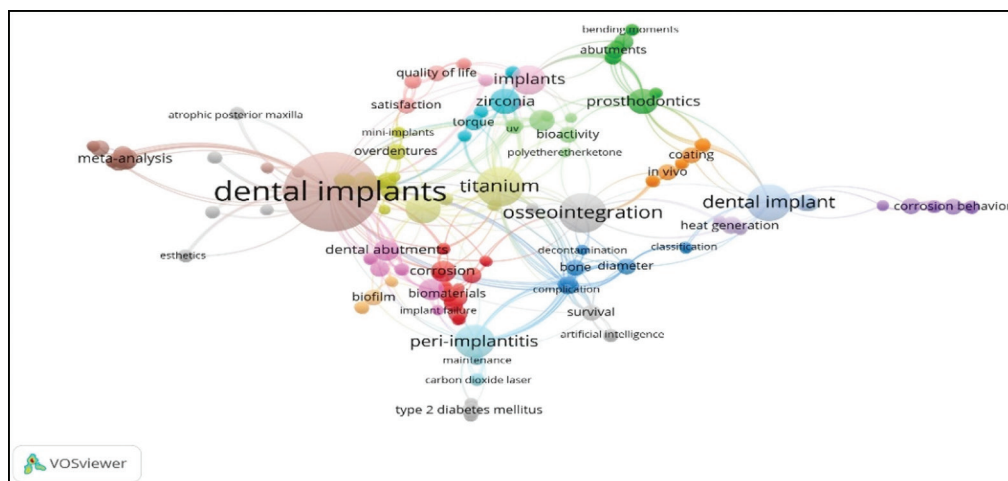


Figure 7: Co-occurrence network of author-used keywords

MENA region as indexed in the WoS database. The countries of the MENA region have varying levels of economic development and account for 6% of the global population. Even though research on implant prosthodontics began in the MENA region in 1971,

there has been an 85% increase in research over the last 10 years (2014–2023). Overall, the MENA region supplied 6.60% of global research output in implant prosthodontics, but this ratio would rise to 13.92% by 2023. Saudi Arabia contributed slightly more than

Table 8: Distribution of 100 most cited articles by different study design (statistically significant * $P < 0.05$)

S. no	Study design	Total articles	Total citation	Citation impact	One-way ANOVA
1	<i>In vitro</i> studies	26	1597	61.42	$F = 149.9$ $P = 0.000$
2	Systematic review and meta-analysis	20	1078	163.42	
3	Analytical study	22	1388	247.3	
4	Narrative review	16	1991	124.44	
5	Randomized clinical trials	8	791	98.88	
6	Animal study	7	450	64.29	
7	Descriptive study	1	36	36	

one-third (34%) of all MENA area research on implant prosthodontics. This substantial expansion indicates that the MENA region has made a noteworthy contribution in recent years, another study revealed that the key bibliometric indicators, related to the publication of implantology articles in dental journals listed in the Journal Citation Reports from 2009 to 2013, exhibited upward trends.^[15]

According to the present review, the 100 most cited articles on implant prosthodontics were published between 1997 and 2020, with an average of 73.31 citations per article, whereas another study looked at the literature on dental implants published between 2007 and 2016, that examined 12,114 papers that were cited with an average of 12.49 citations per paper.^[21]

In the present review, 381 authors contributed to the 100 most cited publications on implant prosthodontics, with 334 (87.66%) authors publishing one article each. Another study found that out of the 264 authors who contributed to the top 100 most cited papers in implant dentistry, 82.2% ($n = 217$) had one top-cited paper each, and 9.8% ($n = 26$) had two top-cited papers each.^[4] According to our findings, the authors of the 100 most referenced publications came from 38 different nations, including 15 from the MENA area and 22 from other collaborating countries. Saudi Arabia led in terms of productivity, contributing 40 articles, whereas the United States, with 26 articles, was the country that collaborated the most. According to another study, authors from 19 nations contributed to the top 100 most cited publications on dental implants, with the United States producing the most articles ($n = 29$).^[4] The study discovered a paucity of scientific collaboration among MENA authors.^[22] Only one essay was written in collaboration with authors from MENA nations, according to our research.

Our results corroborated the findings of a previous study, which discovered that the articles that received

the most citations were found in the Clinical Oral Implant Research, with the *International Journal of Oral & Maxillofacial Implants* coming in second.^[4] The analysis of keywords employed by the authors indicated that dental implants, osseointegration, and titanium were the predominant words in our study, whereas another study examined the term “Implant” as the most frequently utilized, followed by “bone” and “prosthesis.”^[15]

In the present study, an assessment of research methodologies indicated that *in vitro* investigations were predominant, followed by narrative reviews, systematic studies, randomized control trials, and animal studies. Another study of the top 100 implant dentistry publications indicated that *in vivo*, case series, and narrative reviews were the more commonly employed study designs, respectively.^[4]

This was the first bibliometric study done on implant prosthodontics in the MENA region, which is a knowledge gap in this study. Studies reveal that there has been underinvestment in public health, medical education, and research in several MENA nations. Although, growth has picked up across the area and is expected to improve in the coming years. However, attaining development in those domains would need coordination between health officials and healthcare experts.^[18]

Second, the number of researchers from the MENA countries who are currently engaged in research and academic pursuits in Europe, the United States, and other parts of the world is unknown.^[16] Our search query in the Scopus database depended on affiliation address as one of the authors must be affiliated with one of the Arab countries. The dental institutions and dental societies of the MENA countries should come forward with dental research policies, and the native dental researchers should invite other MENA researchers residing abroad for research collaborations.

Identifying the articles in the literature with the highest classic and current relevance may also contribute to and encourage the development of graduate programs specializing in implant dentistry. Finally, the authors hope that this article will bring further recognition to the researchers, institutions, and scientific journals that have contributed most to the development of the specialty of implant dentistry.

LIMITATIONS

Certain studies have not been reached by our search criteria, given the results are based on data retrieval

from WoS. Additionally, only the WoS citation metrics, excluding self-citations, were used. Furthermore, publications produced after 2020 were unable to be incorporated into the current study because there were time limitations in acquiring citation data, and these articles have not been referenced in most of the top 100 cited articles. In addition, productive institutions from MENA nations were not addressed.

The current bibliometric analysis relied only on the WoS database, which may have resulted in the removal of relevant papers that WoS does not index. Other databases, such as Scopus and Google Scholar, include bibliometric data on published articles. Google Scholar content coverage is uncertain, and results vary in their accuracy, whereas citation analysis is disregarded by PubMed. However, WoS offers more complete information and superior graphics than Scopus's citation analysis and most probably WoS was created with the goal of pleasing users in citation analysis.^[23,24] Furthermore, it is recognized as the gold standard in publishing bibliometric research.^[25] Therefore, studies could be conducted to integrate all the search databases of Scopus and PubMed for a thorough coverage of this vast topic.

CONCLUSION

This is the first comprehensive bibliometric analysis study carried out on implant prosthodontics from 1997 to 2020, which revealed the following.

- 1 Saudi Arabia, Iran, Egypt, and the United Arab Emirates are the most productive in research from the MENA region.
- 2 The most prolific collaborating nations were the USA, Canada, England, and Germany.
- 3 Egyptian Knowledge Bank submitted the most documents for the evaluation of institutional productivity, followed by King Saud University.
- 4 The journal with the greatest impact in terms of citations was the *International Journal of Prosthodontics*, with the *Journal of Oral and Maxillofacial Surgery* coming next. In terms of the number of papers published, *Clinical Oral Implant Research* led the way, followed by the *International Journal of Oral and Maxillofacial Implants*.
- 6 The most common keywords used were dental implants, followed by osseointegration and titanium.
- 7 There was a steady increase in the publication of articles on implant prostheses following 2014, emphasizing the significance of the subject matter.
- 8 Analytical studies received the highest citation impact among different study designs.

In the current review, the 100 most frequently cited papers from the MENA region, could serve

as a valuable reference for students, researchers, and clinicians working in the dental specialties of prosthodontics, periodontics, and maxillofacial surgery to plan strategies for future research on implant prostheses.

ACKNOWLEDGEMENT

Not applicable.

FINANCIAL SUPPORT AND SPONSORSHIP

Nil.

CONFLICTS OF INTEREST

There are no conflicts of interest.

AUTHORS CONTRIBUTIONS

Conceptualization: Raj Kiran Chitumalla, Ikram Ul Haq, and Faris Z. Jamjoom, Investigation: Ikram Ul Haq, Raj Kiran Chitumalla, and Arun Gopinathan Pillai. Formal analysis: Raj Kiran Chitumalla, Sulthan Ibrahim Raja Khan, and Swapna Munaga. Validation: Faris Z. Jamjoom, Swapna Munaga, Arun Gopinathan Pillai, Sulthan Ibrahim Raja Khan, and Project administration: Raj Kiran Chitumalla, Ikram Ul Haq and Arun Gopinathan Pillai.

ETHICAL POLICY AND INSTITUTIONAL REVIEW BOARD STATEMENT

Not applicable.

PATIENT DECLARATION OF CONSENT

Patient data involved.

DATA AVAILABILITY STATEMENT

Not applicable.

REFERENCES

1. Branemark PI. Osseointegration and its experimental background. *J Prosthet Dent* 1983;50:399-410.
2. Borges GA, Dini C, Medeiros MMD, Rodrigues Garcia RCM, Barao VAR, Mesquita MF. Bibliometric assessment in implant-retained overdenture articles: Mapping citation and journal impact factor trends. *J Prosthet Dent* 2022;11:S0022-3913(22)00691.
3. Lorusso F, Noumbissi S, Francesco I, Rapone B, Khater AGA, Scarano A. Scientific trends in clinical research on zirconia dental implants: A bibliometric review. *Materials (Basel)* 2020;13:5534.
4. Fardi A, Kodonas K, Lillis T, Veis A. Top-cited articles in implant dentistry. *Int J Oral Maxillofac Implants* 2017;32:555-64.
5. Donthu N, Kumar S, Mukherjee D, Pandey N, Lim WM. How to conduct a bibliometric analysis: An overview and guidelines. *J Bus Res* 2021;133:285-96.
6. Ahmad P, Alam MK, Jakubovics NS, Schwendicke F, Asif JA. 100 years of the *Journal of Dental Research*: A bibliometric analysis. *J Dent Res* 2019;98:1425-36.
7. Feijoo JF, Limeres J, Fernandez-Varela M, Ramos I, Diz P. The 100 most cited articles in dentistry. *Clin Oral Investig* 2014;18:699-706.

8. Praveen G, Chaithanya R, Alla RK, Shammas M, Abdurahiman VT, Anitha A. The 100 most cited articles in prosthodontic journals: A bibliometric analysis of articles published between 1951 and 2019. *J Prosthet Dent* 2020;123:724-30.
9. Grillo R, Al-Moraissi E, Balel Y, Eshghpour M, Samieirad S, Teixeira RG. Oral and maxillofacial literature from Middle East: A bibliometric analysis and list of top-100 most cited articles. *J Stomatol Oral Maxillofac Surg* 2023;124:101293.
10. Aljabbary RS, Ul Haq I, Shujaat S. Bibliometric analysis of the 100 most-cited articles on periodontics in the Arab world. *Cureus* 2023;15:e45734.
11. Corbella S, Francetti L, Taschieri S, Weinstein R, Del Fabbro M. Analysis of the 100 most-cited articles in periodontology. *J Investig Clin Dent* 2017;8:e12222.
12. Hui J, Han Z, Geng G, Yan W, Shao P. The 100 top-cited articles in orthodontics from 1975 to 2011. *Angle Orthod* 2013;83:491-9.
13. Fardi A, Kodonas K, Gogos C, Economides N. Top-cited articles in endodontic journals. *J Endod* 2011;37:1183-90.
14. Alarcon MA, Esparza D, Montoya C, Monje A, Faggion CM. The 300 most-cited articles in implant dentistry. *Int J Oral Maxillofac Implants* 2017;32:e1-8.
15. Tarazona B, Vidal-Infer A, Alonso-Arroyo A. Bibliometric analysis of the scientific production in implantology (2009-2013). *Clin Oral Implants Res* 2017;28:864-70.
16. Dini C, Pereira MMA, Souza JGS, de Avila ED, Barao VAR. Mapping the trends and impact of research collaboration between countries in oral implantology publications: A bibliometric analysis from 1999 to 2019. *J Prosthet Dent* 2022. doi:10.1016/j.prosdent.2022.10.009.
17. Alfadley AA, Ul Haq I, Alfawaz HA, Jamleh AO. Scientometric evaluation of endodontic publications by Gulf Cooperation Council region in 21st century. *Saudi Dent J* 2022;34:107-13.
18. Roghanizadeh L, Akbarzadeh Baghban A, Azizzadeh J, Asgary S. A bibliometric study on the top 101 most-cited articles of Dental Journals of the Middle East/North Africa countries from 2011 to 2021. *J Lasers Med Sci* 2023;14:e15.
19. MENA definition. Available from: <https://worldpopulationreview.com/country-rankings/mena-countries>. [Last accessed on 06 Mar 2024].
20. List of MENA countries. Available from: <https://www.worldbank.org/en/region/mena>. [Last accessed on 6th Mar 2024].
21. Yeung AWK, Leung WK. Citation network analysis of dental implant literature from 2007 to 2016. *Int J Oral Maxillofac Implants* 2018;33:1240-6.
22. Mubin O, Alnajjar F, Arsalan M. HCI research in the Middle East and North Africa: A bibliometric and socioeconomic overview. *Int J Hum-Comput Interact* 2022;38:1546-1562.
23. Kulkarni AV, Aziz B, Shams I, Busse JW. Comparisons of citations in Web of Science, Scopus, and Google Scholar for articles published in general medical journals. *JAMA* 2009;302:1092-6.
24. Falagas ME, Pitsouni EI, Malietzis GA, Pappas G. Comparison of PubMed, Scopus, Web of Science, and Google Scholar: Strengths and weaknesses. *FASEB J* 2008;22:338-42.
25. Pranckute R. Web of Science (WoS) and Scopus: The titans of bibliographic information in today's academic world. *Publications* 2021;9:12.

APPENDIX

Appendix: 100 most cited articles according to total citation and citation density by year

S. no.	Bibliographic details of articles	Total citations	Citation density by year
1	Najeeb S, Zafar MS, Khurshid Z, Siddiqui F. Applications of polyetheretherketone (PEEK) in oral implantology and prosthodontics. <i>J Prosthodont Res.</i> 2016;60(1):12-19. doi:10.1016/j.jpor.2015.10.001	457	57.13
2	Saini M, Singh Y, Arora P, Arora V, Jain K. Implant biomaterials: A comprehensive review. <i>World J Clin Cases.</i> 2015;3(1):52-57. doi:10.12998/wjcc.v3.i1.52	438	48.67
3	Awad MA, Lund JP, Shapiro SH, <i>et al.</i> Oral health status and treatment satisfaction with mandibular implant overdentures and conventional dentures: a randomized clinical trial in a senior population. <i>Int J Prosthodont.</i> 2003;16(4):390-396	247	11.76
4	ung RE, Holderegger C, Sailer I, Khraisat A, Suter A, Hämmerle CH. The effect of all-ceramic and porcelain-fused-to-metal restorations on marginal peri-implant soft tissue color: a randomized controlled clinical trial. <i>Int J Periodontics Restorative Dent.</i> 2008;28(4):357-365	241	15.06
5	Bouri A Jr, Bissada N, Al-Zahrani MS, Faddoul F, Nouneh I. Width of keratinized gingiva and the health status of the supporting tissues around dental implants. <i>Int J Oral Maxillofac Implants.</i> 2008;23(2):323-326	216	13.50
6	Attard NJ, Zarb GA. Immediate and early implant loading protocols: a literature review of clinical studies. <i>J Prosthet Dent.</i> 2005;94(3):242-258. doi:10.1016/j.prosdent.2005.04.015	208	10.95
7	Sharawy M, Misch CE, Weller N, Tehemar S. Heat generation during implant drilling: the significance of motor speed. <i>J Oral Maxillofac Surg.</i> 2002;60(10):1160-1169. doi:10.1053/joms.2002.34992	163	7.41
8	Tehemar SH. Factors affecting heat generation during implant site preparation: a review of biologic observations and future considerations. <i>Int J Oral Maxillofac Implants.</i> 1999;14(1):127-136	147	5.88
9	Fathi MH, Salehi M, Saatchi A, Mortazavi V, Moosavi SB. <i>In vitro</i> corrosion behavior of bioceramic, metallic, and bioceramic-metallic coated stainless steel dental implants. <i>Dent Mater.</i> 2003;19(3):188-198. doi:10.1016/s0109-5641(02)00029-5	143	6.81
10	Rasouli R, Barhoum A, Uludag H. A review of nanostructured surfaces and materials for dental implants: surface coating, patterning and functionalization for improved performance. <i>Biomater Sci.</i> 2018;6(6):1312-1338. doi:10.1039/c8bm00021b	112	18.67
11	Osman RB, van der Veen AJ, Huiberts D, Wismeijer D, Alharbi N. 3D-printing zirconia implants; a dream or a reality? An <i>in vitro</i> study evaluating the dimensional accuracy, surface topography and mechanical properties of printed zirconia implant and discs. <i>J Mech Behav Biomed Mater.</i> 2017;75:521-528. doi:10.1016/j.jmbbm.2017.08.018	112	16.00
12	Adibrad M, Shahabuei M, Sahabi M. Significance of the width of keratinized mucosa on the health status of the supporting tissue around implants supporting overdentures. <i>J Oral Implantol.</i> 2009;35(5):232-237. doi:10.1563/AAID-JOI-D-09-00035.1	107	7.13
13	Cordioli G, Majzoub Z. Heat generation during implant site preparation: an <i>in vitro</i> study. <i>Int J Oral Maxillofac Implants.</i> 1997;12(2):186-193	105	3.89
14	Tawil G, Younan R, Azar P, Sleilati G. Conventional and advanced implant treatment in the type II diabetic patient: surgical protocol and long-term clinical results. <i>Int J Oral Maxillofac Implants.</i> 2008;23(4):744-752	93	5.81
15	Xuereb M, Camilleri J, Attard NJ. Systematic review of current dental implant coating materials and novel coating techniques. <i>Int J Prosthodont.</i> 2015;28(1):51-59. doi:10.11607/ijp.4124	92	10.22
16	Razavi M, Fathi M, Savabi O, Vashae D, Tayebi L. <i>In vivo</i> assessments of bioabsorbable AZ91 magnesium implants coated with nanostructured fluoridated hydroxyapatite by MAO/EPD technique for biomedical applications. <i>Mater Sci Eng C Mater Biol Appl.</i> 2015;48:21-27. doi:10.1016/j.msec.2014.11.020	91	10.11
17	Al-Nsour MM, Chan HL, Wang HL. Effect of the platform-switching technique on preservation of peri-implant marginal bone: a systematic review. <i>Int J Oral Maxillofac Implants.</i> 2012;27(1):138-145	91	7.58

S. no.	Bibliographic details of articles	Total citations	Citation density by year
18	Koutouzis T, Wallet S, Calderon N, Lundgren T. Bacterial colonization of the implant-abutment interface using an <i>in vitro</i> dynamic loading model. <i>J Periodontol.</i> 2011;82(4):613-618. doi:10.1902/jop.2010.100415	88	6.77
19	Atieh MA, Alsabeeha NH, Payne AG, Duncan W, Faggion CM, Esposito M. Interventions for replacing missing teeth: alveolar ridge preservation techniques for dental implant site development. <i>Cochrane Database Syst Rev.</i> 2015;2015(5):CD010176. doi:10.1002/14651858.CD010176.pub2	83	9.22
20	Al-Ekrish AA, Ekram M. A comparative study of the accuracy and reliability of multidetector computed tomography and cone beam computed tomography in the assessment of dental implant site dimensions. <i>Dentomaxillofac Radiol.</i> 2011;40(2):67-75. doi:10.1259/dmfr/27546065	83	6.38
21	Rokn A, Aslroosta H, Akbari S, Najafi H, Zayeri F, Hashemi K. Prevalence of peri-implantitis in patients not participating in well-designed supportive periodontal treatments: a cross-sectional study. <i>Clin Oral Implants Res.</i> 2017;28(3):314-319. doi:10.1111/clr.12800	81	11.57
22	Baqain ZH, Moqbel WY, Sawair FA. Early dental implant failure: risk factors. <i>Br J Oral Maxillofac Surg.</i> 2012;50(3):239-243. doi:10.1016/j.bjoms.2011.04.074	79	6.58
23	Najeeb S, Bds ZK, Bds SZ, Bds MS. Bioactivity and osseointegration of PEEK are inferior to those of titanium: A systematic review. <i>J Oral Implantol.</i> 2016;42(6):512-516. doi:10.1563/aaid-joi-D-16-00072	78	9.75
24	Javed F, Al-Hezaimi K, Almas K, Romanos GE. Is titanium sensitivity associated with allergic reactions in patients with dental implants? A systematic review. <i>Clin Implant Dent Relat Res.</i> 2013;15(1):47-52. doi:10.1111/j.1708-8208.2010.00330.x	76	6.91
25	Alhassani AA, AlGhamdi AS. Inferior alveolar nerve injury in implant dentistry: diagnosis, causes, prevention, and management. <i>J Oral Implantol.</i> 2010;36(5):401-407. doi:10.1563/AAID-JOI-D-09-00059	76	5.43
26	Vigolo P, Fonzi F, Majzoub Z, Cordioli G. An <i>in vitro</i> evaluation of titanium, zirconia, and alumina procera abutments with hexagonal connection. <i>Int J Oral Maxillofac Implants.</i> 2006;21(4):575-580	76	4.22
27	Al-Johany SS, Al Amri MD, Alsaeed S, Alalola B. Dental implant length and diameter: A proposed classification scheme. <i>J Prosthodont.</i> 2017;26(3):252-260. doi:10.1111/jopr.12517	74	10.57
28	Alghamdi H, Anand PS, Anil S. Undersized implant site preparation to enhance primary implant stability in poor bone density: a prospective clinical study. <i>J Oral Maxillofac Surg.</i> 2011;69(12):e506-e512. doi:10.1016/j.joms.2011.08.007	72	5.54
29	Al Amri MD, Kellesarian SV, Al-Kheraif AA, Malmstrom H, Javed F, Romanos GE. Effect of oral hygiene maintenance on HbA1c levels and peri-implant parameters around immediately-loaded dental implants placed in type-2 diabetic patients: 2 years follow-up. <i>Clin Oral Implants Res.</i> 2016;27(11):1439-1443. doi:10.1111/clr.12758	70	8.75
30	Al-Khabbaz AK, Griffin TJ, Al-Shammari KF. Assessment of pain associated with the surgical placement of dental implants. <i>J Periodontol.</i> 2007;78(2):239-246. doi:10.1902/jop.2007.060032	70	4.12
31	Alikhasi M, Siadat H, Nasirpour A, Hasanzade M. Three-dimensional accuracy of digital impression versus conventional method: Effect of implant angulation and connection type. <i>Int J Dent.</i> 2018;2018:3761750. doi:10.1155/2018/3761750	69	11.50
32	Awad MA, Rashid F, Feine JS; Overdenture Effectiveness Study Team Consortium. The effect of mandibular 2-implant overdentures on oral health-related quality of life: An international multicentre study. <i>Clin Oral Implants Res.</i> 2014;25(1):46-51. doi:10.1111/clr.12205	68	6.80
33	Marghalani A, Weber HP, Finkelman M, Kudara Y, El Rafie K, Papaspyridakos P. Digital versus conventional implant impressions for partially edentulous arches: An evaluation of accuracy. <i>J Prosthet Dent.</i> 2018;119(4):574-579. doi:10.1016/j.prosdent.2017.07.002	67	11.17

S. no.	Bibliographic details of articles	Total citations	Citation density by year
34	Khzam N, Arora H, Kim P, Fisher A, Mattheos N, Ivanovski S. Systematic review of soft tissue alterations and esthetic outcomes following immediate implant placement and restoration of single implants in the anterior maxilla. <i>J Periodontol.</i> 2015;86(12):1321-1330. doi:10.1902/jop.2015.150287	67	7.44
35	Osman RB, Swain MV, Atieh M, Ma S, Duncan W. Ceramic implants (Y-TZP): Are they a viable alternative to titanium implants for the support of overdentures? A randomized clinical trial. <i>Clin Oral Implants Res.</i> 2014;25(12):1366-1377. doi:10.1111/clr.12272	66	6.60
36	Parnia F, Yazdani J, Javaherzadeh V, Maleki Dizaj S. Overview of nanoparticle coating of dental implants for enhanced osseointegration and antimicrobial purposes. <i>J Pharm Pharm Sci.</i> 2017;20(0):148-160. doi:10.18433/J3GP6G	65	9.29
37	Elsyad MA, Gebreel AA, Fouad MM, Elshoukouki AH. The clinical and radiographic outcome of immediately loaded mini implants supporting a mandibular overdenture. A 3-year prospective study. <i>J Oral Rehabil.</i> 2011;38(11):827-834. doi:10.1111/j.1365-2842.2011.02213.x	65	5.00
38	Elsyad MA, Al-Mahdy YF, Fouad MM. Marginal bone loss adjacent to conventional and immediate loaded two implants supporting a ball-retained mandibular overdenture: A 3-year randomized clinical trial. <i>Clin Oral Implants Res.</i> 2012;23(4):496-503. doi:10.1111/j.1600-0501.2011.02173.x	63	5.25
39	Alghamdi HS. Methods to improve osseointegration of dental implants in low quality (Type-IV) bone: An overview. <i>J Funct Biomater.</i> 2018;9(1):7. doi:10.3390/jfb9010007	62	10.33
40	Yazdani J, Ahmadian E, Sharifi S, Shahi S, Maleki Dizaj S. A short view on nanohydroxyapatite as coating of dental implants. <i>Biomed Pharmacother.</i> 2018;105:553-557. doi:10.1016/j.biopha.2018.06.013	62	10.33
41	Sakka S, Coulthard P. Implant failure: Etiology and complications. <i>Med Oral Patol Oral Cir Bucal.</i> 2011;16(1):e42-e44. Published 2011 Jan 1. doi:10.4317/medoral.16.e42	62	4.77
42	Lorusso F, Noubissi S, Francesco I, Rapone B, Khater AGA, Scarano A. Scientific trends in clinical research on zirconia dental implants: A bibliometric review. <i>Materials (Basel).</i> 2020;13(23):5534. doi:10.3390/ma13235534	60	15.00
43	Al-Dajani M. Incidence, risk factors, and complications of Schneiderian membrane perforation in sinus lift surgery: A meta-analysis. <i>Implant Dent.</i> 2016;25(3):409-415. doi:10.1097/ID.0000000000000411	59	7.38
44	Hermann JS, Jones AA, Bakaen LG, Buser D, Schoolfield JD, Cochran DL. Influence of a machined collar on crestal bone changes around titanium implants: a histometric study in the canine mandible. <i>J Periodontol.</i> 2011;82(9):1329-1338. doi:10.1902/jop.2011.090728	57	4.38
45	Lee A, Wang HL. Biofilm related to dental implants. <i>Implant Dent.</i> 2010;19(5):387-393. doi:10.1097/ID.0b013e3181effa53	57	4.07
46	Hyland R, Ellis J, Thomason M, El-Feky A, Moynihan P. A qualitative study on patient perspectives of how conventional and implant-supported dentures affect eating. <i>J Dent.</i> 2009;37(9):718-723. doi:10.1016/j.jdent.2009.05.028	57	3.80
47	Papaspyridakos P, Vazouras K, Chen YW, <i>et al.</i> Digital vs conventional implant impressions: A systematic review and meta-analysis. <i>J Prosthodont.</i> 2020;29(8):660-678. doi:10.1111/jopr.13211	56	14.00
48	El Nahass H, N Naiem S. Analysis of the dimensions of the labial bone wall in the anterior maxilla: a cone-beam computed tomography study. <i>Clin Oral Implants Res.</i> 2015;26(4):e57-e61. doi:10.1111/clr.12332	56	6.22
49	Alfadda SA, Attard NJ, David LA. Five-year clinical results of immediately loaded dental implants using mandibular overdentures. <i>Int J Prosthodont.</i> 2009;22(4):368-373	56	3.73
50	Akram Z, Vohra F, Bukhari IA, Sheikh SA, Javed F. Clinical and radiographic peri-implant parameters and proinflammatory cytokine levels among cigarette smokers, smokeless tobacco users, and nontobacco users. <i>Clin Implant Dent Relat Res.</i> 2018;20(1):76-81. doi:10.1111/cid.12575	55	9.17
51	Bulaqi HA, Mousavi Mashhadi M, Safari H, Samandari MM, Geramipanah F. Effect of increased crown height on stress distribution in short dental implant components and their surrounding bone: A finite element analysis. <i>J Prosthet Dent.</i> 2015;113(6):548-557. doi:10.1016/j.prosdent.2014.11.007	55	6.11

S. no.	Bibliographic details of articles	Total citations	Citation density by year
52	Al-Ghaffli SA, Michalakakis KX, Hirayama H, Kang K. The <i>in vitro</i> effect of different implant angulations and cyclic dislodgement on the retentive properties of an overdenture attachment system. <i>J Prosthet Dent.</i> 2009;102(3):140-147. doi:10.1016/S0022-3913(09)60134-7	55	3.67
53	Naseri R, Yaghini J, Feizi A. Levels of smoking and dental implants failure: A systematic review and meta-analysis. <i>J Clin Periodontol.</i> 2020;47(4):518-528. doi:10.1111/jcpe.13257	54	13.50
54	Alrabeah GO, Brett P, Knowles JC, Petridis H. The effect of metal ions released from different dental implant-abutment couples on osteoblast function and secretion of bone resorbing mediators. <i>J Dent.</i> 2017;66:91-101. doi:10.1016/j.jdent.2017.08.002	53	7.57
55	Elsyad MA, Elsaih EA, Khairallah AS. Marginal bone resorption around immediate and delayed loaded implants supporting a locator-retained mandibular overdenture. A 1-year randomised controlled trial. <i>J Oral Rehabil.</i> 2014;41(8):608-618. doi:10.1111/joor.12182	51	5.10
56	Alsharbaty MHM, Alikhasi M, Zarrati S, Shamshiri AR. A clinical comparative study of 3-dimensional accuracy between digital and conventional implant impression techniques [published correction appears in <i>J Prosthodont.</i> 2019;28(4):e902-e908. doi:10.1111/jopr.12764	50	10.00
57	Divakar DD, Jastaniyah NT, Altamimi HG, <i>et al.</i> Enhanced antimicrobial activity of naturally derived bioactive molecule chitosan conjugated silver nanoparticle against dental implant pathogens. <i>Int J Biol Macromol.</i> 2018;108:790-797. doi:10.1016/j.ijbiomac.2017.10.166	49	8.17
58	Fluegge T, Att W, Metzger M, Nelson K. A novel method to evaluate precision of optical implant impressions with commercial scan bodies-an experimental approach. <i>J Prosthodont.</i> 2017;26(1):34-41. doi:10.1111/jopr.12362	49	7.00
59	Chochlidakis K, Papaspyridakos P, Tsigarida A, <i>et al.</i> Digital versus conventional full-arch implant impressions: A prospective study on 16 edentulous maxillae. <i>J Prosthodont.</i> 2020;29(4):281-286. doi:10.1111/jopr.13162	48	12.00
60	Al-Hashedi AA, Laurenti M, Benhamou V, Tamimi F. Decontamination of titanium implants using physical methods. <i>Clin Oral Implants Res.</i> 2017;28(8):1013-1021. doi:10.1111/clr.12914	48	6.86
61	Hafezeqoran A, Koodaryan R. Effect of zirconia dental implant surfaces on bone integration: A systematic review and meta-analysis. <i>Biomed Res Int.</i> 2017;2017:9246721. doi:10.1155/2017/9246721	47	6.71
62	Kinaia BM, Shah M, Neely AL, Goodis HE. Crestal bone level changes around immediately placed implants: A systematic review and meta-analyses with at least 12 months' follow-up after functional loading. <i>J Periodontol.</i> 2014;85(11):1537-1548. doi:10.1902/jop.2014.130722	47	4.70
63	Nooh N. Dental implant survival in irradiated oral cancer patients: A systematic review of the literature. <i>Int J Oral Maxillofac Implants.</i> 2013;28(5):1233-1242. doi:10.11607/jomi.3045	47	4.27
64	Makary C, Rebaudi A, Sammartino G, Naaman N. Implant primary stability determined by resonance frequency analysis: Correlation with insertion torque, histologic bone volume, and torsional stability at 6 weeks. <i>Implant Dent.</i> 2012;21(6):474-480. doi:10.1097/ID.0b013e31826918f1	47	3.92
65	Grandi T, Guazzi P, Samarani R, Garuti G. Immediate positioning of definitive abutments versus repeated abutment replacements in immediately loaded implants: Effects on bone healing at the 1-year follow-up of a multicentre randomised controlled trial. <i>Eur J Oral Implantol.</i> 2012;5(1):9-16	46	3.83
66	Al Qahtani MS, Wu Y, Spintzyk S, <i>et al.</i> UV-A and UV-C light induced hydrophilization of dental implants. <i>Dent Mater.</i> 2015;31(8):e157-e167. doi:10.1016/j.dental.2015.04.011	45	5.00
67	Azari A, Nikzad S. Computer-assisted implantology: Historical background and potential outcomes-a review. <i>Int J Med Robot.</i> 2008;4(2):95-104. doi:10.1002/rcs.188	45	2.81
68	Salaie RN, Besinis A, Le H, Tredwin C, Handy RD. The biocompatibility of silver and nanohydroxyapatite coatings on titanium dental implants with human primary osteoblast cells. <i>Mater Sci Eng C Mater Biol Appl.</i> 2020;107:110210. doi:10.1016/j.msec.2019.110210	44	11.00

S. no.	Bibliographic details of articles	Total citations	Citation density by year
69	Kazemi M, Ahangarani S, Esmailian M, Shanaghi A. Investigation on the corrosion behavior and biocompatibility of Ti-6Al-4V implant coated with HA/TiN dual layer for medical applications. <i>Surf Coat Technol.</i> 2020 Sep 15; 397:126044. doi:10.1016/j.surfcoat.2020.126044	44	11.00
70	Elsyad MA. Patient satisfaction and prosthetic aspects with mini-implants retained mandibular overdentures. A 5-year prospective study. <i>Clin Oral Implants Res.</i> 2016;27(7):926-933. doi:10.1111/clr.12660	44	5.50
71	Ioannidis A, Gallucci GO, Jung RE, Borzangy S, Hämmerle CH, Benic GI. Titanium-zirconium narrow-diameter versus titanium regular-diameter implants for anterior and premolar single crowns: 3-year results of a randomized controlled clinical study. <i>J Clin Periodontol.</i> 2015;42(11):1060-1070. doi:10.1111/jcpe.12468	44	4.89
72	Atieh MA, Alsabeeha N, Duncan WJ. Stability of tapered and parallel-walled dental implants: A systematic review and meta-analysis. <i>Clin Implant Dent Relat Res.</i> 2018;20(4):634-645. doi:10.1111/cid.12623	42	7.00
73	Papaspyridakos P, Bordin TB, Kim YJ, <i>et al.</i> Technical complications and prosthesis survival rates with implant-supported fixed complete dental prostheses: A retrospective study with 1- to 12-year follow-Up. <i>J Prosthodont.</i> 2020;29(1):3-11. doi:10.1111/jopr.13119	40	10.00
74	Lerner H, Mouhyi J, Admakin O, Mangano F. Artificial intelligence in fixed implant prosthodontics: A retrospective study of 106 implant-supported monolithic zirconia crowns inserted in the posterior jaws of 90 patients. <i>BMC Oral Health.</i> 2020;20(1):80. Published 2020 Mar 19. doi:10.1186/s12903-020-1062-4	39	9.75
75	Al Subaie A, Emami E, Tamimi I, <i>et al.</i> Systemic administration of omeprazole interferes with bone healing and implant osseointegration: An <i>in vivo</i> study on rat tibiae. <i>J Clin Periodontol.</i> 2016;43(2):193-203. doi:10.1111/jcpe.12506	39	4.88
76	Pirmoradian M, Naeeni HA, Firouzbakht M, Toghraie D, Khabaz MK, Darabi R. Finite element analysis and experimental evaluation on stress distribution and sensitivity of dental implants to assess optimum length and thread pitch. <i>Comput Methods Programs Biomed.</i> 2020;187:105258. doi:10.1016/j.cmpb.2019.105258	38	9.50
77	Nouh I, Kern M, Sabet AE, Aboelfadl AK, Hamdy AM, Chaar MS. Mechanical behavior of posterior all-ceramic hybrid-abutment-crowns versus hybrid-abutments with separate crowns-A laboratory study. <i>Clin Oral Implants Res.</i> 2019;30(1):90-98. doi:10.1111/clr.13395	38	7.60
78	Rismanchian M, Hatami M, Badrian H, Khalighinejad N, Goroohi H. Evaluation of microgap size and microbial leakage in the connection area of 4 abutments with Straumann (ITI) implant. <i>J Oral Implantol.</i> 2012;38(6):677-685. doi:10.1563/AAID-JOI-D-11-00167	38	3.17
79	Souza AB, Alshihri A, Kämmerer PW, Araújo MG, Gallucci GO. Histological and micro-CT analysis of peri-implant soft and hard tissue healing on implants with different healing abutments configurations. <i>Clin Oral Implants Res.</i> 2018;29(10):1007-1015. doi:10.1111/clr.13367	37	6.17
80	Ramakrishnaiah R, Al Kheraif AA, Mohammad A, <i>et al.</i> Preliminary fabrication and characterization of electron beam melted Ti-6Al-4V customized dental implant. <i>Saudi J Biol Sci.</i> 2017;24(4):787-796. doi:10.1016/j.sjbs.2016.05.001	37	5.29
81	Al-Rabab'ah M, Hamadneh W, Alsalem I, Khraisat A, Abu Karaky A. Use of high performance polymers as dental implant abutments and frameworks: A case series report. <i>J Prosthodont.</i> 2019;28(4):365-372. doi:10.1111/jopr.12639	36	7.20
82	Alqahtani F, Alqahtani M, Shafqat SS, Akram Z, Al-Kheraif AA, Javed F. Efficacy of mechanical debridement with adjunctive probiotic therapy in the treatment of peri-implant mucositis in cigarette-smokers and never-smokers. <i>Clin Implant Dent Relat Res.</i> 2019;21(4):734-740. doi:10.1111/cid.12795	36	7.20
83	Sharka R, Abed H, Hector M. Oral health-related quality of life and satisfaction of edentulous patients using conventional complete dentures and implant-retained overdentures: An umbrella systematic review. <i>Gerodontology.</i> 2019;36(3):195-204. doi:10.1111/ger.12399	35	7.00

S. no.	Bibliographic details of articles	Total citations	Citation density by year
84	Madi M, Htet M, Zakaria O, Alagl A, Kasugai S. Re-osseointegration of dental implants after periimplantitis treatments: A systematic review. <i>Implant Dent.</i> 2018;27(1):101-110. doi:10.1097/ID.0000000000000712	35	5.83
85	Ketabi M, Deporter D, Atenafu for example, A systematic review of outcomes following immediate molar implant placement based on recently published studies. <i>Clin Implant Dent Relat Res.</i> 2016;18(6):1084-1094. doi:10.1111/cid.12390	35	4.38
86	Natto ZS, Aladmawy M, Levi PA Jr, Wang HL. Comparison of the efficacy of different types of lasers for the treatment of peri-implantitis: A systematic review. <i>Int J Oral Maxillofac Implants.</i> 2015;30(2):338-345. doi:10.11607/jomi.3846	35	3.89
87	Alqahtani F, Alqahtani M, Albaqawi AH, Al-Kheraif AA, Javed F. Comparison of cotinine levels in the peri-implant sulcular fluid among cigarette and waterpipe smokers, electronic-cigarette users, and nonsmokers. <i>Clin Implant Dent Relat Res.</i> 2019;21(4):702-707. doi:10.1111/cid.12813	34	6.80
88	Papaspyridakos P, Bordin TB, Natto ZS, <i>et al.</i> Complications and survival rates of 55 metal-ceramic implant-supported fixed complete-arch prostheses: A cohort study with mean 5-year follow-up. <i>J Prosthet Dent.</i> 2019;122(5):441-449. doi:10.1016/j.prosdent.2019.01.022	34	6.80
89	Alrabiah M, Al-Aali KA, Al-Sowygh ZH, Binmahfooz AM, Mokeem SA, Abduljabbar T. Association of advanced glycation end products with peri-implant inflammation in prediabetes and type 2 diabetes mellitus patients. <i>Clin Implant Dent Relat Res.</i> 2018;20(4):535-540. doi:10.1111/cid.12607	34	5.67
90	Payne AG, Alsabeeha NH, Atieh MA, Esposito M, Ma S, Anas El-Wegoud M. Interventions for replacing missing teeth: Attachment systems for implant overdentures in edentulous jaws. <i>Cochrane Database Syst Rev.</i> 2018;10(10):CD008001. Published 2018 Oct 11. doi:10.1002/14651858.CD008001.pub2	34	5.67
91	Alikhasi M, Monzavi A, Bassir SH, Naini RB, Khosronedjad N, Keshavarz S. A comparison of precision of fit, rotational freedom, and torque loss with copy-milled zirconia and prefabricated titanium abutments. <i>Int J Oral Maxillofac Implants.</i> 2013;28(4):996-1002. doi:10.11607/jomi.2937	34	3.09
92	Zafar MS, Fareed MA, Riaz S, Latif M, Habib SR, Khurshid Z. Customized therapeutic surface coatings for dental implants. <i>Coatings.</i> 2020 Jun 17;10(6):568. https://doi.org/10.3390/coatings10060568	33	8.25
93	Albaker AM, ArRejaie AS, Alrabiah M, Abduljabbar T. Effect of photodynamic and laser therapy in the treatment of peri-implant mucositis: A systematic review. <i>Photodiagnosis Photodyn Ther.</i> 2018;21:147-152. doi:10.1016/j.pdpdt.2017.11.011	33	5.50
94	Smith MM, Knight ET, Al-Harathi L, Leichter JW. Chronic periodontitis and implant dentistry. <i>Periodontol 2000.</i> 2017;74(1):63-73. doi:10.1111/prd.12190	33	4.71
95	Alsahhaf A, Spies BC, Vach K, Kohal RJ. Fracture resistance of zirconia-based implant abutments after artificial long-term aging. <i>J Mech Behav Biomed Mater.</i> 2017;66:224-232. doi:10.1016/j.jmbbm.2016.11.018	33	4.71
96	Elsyad MA, Hegazy SA, Hammouda NI, Al-Tonbary GY, Habib AA. Chewing efficiency and electromyographic activity of masseter muscle with three designs of implant-supported mandibular overdentures. A cross-over study. <i>Clin Oral Implants Res.</i> 2014;25(6):742-748. doi:10.1111/clr.12137	33	3.30
97	Reddy MS, Sundram R, Eid Abdemagyd HA. Application of finite element model in implant dentistry: A systematic review. <i>J Pharm Bioallied Sci.</i> 2019;11(Suppl 2):S85-S91. doi:10.4103/JPBS.JPBS_296_18	32	6.40
98	Johansson P, Barkarmo S, Hawthorn M, Peruzzi N, Kjellin P, Wennerberg A. Biomechanical, histological, and computed X-ray tomographic analyses of hydroxyapatite coated PEEK implants in an extended healing model in rabbit. <i>J Biomed Mater Res A.</i> 2018;106(5):1440-1447. doi:10.1002/jbm.a.36345	32	5.33
99	Ansari Z, Kalantar M, Kharaziha M, Ambrosio L, Raucci MG. Polycaprolactone/fluoride substituted-hydroxyapatite (PCL/FHA) nanocomposite coatings prepared by <i>in situ</i> sol-gel process for dental implant applications. <i>Prog Org Coat.</i> 2020;147: 105873. https://doi.org/10.1016/j.porgcoat.2020.105873	31	7.75
100	Htet M, Madi M, Zakaria O, <i>et al.</i> Decontamination of anodized implant surface with different modalities for peri-implantitis treatment: Lasers and mechanical debridement with citric acid. <i>J Periodontol.</i> 2016;87(8):953-961. doi:10.1902/jop.2016.150615	31	3.88