

# Publication performance and trends in bruxism research: A bibliometric analysis

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## Abstract

**Background:** Bruxism is an umbrella term that encompasses a multidimensional spectrum of masticatory muscle activities.

**Objective:** The purpose of this study was to do a bibliometric analysis including citation performance in the research topic of bruxism, by using an innovative method including details of article title, author keyword, *KeyWords Plus* and abstracts.

**Methods:** The data were retrieved 2022-12-19 from the Clarivate Analytics Web of Science Core Collection, and the online version of the Science Citation Index Expanded (SCI-EXPANDED) for studies published 1992 to 2021. To evaluate research trends, the distribution of keywords in the article title and author-selected keywords were used.

**Results:** The search yielded 3233 documents in SCI-EXPANDED, of which 2598 were of the document-type 'articles' published in 676 journals. The analysis of the articles revealed that "bruxism/sleep bruxism," "electromyography," "temporomandibular disorders" and "masticatory muscles" are the most used keywords by the authors. Further, the most frequently cited study was published 9 years ago and handles the present definition of bruxism.

**Conclusion:** The most productive authors and those with the highest performance have some common features; they have several national and international collaborations; and they have published articles about the definition, aetiology/pathophysiology and prevalence of bruxism, all senior researchers in the field of TMD. Hopefully, based on this study, researchers and clinicians will have information to be stimulated to outline future research projects on bruxism-related aspects, and to initiate new international or multinational collaborations.

## KEYWORDS

awake bruxism, bruxism, bibliometrics, polysomnography, sleep bruxism, temporomandibular disorders

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## 1 | INTRODUCTION

Bruxism is an umbrella term that encompasses a multidimensional spectrum of masticatory muscle activities. In the year 2013, bruxism was defined by a consensus group as 'a repetitive jaw-muscle activity characterized by clenching or grinding of the teeth and/or by bracing or thrusting of the mandible'.<sup>1,2</sup> The same consensus group also proposed that bruxism 'has two distinct circadian manifestations: it can occur during sleep (indicated as sleep bruxism; SB) or during wakefulness (indicated as awake bruxism; AB)'.<sup>1,2</sup> Thus, bruxism is divided in either AB or SB, and these types are differentiated by differences in aetiology, comorbidities and consequences related to the multidimensional spectrum of masticatory muscle activities exerted.<sup>3</sup> However, before this new definition, the most commonly used definitions were formulated in the eighth edition of the Glossary of Prosthodontic Terms,<sup>4</sup> in the second edition of the International Classification of Sleep Disorders<sup>5</sup> and in the fourth edition of the Orofacial Pain Guidelines, published by the American Academy of Orofacial Pain.<sup>6</sup> Given the limitations and shortcomings of these three definitions, this new definition was proposed. However, we still do not know which impact the new definition has had in research, in clinic, or in education. One way to start evaluating if this new definition has had any impact is to investigate if it has had any impact in research. If so, it would be shown in this bibliometric analysis.

Evidence based medicine is becoming a gradually more important component in the practice of the modern health professional. When it comes to making decisions about the care of individual patients or directing the patients for further and future investigations a thorough, explicit and sensible use of current best evidence, that is evidence based medicine, is essential.<sup>7</sup> This since knowledge of the present literature provides a better understanding of disease causes, processes and management to the modern health professional. In regard to sleep bruxism, the modern health professional can rely on scientific evidence since there is evidence that occlusal appliances have a moderate to high effect in reducing the bruxo-episodes, a moderate effect in prohibiting further dental wear, but no effect on sleep quality.<sup>8</sup> When it comes to biofeedback, as treatment of sleep bruxism, contingent electrical stimulation seems to show a reduction in sleep bruxism, but only in short term.<sup>9</sup> The urge for knowledge and current best evidence results in a huge amount of publications, rapidly increasing over the past 100 years.<sup>7</sup> The strive to increase knowledge and to provide evidence for current best practice has, however, a downside.<sup>10</sup> To maintain knowledge based on the huge amount of recent literature is an overwhelming task for the modern health professional. To hopefully end up with the most important or influential publications, the modern health professional has to find a needle in the haystack.<sup>10,11</sup>

To overcome this, the research field of citation analysis, also known as bibliometrics, has been born.<sup>12</sup> Bibliometrics are used to summarize a topic and provide a complete picture of the analysed topic. To do this, bibliometrics is a powerful tool used to follow the dynamics and evolution of the scientific knowledge within a topic by studying and interpreting the developments within the specific topic,

which in turn could provide future perspectives. So bibliometric analysis is performed by a comprehensive review of research trends, and an investigation on publication performances.<sup>13,14</sup> Bibliometrics can also be used to quantify the quality of publications for organizations and to identify the impact of publications and research groups in their field of research.<sup>15,16</sup> Taken together, bibliometrics can help modern health professionals, but also organizations, research grant providers and fund raisers to find the most relevant publications for their specific purpose.

Traditionally, the purpose of this bibliometric analysis is not just to synthetically analyse citation performance in a field, in this case the topic of bruxism, but this bibliometric analysis will also address a more innovative method. In this case, details of article title, author keywords, *KeyWords Plus*<sup>17</sup> and abstracts are included in the bibliometric analyses.<sup>18</sup>

## 2 | MATERIALS AND METHODS

The Clarivate Analytics Web of Science Core Collection, the online version of the Science Citation Index Expanded (SCI-EXPANDED), was used to retrieve the data for this study (data updated on 19 December 2022). The 2021 journal impact factor ( $IF_{2021}$ ) used was the impact factor reported in the Journal Citation Report (JCR) on 29 June 2021. Documents published in 2021 after  $IF_{2021}$  was presented were also included in the search from SCI-EXPANDED. Quotation marks (" ") and Boolean operator "or" were used to ensure the appearance of at least one search keyword in the terms of TOPIC (title, abstract, author keywords, and *KeyWords Plus*) from 1992 to 2021, as in our previous study with identical set-up, but different topic.<sup>11</sup>

The search keyword was as follows: "bruxism." To have a more inclusive and accurate analysis common terms, such as "clenching," "tooth grinding," "teeth grinding," "grinding of the teeth," "grinding of teeth," and "grinding of tooth" and non-English terms: "bruxismo" and "bruxismus" in SCI-EXPANDED were also considered.

A total of 3477 documents were found in SCI-EXPANDED from 1992 to 2021. *KeyWords Plus* supplies additional search terms. These search terms were extracted from the titles of articles cited by authors in their bibliographies and footnotes in the database Institute of Science Information (ISI) (now Clarivate Analytics), that substantially augments title-word and author-keyword indexing.<sup>19</sup> It can though be pointed out that documents only searched out by *KeyWords Plus* were irrelevant to the search topic.<sup>20</sup> Ho's group firstly proposed the 'front page' as a filter including the article title, abstract and author keywords.<sup>21</sup> This filter can avoid introducing unrelated publications for bibliometric analysis, since it was reported that big differences occurred when using the 'front page' as a filter in bibliometric research topics published in medical-related journals in SCI-EXPANDED, for example, *Chinese Medical Journal*,<sup>22</sup> *World Neurosurgery*,<sup>23</sup> *Annals of Translational Medicine*,<sup>24</sup> and *BioMed Research International*.<sup>25</sup>

As in our previous study,<sup>11</sup> the full record in SCI-EXPANDED and the number of citations for each year retrieved from each document

were checked and downloaded into Excel Microsoft 365, and additional coding was manually performed.<sup>26,27</sup> The functions in the Excel Microsoft 365, for example, Counta, Concatenate, Filter, Match, Vlookup, Proper, Rank, Replace, Freeze Panes, Sort, Sum and Len were applied. Finally, 3233 documents (93% of 3477 documents) including search keywords in their 'front page' were defined as bruxism-related publications.

In this study, we used the term corresponding author instead of the label 'reprint author' used in the SCI-EXPANDED database.<sup>28</sup> In publications with unspecified authorship, single authors were labelled both the first and corresponding author.<sup>29</sup> In the same way, this study classified institutions as the first and the corresponding-author institution, in a single institutional publication.<sup>29</sup> In multi-corresponding author publications, all corresponding authors, all institutes and all countries were considered in the analysis. Publications with corresponding authors in SCI-EXPANDED, with only address displayed but no affiliation names were checked out and in these cases the addresses were changed to be affiliation names.

From a geographical point of view, affiliations in England, Scotland, North Ireland (Northern Ireland) and Wales were reclassified as the United Kingdom (UK),<sup>30</sup> while affiliations in Hong Kong before 1997 were reclassified as China.<sup>31</sup>

The following three citation indicators were used to assess the publications: (1)  $C_{\text{year}}$  that is the number of citations from Web of Science Core Collection in the most recent year (2021 in this study,  $C_{2021}$ )<sup>15</sup>; (2)  $TC_{\text{year}}$  that is the total citations from Web of Science Core Collection received since publication year till the end of the most recent year (2021 in this study,  $TC_{2021}$ )<sup>32</sup>; and (3)  $CPP_{\text{year}}$  that is the average citations per publication ( $CPP_{2021} = TC_{2021}/TP$ ),  $TP$ : total number of publications.<sup>33</sup>

The following six publication indicators were applied to evaluate publication performance of countries and institutions<sup>34</sup>: (a)  $TP$  that is the total number of articles; (b)  $IP$  that is the number of single-country articles ( $IP_c$ ) or single-institution articles ( $IP_i$ ); (c)  $CP$  that is the number of internationally articles ( $CP_c$ ) or inter-institutionally collaborative articles ( $CP_i$ ); (d)  $FP$  that is the number of first-author articles; (e)  $RP$  that is the number of corresponding-author articles; and (f)  $SP$  that is the number of single-author articles.

To evaluate the publication impact on countries and institutes the following six citation publication indicators ( $CPP_{2021}$ ) were applied<sup>35</sup>: (1)  $TP-CPP_{2021}$  for the total  $TC_{2021}$  of all articles per the total number of articles ( $TP$ ); (2)  $IP-CPP_{2021}$  for the total  $TC_{2021}$  of all single-country articles per the number of single-country articles,  $IP_c-CPP_{2021}$  or the total  $TC_{2021}$  of all single-institute articles per the single-institute articles,  $IP_i-CPP_{2021}$ ; (3)  $CP-CPP_{2021}$  for the total  $TC_{2021}$  of all internationally collaborative articles per the number of internationally collaborative articles,  $CP_c-CPP_{2021}$  or the total  $TC_{2021}$  of all inter-institutionally collaborative articles per the number of inter-institutionally collaborative articles,  $CP_i-CPP_{2021}$ ; (4)  $FP-CPP_{2021}$  for the total  $TC_{2021}$  of all first-author articles per the number of first-author articles ( $FP$ ); (5)  $RP-CPP_{2021}$  for the total  $TC_{2021}$  of all corresponding-author articles per the number of

corresponding-author articles ( $RP$ ); (6)  $SP-CPP_{2021}$ : the total  $TC_{2021}$  of all single-author articles per the number of single-author articles ( $SP$ ).

In order to describe the characteristics of document types, this study has followed the suggestion, previously presented by Ho et al., where the basic information of a document type in a specific research topic should be presented using the characteristics average citations per publication ( $CPP_{\text{year}} = TC_{\text{year}}/TP$ ) as well as average number of authors per publication ( $APP = AU/TP$ ).<sup>36</sup> Further, it has also been shown that the use of  $TC_{2021}$  and  $CPP_{2021}$  is advantageous than just using the number of citations from the Web of Science Core Collection, since these variables can ensure repeatability due to their invariability.<sup>37</sup>

Finally, the Y-index was used to evaluate publication performance of authors. The Y-index ( $j, h$ ) is defined as<sup>15,38</sup>: where  $j$  is a constant related to the publication potential, the sum of the first-author articles and the corresponding-author articles; and  $h$  is a constant related to the publication characteristics, polar angle about the proportion of  $RP$  to  $FP$ . The greater the value of  $j$ , the more the first- and corresponding-author contributes to the articles.

$h = \pi/2$  indicates an author that has only published corresponding-author articles, and  $j$  is the number of corresponding-author articles.  $\pi/2 > h > \pi/4$  indicates that an author has more corresponding-author articles than first-author articles ( $FP > 0$ ).  $h = \pi/4$  indicates that an author has the same number of first- and corresponding-author articles ( $FP > 0$  and  $RP > 0$ ).  $\pi/4 < h < 0$  indicates an author with more first-author articles than corresponding-author articles ( $RP > 0$ ).  $h = 0$  indicates that an author has only published first-author articles, and  $j$  is the number of first-author articles.

### 3 | RESULTS

#### 3.1 | Characteristics of document types

This bibliometrics analysis is based on a total of 3233 bruxism documents published in SCI-EXPANDED, found among 11 document types, shown in Table 1.

Further, when it comes to the document type 'meeting abstracts' a total of 268 'meeting abstracts' were published in 50 different journals. Most 'meeting abstracts' were published in the *Journal of Dental Research* ( $n = 108$ ; 40% of 268 'meeting abstracts') and in the journal *Sleep* ( $n = 41$ ; 15% of 268 'meeting abstracts'). One has to point out that the cumulative percentages exceed 100% in Table 1. However, this is explained by the fact that documents are categorized in two document types in Web of Science Core Collection, for example, 46 'proceedings papers' and one 'book chapter' were classified as the document type 'articles'.<sup>39</sup>

Since the content of different document types varies, only the document type 'articles' was further analysed. The far most used language was English with 2519 articles (97% of 2598 articles) followed by German (28 articles), Portuguese (21), Spanish (11), French (7), Turkish (5), Russian (3), Italian and Polish (both two articles). Non-English

TABLE 1 Citations and authors according to the document type.

Document type	TP	%	TP*	AU	APP	TC <sub>2021</sub>	CPP <sub>2021</sub>
Article	2598	80	2598	12 982	5.0	57 964	22
Meeting abstract	268	8.3	268	1257	4.7	70	0.26
Review	212	6.6	212	957	4.5	8043	38
Letter	72	2.2	72	189	2.6	308	4.3
Proceedings paper	70	2.2	70	309	4.4	2840	41
Editorial material	66	2.0	63	176	2.8	334	5.1
Correction	6	0.19	5	26	5.2	1	0.17
News item	5	0.15	1	1	1.0	2	0.40
Note	5	0.15	5	18	3.6	56	11
Biographical-item	1	0.031	1	8	8.0	3	3.0

Note: About 80% of the 3233 were articles with an average number of authors per publication (APP) of 5.0. The document type 'proceedings papers' with a total of 70 documents had the greatest average number of citations (TC<sub>2021</sub>) per publication (TP) (CPP<sub>2021</sub>) value reaching 41. The CPP<sub>2021</sub> of the document type 'reviews' was found to be 1.7 times higher than the document type 'articles'.

Abbreviations: AU, number of authors; TP, number of publications; TP\*, number of publications with author information.

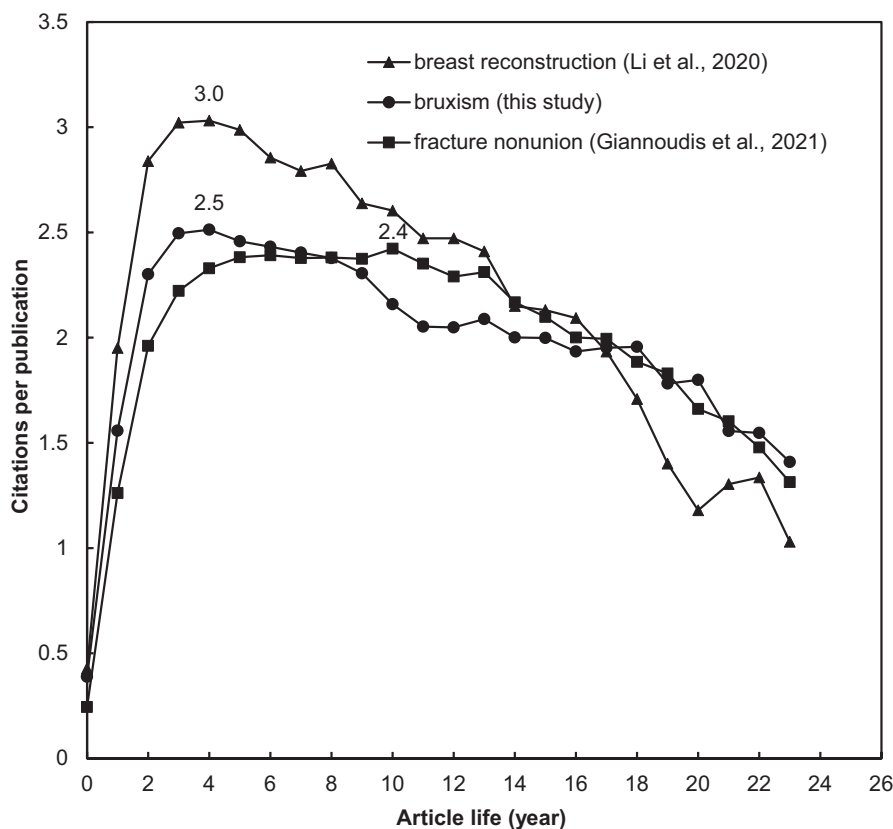


FIGURE 1 Citations per publication by article life.

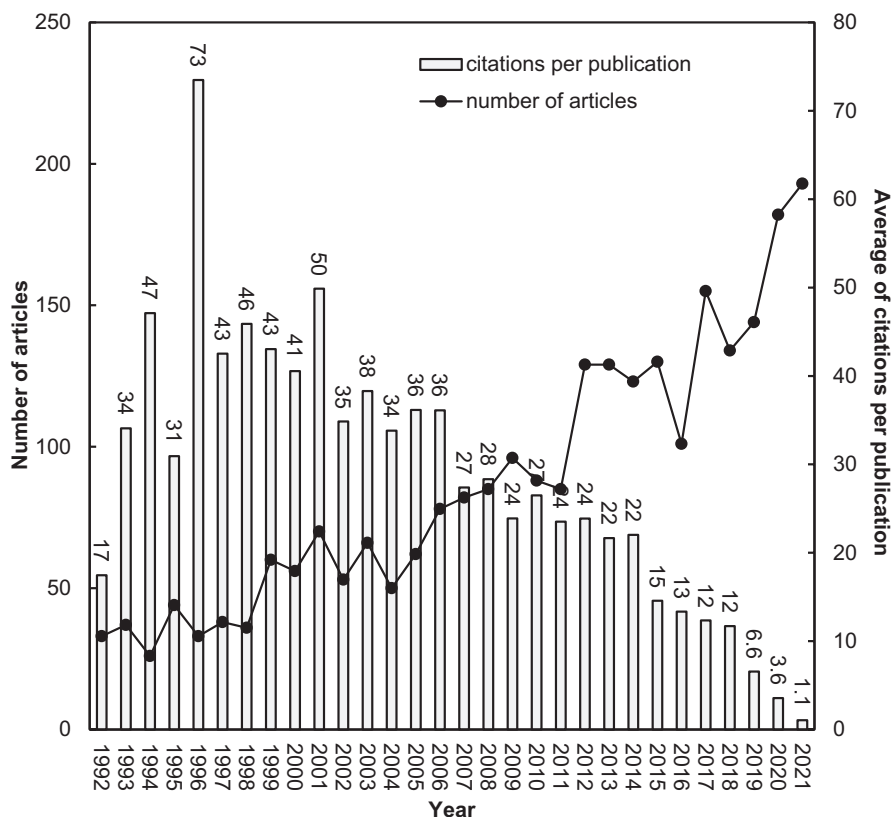
articles had fewer citations (CPP<sub>2021</sub> 4.9) and authors (APP 4.6) compared to English articles (CPP<sub>2021</sub> 23 and APP 5.1, respectively).

### 3.2 | Characteristics of publication outputs

The CPP with article life for all the 2598 bruxism-related articles is displayed in Figure 1. For bruxism-related articles, it took three full years to reach a peak CPP of 2.5. However, the impact of the bruxism-related articles decreased sharply after their peak.

The mean value of TC<sub>2021</sub> was 22, with 700 as the maximal value for a single article. In Figure 2, the distribution of the annual number of articles and their CPP<sub>2021</sub> by year is shown, expressed as TC<sub>2021</sub>/TP.<sup>33</sup> The number of publications in the field of bruxism is increasing, but fluctuant from 1992 to 2004. However, between the years 2004 to 2021 there is a sharp increase in number of publications. In 1996, a total of 33 articles reached the greatest CPP<sub>2021</sub> (=73). The high CPP<sub>2021</sub> that was reached in 1996 can be attributed to the two of the top nine most frequently cited articles in the field of bruxism, by Lindquist et al.,<sup>40</sup> and Lavigne et al.<sup>41</sup> with TC<sub>2021</sub> of

**FIGURE 2** Number of bruxism-related articles and average number of citations per publication by year.



504, and 439, respectively. The number of citations, on the contrary, are decreasing rapidly over time, and as shown in Figure 2, it takes approximately about 8 years to reach a plateau in  $CPP_{year}$ .

### 3.3 | Web of Science Category and Journal

In 2021, 9649 journals were indexed in JCR with citation references across 178 Web of Science categories in SCI-EXPANDED. Articles related to bruxism were published in a total of 676 journals in 120 Web of Science categories in SCI-EXPANDED. Eighty per cent of the articles (2070 articles) were published in the top six productive Web of Science categories. Fifty-three per cent of the articles (1385) were published in the categories of dentistry, oral surgery and medicine (containing 92 journals), followed by clinical neurology (212 journals) with 274 articles (11%), neurosciences (274 journals) with 262 articles (10%), biomedical engineering (98 journals) with 106 articles (4.1%), general and internal medicine (172 journals) with 95 articles (3.7%) and veterinary sciences (144 journals) with 91 articles (3.5%).

Comparing the top six categories, articles published in the category of neurosciences had the greatest  $CPP_{2021}$  of 30, followed by biomedical engineering ( $CPP_{2021}=29$ ), clinical neurology (27), dentistry, oral surgery and medicine (25), veterinary sciences (12), and general and internal medicine (7.7).

When it comes to impact factors,  $CPP_{2021}$  and  $APP$ , Table S1 shows the top 10 most productive journals. The *Journal of Oral Rehabilitation* (JOR) ( $IF_{2021}=3.558$ ) published 308 articles, placing them on the first place. These 308 articles represent 12% of

all articles related to bruxism, followed by *Cranio-The Journal of Craniomandibular & Sleep Practice* ( $IF_{2021}=1.670$ ) with 158 articles (6.1%). *Sleep and Breathing* was the only journal among the top 10 most productive that was not classified in the category of dentistry, oral surgery and medicine. Comparing the top 10 productive journals, bruxism-related articles published in the *Journal of Dental Research* ( $IF_{2021}=8.924$ ) had the highest  $CPP_{2021}$  of 75, while articles in *Cranio-The Journal of Craniomandibular & Sleep Practice* had only a  $CPP_{2021}$  of 13. The  $APP$  ranged from 6.0 in the *Sleep and Breathing* to 3.8 in the *Journal of Prosthetic Dentistry*. The journal with the highest  $IF_{2021}$  of 33.883 was *Gastroenterology* with one article followed by *Psychotherapy and Psychosomatics* with one article ( $IF_{2021}=25.617$ ), and the *International Journal of Oral Science* with three articles ( $IF_{2021}=24.897$ ).

### 3.4 | Publication performances: countries and institutions

There were nine bruxism-related articles (0.35% of 2598 articles) without affiliations in SCI-EXPANDED. The bruxism-related articles were published by authors affiliated from 76 different countries. A total of 2044 single-country articles (79%) were published by authors from 61 different countries with an  $IP_C-CPP_{2021}$  of 22. The remaining 545 publications (21%) were internationally collaborative articles published by authors from 70 countries with a  $CP_C-CPP_{2021}$  of 22. These results indicate that international collaborations slightly raise the citation-score in bruxism research. Six publication

indicators and the six related citation indicators ( $CPP_{2021}$ )<sup>35</sup> were applied to compare the top 10 productive countries (Table S2). Japan ranked top in four publication indicators with a  $TP$  of 417 articles (16%), an  $FP$  of 360 articles (14% of first-author articles), an  $RP$  of 363 articles (14% of corresponding-author articles) and an  $IP_C$  of 288 articles (14% of single-country articles). Further, the United States ranked top in two publication indicators with a  $CP_C$  of 158 articles (29% of 545 internationally collaborative articles) and an  $SP$  of 27 articles (32% of 84 single-author articles). In a comparison of the top 10 productive countries, Canada with 137 articles had the greatest  $TP-CPP_{2021}$ ,  $IP_C-CPP_{2021}$ ,  $CP_C-CPP_{2021}$ ,  $FP-CPP_{2021}$  and  $RP-CPP_{2021}$  of 55, 64, 48, 59 and 59, respectively. The United States with an  $SP$  of 27, on the other side, had the highest  $SP-CPP_{2021}$  of 20.

Concerning institutions, 1030 bruxism-related articles (40%) originated from single institutions with an  $IP_1-CPP_{2021}$  of 22 while 1559 articles (60%) were institutional collaborations with a  $CP_1-CPP_{2021}$  of 23. The top nine productive institutions and their characteristics are presented in Table S3. The University of Sao Paulo in Brazil ranked top in three of the five publication indicators with a  $TP$  of 87 articles (3.4%), an  $FP$  of 56 articles (2.2% of first-author articles) and an  $RP$  of 49 articles (1.9% of corresponding-author articles). The Tokyo Medical and Dental University in Japan also ranked the top with an  $IP_1$  of 30 articles (2.9% of single-institution articles). The University of Amsterdam in Netherlands ranked top with a  $CP_1$  of 76 articles (4.9% of inter-institutionally collaborative articles). Compared to the top nine productive institutes in Table S3, the University of Montreal in Canada with a  $TP$  of 72 articles, an  $IP_1$  of six articles, a  $CP_1$  of 66 articles, an  $FP$  of 37 articles and an  $RP$  of 39 articles had the greatest  $TP-CPP_{2021}$  of 74,  $IP_1-CPP_{2021}$  of 80,  $CP_1-CPP_{2021}$  of 74,  $FP-CPP_{2021}$  of 85 and  $RP-CPP_{2021}$  of 75, respectively.

### 3.5 | Publication performances: authors

When it comes to articles related to bruxism the  $APP$  was 5.0, while the maximum number of authors was 25. Of the bruxism-related articles, 66% were published by groups of three to six authors. Among them 479 (18%), 454 (17%), 397 (15%) and 382 (15%) were written by groups of 4, 5, 3 and 6 authors, respectively. Table S4 listed the top 20 productive authors with four publication indicators, their citation indicators and Y-index constants. Articles with  $TC_{2021}$  of 100 or more were named highly cited articles.<sup>38</sup> F. Lobbezoo was the most productive author with 98 articles, including 17 first-author articles (ranked second), 23 corresponding-author articles (ranked third) and four first-author highly cited articles (ranked second). Second most productive was D. Manfredini who published 59 bruxism-related articles including 23 first-author articles (ranked first) and 27 corresponding-author articles (ranked first). G.J. Lavigne, on the contrary, published the most first-author highly cited articles ( $n=5$ ) (ranked first). Furthermore, P. Svensson was the only author having single-author articles among the top 67 productive authors. A. Ghanizadeh had the most single-author articles ( $n=3$ ). Comparing the top 20 productive authors with  $TP$  of 18 articles or more, J.Y.

Montplaisir with 20 articles had the greatest  $TP-CPP_{2020}$  of 122 for total articles. However, G.J. Lavigne with an  $FP$  of eight articles, an  $RP$  of 24 articles and a  $TP^*$  of five articles had the greatest  $FP-CPP_{2021}$  of 190,  $RP-CPP_{2021}$  of 108 and  $FP^*-CPP_{2020}$  of 264, respectively. Seven of the 20 most productive authors, including G.T. Clark, G.E. Carlsson, H.J. Schindler, S. Valenzuela, H. Santander, P.H. Rompre and J.Y. Montplaisir, were not in the top 20 publication potential authors as evaluated by Y-index.

A total of 2526 bruxism-related articles (97%) that had both first and corresponding author information in SCI-EXPANDED were extensively investigated based on the Y-index. These bruxism-related articles were contributed by 8133 authors in which:

- 5689 authors (70%) had no first- and no corresponding-author articles with Y-index (0, 0).
- 543 authors (6.7%) published only corresponding-author articles with  $h=\pi/2$ .
- 99 authors (1.2%) published more corresponding-author articles than first-author articles with  $\pi/2 > h > \pi/4$  ( $FP > 0$ ).
- 1030 authors (13%) published the same number of first- and corresponding-author articles with  $h=\pi/4$  ( $FP > 0$  and  $RP > 0$ ).
- 50 authors (0.61%) published more first-author articles than corresponding-author articles with  $\pi/4 > h > 0$  ( $RP > 0$ ).
- 722 authors (8.9%) published only first-author articles with  $h=0$ .

In the polar coordinates (Figure 3), the distribution of the Y-index ( $j, h$ ) of the leading 23 potential authors in bruxism research with  $j \geq 13$  was demonstrated. Every point has a coordinate Y-index ( $j, h$ ) that could symbolize a single or multiple authors, for example, K.G. Raphael and A.G. Glaros having the same Y-index (13, 0.8622). D. Manfredini with Y-index (50, 0.8652) had the greatest publication potential in bruxism research.

M. Wieckiewicz (18, 1.373), E. Winocur (18, 1.204), T. lida (18, 0.8961) and J.M. Serra-Negra (18,  $\pi/4$ ) all had the same  $j$  of 18. All these authors are located on the same curve ( $j=18$ ) in Figure 3, indicating that they had the same publication potential in bruxism research with a  $j$  of 18 but different publication characteristics.<sup>42</sup> Wieckiewicz published a greater ratio of corresponding-author articles than first-author articles with an  $h$  of 1.373 followed by Winocur (1.204) and lida (0.8961). Serra-Negra published the same number of first-author articles and corresponding-author articles with an  $h$  of  $\pi/4$ . Similarly, I. Cioffi (1.279), T. Kuboki (1.153), A. Johansson (1.012), K.G. Raphael (0.8622), A.G. Glaros (0.8622) and T. Arima (0.7086) are also located on the same curve with  $j$  of 13. Cioffi had a greater ratio of corresponding-author articles than first-author articles with an  $h$  of 1.279 followed by Kuboki (1.153), Johansson (1.012), as well as Raphael and Glaros (0.8622). However, Arima published more first-author articles than corresponding-author articles with an  $h$  of 0.7086 indicating that Arima still actively performs bruxism research. B.R. Chrcanovic, S. Tecco, J.M. Serra-Negra and M.A. Ommerborn are located on the diagonal line ( $h=\pi/4$ ) indicating that they had the same publication characteristics but different publication potential. Chrcanovic had the greatest publication potential



FIGURE 3 Top 23 authors with Y-index ( $j \geq 11$ ).

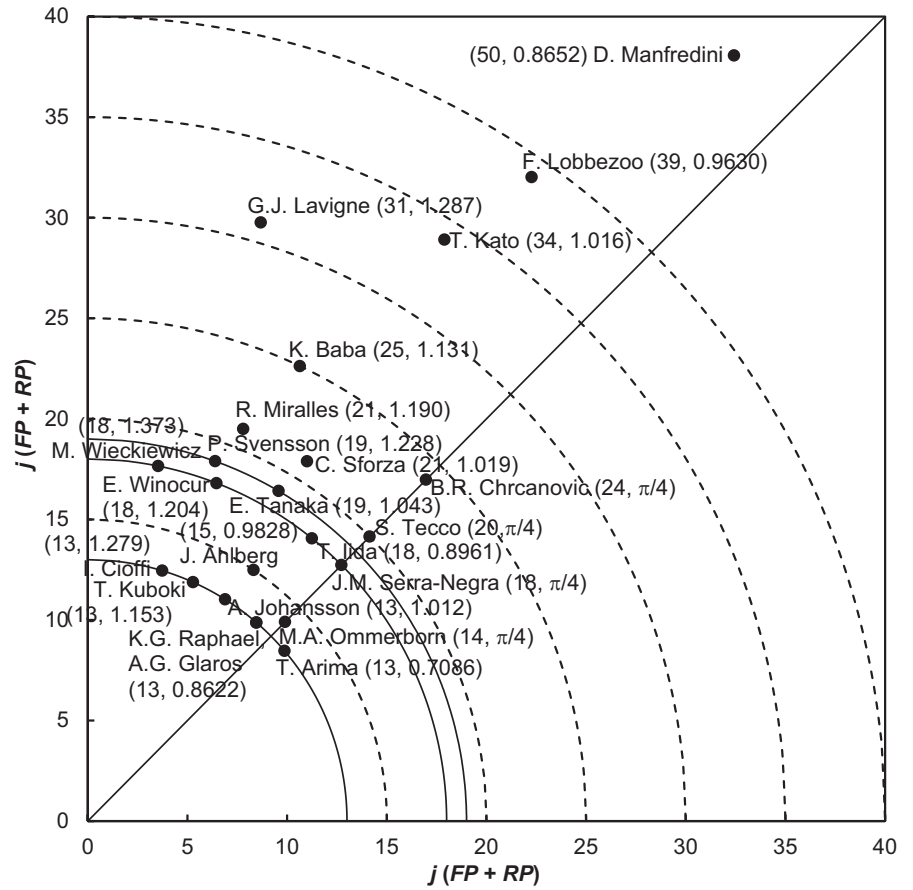
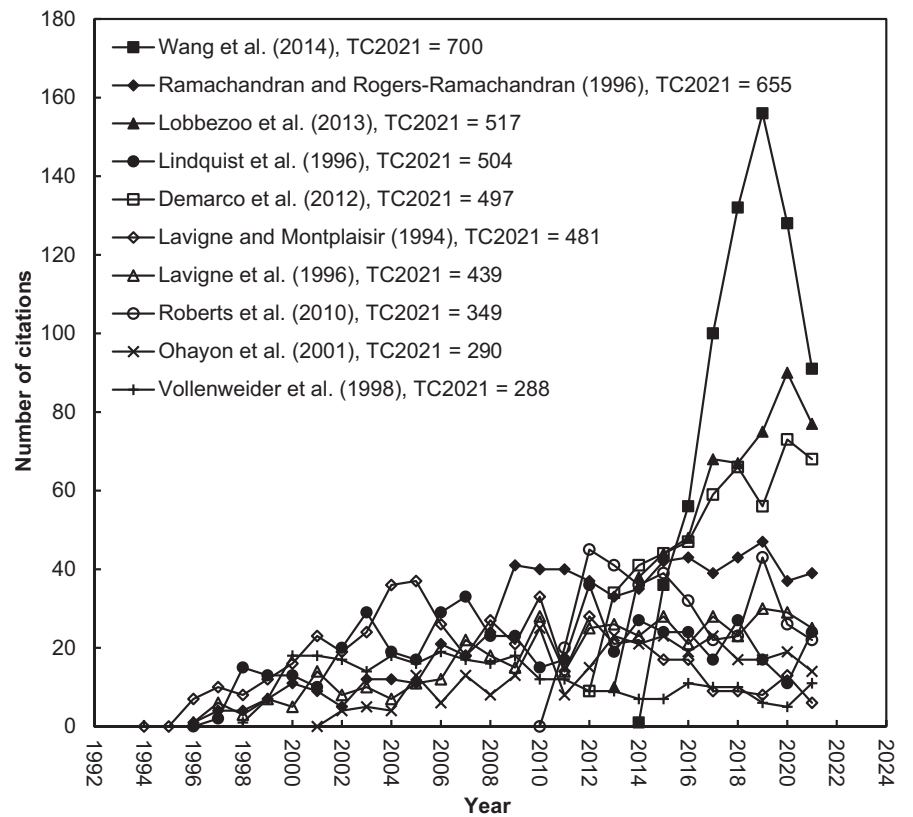


FIGURE 4 Citation histories of the top 10 most frequently cited articles.



with a  $j$  of 24 followed by Tecco, Serra-Negra and Ommerborn with a  $j$  of 20, 28 and 14, respectively. The location on the graph along with one of the curves or along a line from the origin represents different families of author publication potential or publication characteristics, respectively.<sup>25</sup>

### 3.6 | Citation histories of the 10 most frequently cited articles

A total of 899 bruxism-related articles (35%), 2458 articles (95% of articles with abstract in SCI-EXPANDED), and 920 articles (46% of articles with author keywords in SCI-EXPANDED) containing search keywords in their title, abstract and author keywords, respectively, were included.

Four of the top 10 most frequently cited articles contained search keywords in their title, abstract and author keywords, respectively. Table S5 shows the top nine most frequently cited articles. Only G.J. Lavigne published two of the top 10 articles as first author. The top 10 articles were published in the 10 different journals. The citation histories of the bruxism-related articles are shown in Figure 4. Four of the top 10 most frequently cited articles were still in high impact in the most recent year of 2021, ranked top 10 in  $C_{2021}$ . The top article by Wang et al.<sup>43</sup> had sharply increasing citations after its publication for five full years, and then decreasing to reach a  $C_{2021}$  of 91 (rank second). The article by Lavigne and Montplaisir<sup>44</sup> had a long citation history with a  $TC_{2021}$  of 481 (rank 6th) and a  $C_{2021}$  of six (rank 256th). It had high citations after its publication, but it is not in a high-impact position in the most recent year of 2021. In addition, the article by Lobbezoo et al.<sup>2</sup> with a  $TC_{2021}$  of 276 (rank 13th) had an extremely increasing number of citations after its publication to reach a  $C_{2021}$  of 115 (rank first). The article was the one with most impact in the most recent year of 2021.

### 3.7 | Research foci

The 20 most frequently used author keywords in bruxism-related research and their distribution in three sub-periods (1992–2001, 2002–2011 and 2012–2021) are listed in Table S6. The most frequently used author keywords, except for the search words, were “electromyography,” “temporomandibular disorders,” “masticatory muscles” and “masseter muscle.”

## 4 | DISCUSSION

The main finding of this analysis in publication performance was that the four most used keywords in bruxism-related publications are as follows: (a) bruxism/sleep bruxism, (b) electromyography, (c) temporomandibular disorders (TMDs) and (d) masticatory muscles. The relatively newly published paper on the definition of bruxism by the article by Lobbezoo et al.<sup>2</sup> was found to have the greatest

impact among all bruxism-related publications in the year 2021, even though it has not the greatest number of citations. Hence, the impact of a certain publication is not only based on the number of citations, but the citation history. This analysis also found some success factors. To become a highly productive author reaching the highest possible performance one must consider the following three aspects: (1) have several national and international collaborations; (2) publish articles about the definition, aetiology/pathophysiology and/or prevalence of bruxism; and (3) be a senior researcher in the field of TMD.

### 4.1 | Document types

When it comes to average citations per publication type (CPP), the difference between publication types ‘reviews’ and ‘articles’, in favour of reviews, found in this analysis is larger in the topic of bruxism than that of other medical-related topics as, for example, insomnia (1.4 times),<sup>45</sup> fracture nonunion (1.3 times)<sup>46</sup> and breast reconstruction (0.86 times).<sup>47</sup> However, it is, not surprisingly, in line with the closely related topic of TMD that also had a  $CPP_{2021}$  that was 1.7 times higher.<sup>11</sup>

Further, another finding that was expected and follow the results from a previous bibliometric analysis regarding TMD<sup>11</sup> was that  $CPP_{2021}$  was almost fivefold for articles published in English when compared to non-English publications. The same goes for the fact that there are slightly fewer authors per publication for non-English publications. As mentioned above, this finding is consistent with the finding from the closely related topic of TMD.<sup>11</sup> However, one must not forget that bruxism is part of the field of TMD, and that countries/languages commonly used for research in TMD are also similar in the field of bruxism, which can explain why English is the dominant language.

As for the document type ‘meeting abstracts’, this study showed that the two journals *Journal of Dental Research* (the official journal of the International Association for Dental Research) and *Sleep* (the official journal of the Sleep Research Society) answered to 55% of the total published ‘meeting abstracts’. This finding is not surprising and could be explained by the fact that these two journals publish special issues with ‘meeting abstracts’ on a yearly basis. The *Journal of Dental Research* published for example the special issue Interface between Materials and Oral Biology in 2021 and the Oral Microbiome in 2020. The journal *Sleep* on the contrary published the special issue for the Annual Meeting of the Associated Professional Sleep Societies.

### 4.2 | Characteristics of publication outputs

When it comes to the understanding of citation history in a specific research topic, a relationship between average number of citations per publication (CPP) and article life is proposed to be illustrated in a figure.<sup>48</sup> In this study, it took three full years for



bruxism-related articles to reach a peak in *CPP*, which is similar to another medical-related topic of breast reconstruction with a *CPP* of 3.0<sup>47</sup> after three full years. However, when comparing to other medical-related topics such as dengue fever,<sup>42</sup> Ebola,<sup>49</sup> breast reconstruction,<sup>47</sup> insomnia<sup>45</sup> and Q fever<sup>25</sup> as well as the closely related field of TMD<sup>11</sup> that need a decade to reach a peak in *CPP* bruxism-related articles seems to have a rapid peak, but also sharp decrease after the peak. Generally, the *CPP* of articles sharply increases to attain its peak values after the publication year followed by a gradual decrease,<sup>48</sup> and not as rapid as for the bruxism-related publications. This rapid decrease is also in contrast to articles related to the medical-related topic of fracture nonunion sharply increased for three full years to reach a plateau with a *CPP* of about 2.4 for 10 years.<sup>46</sup>

To understand development trends and impacts of publications in a specific research topic, Ho<sup>33</sup> proposed a correlation between annual number of articles (*TP*) and their average number of citations per publication by year ( $CPP_{\text{year}} = TC_{\text{year}}/TP$ ). In the research field of bruxism, there is a sharp increase in the number of publications between the years 2004–2021, which is not a surprising finding since it follows the trend from the closely related research field of TMD in which there has been a rapid increase in the number of publications between the years of 1992–2021, as shown in a recent publication.<sup>11</sup> However, if you closely analyse the increase in the field of bruxism between the years of 2004–2021 one can see that the greatest increase starts from year 2016, which could be explained by the establishment of the new definition of bruxism in the year 2013,<sup>3</sup> which consequently leads to massive interest and increase in research in this field. However, when it comes to  $CPP_{\text{year}}$  it takes approximately 8 years for publications in the field of bruxism to reach a plateau in accumulated citations, which is faster than both for the closely related field of TMD (10 years)<sup>11</sup> and for other medical-related topics, as for instance, fracture nonunion needing (14 years)<sup>46</sup> and breast reconstruction needing (10 years).<sup>47</sup> Based on this and on articles in other medical-related fields, such as dengue fever,<sup>42</sup> Ebola,<sup>49</sup> breast reconstruction,<sup>47</sup> insomnia<sup>45</sup> and Q fever,<sup>25</sup> one can draw the conclusion that it takes approximately 10 years before you can evaluate which impact an article has in its field.<sup>50</sup> Therefore, older articles have a greater chance to be identified than more recently published, even though the more recent could have significant and pioneering results.<sup>51</sup>

### 4.3 | Web of science category and journal

The characteristics of a research topic in the Web of Science categories was in this study based on the average of citations per publication ( $CPP_{\text{year}} = TC_{\text{year}}/TP$ ) and the average number of authors per publication ( $APP = AU/TP$ ), a method described in 2022.<sup>35,46</sup> Not surprisingly, the top productive Web of Science category, with more than half of all published bruxism-related articles, was 'dentistry, oral surgery, and medicine', which can be explained by the fact that this is a research topic that is highly relevant in this field. Further,

the closely related research field of TMD showed similar results with 64% of the published articles in the Web of Science category of 'dentistry, oral surgery and medicine'.<sup>11</sup> This finding is also in line with other medical-related topics such as fracture nonunion that had 69% of its published articles in the Web of Science category of 'orthopaedics'.<sup>46</sup>

Even though *Journal of Oral Rehabilitation* does not have the highest impact factor, it was expected that would be the journal with most publications, as it also was the top journal in the bibliometric analysis of the closely related topic of TMD.<sup>11</sup> One explanation could be that it reaches out to the audience that is interested in this topic since it aims to cover the broad area of oral rehabilitation that is a result of a developmental or an acquired disturbance in the orofacial region that could be tooth wear and tooth load, that is bruxism, or caused by orofacial pain conditions, orofacial traumas, as well as different dental and oral diseases. One could say that this finding is surprising since it is well known that authors strive to publish in the journals with the highest impact factors,<sup>52</sup> but this does not seem to be the fact for authors in the fields of TMD and bruxism who instead seem to target their readers.

### 4.4 | Publication performances: countries and institutions

As for the closely related research field of TMD,<sup>11</sup> the top three most productive countries were Japan, the United States and Brazil. These countries are also strong countries in other dental disciplines, such as prosthodontics and endodontics.<sup>53,54</sup> However, on surprising finding was that Sweden that was ranked fourth in the closely related research field of TMD,<sup>11</sup> ranked second in the field of prosthodontics<sup>53</sup> and ranked third in the field of endodontics<sup>54</sup> was only ranked 10 in the research field of bruxism, but with the second highest  $CPP_{2021}$ . Taken together, the top 10 most productive countries are the same in most of the dental disciplines.

When it comes to the determination of the institution of the corresponding author, it might be either the origin of where the study took place or the origin of the publication.<sup>15</sup> University of Sao Paulo was not surprisingly top productive institution, as it also was for the closely related topic of TMD.<sup>11</sup> However, among the other top productive institutions in the field of TMD only Aarhus University (Denmark), University of Amsterdam (the Netherlands) and Karolinska Institutet (Sweden) remained among the top nine productive in the field of bruxism. The rest of the positions were instead replaced by three universities from Japan and one from Canada. However, this is though in line with what could be expected since they are strong countries in dental research.<sup>11,53,54</sup> One explanation could be the availability of financial resources and presence of a big possible scientifically available population that could be found in United States and in Europe. Further, studies have shown that low to middle income level countries have less scientific articles published in medical journals with high impact factors.<sup>55,56</sup>

#### 4.5 | Publication performances: authors

It is widely established that two the most contributing authors in a research article are the first and the corresponding authors.<sup>47,57</sup> However, in this analysis more aspects than the authorship were evaluated. One must consider a potential bias in the analysis of authorship, that is that different authors might have the same name, or the same author using different names over time.<sup>28</sup> When it comes to the top productive authors in this analysis, the outcome was not surprising with top four being F. Lobezoo, D. Manfredini, G.J. Lavigne and P. Svensson. They are leading researchers in the field of TMD, and were also shown to be among the top productive authors in the field of TMD.<sup>11</sup> When it comes to F. Lobezoo he is the author leading the work with the new definition of bruxism,<sup>1-3</sup> D. Manfredini has focused on bruxism, diagnostics and treatment of TMD, which also stands for J. Lavigne, and P. Svensson. According to the Y-index, D. Manfredini also has the greatest publication potential among all authors in the field of bruxism, which is in line with his research interest (<https://pubmed.ncbi.nlm.nih.gov/?term=Manfredini%2C+Daniele%5BAuthor%5D>), and also what has been previously published in the closely related field of TMD.<sup>11</sup>

#### 4.6 | Citation histories of the 10 most frequently cited articles

From time to time, the number of citations is updated on the Web of Science Core Collection. To have the most reliable results in a bibliometric study, it is recommended to use data from the database directly and to use the total number of citations from the Web of Science Core Collection since publication year to the end of the most recent year, in this case of 2021 ( $TC_{2021}$ ).<sup>58</sup> Since citations of a highly cited article are not always high,<sup>38</sup> it is necessary to understand the citation history of a highly cited article. One example of this is the relatively new article with new definition of bruxism by Lobezoo et al.,<sup>2</sup> that had an extreme increase of citations after publication, that is a short citation history, making it the article with the highest impact of the year 2021, while another but older article by Lavigne and Montplaisir<sup>44</sup> having several citations from the past, that is a long citation history, but with little impact during the year 2021.

#### 4.7 | Research foci

The article title, abstract, author keywords and *KeyWords Plus* express the most important information about the research. Based on this, a very useful tool for evaluating research foci and the development trends in a specific research topic is word distribution analysis.<sup>59</sup> Ho and co-workers suggested that distributions of words in article titles and abstracts, author keywords, and *KeyWords Plus* should be used to determine research foci and trends.<sup>18,59</sup> These analyses are used to minimize limitations: the incomplete meaning of individual words in article titles and abstracts, the small sample size

of author keywords, and the indirect relationship between *KeyWords Plus* and research topics.<sup>31</sup> Therefore, the article title, article abstract, author keywords and words in *KeyWords Plus* were analysed during the research period to show rough trends.<sup>59</sup> Not surprisingly among the most frequently used search terms after “bruxism/sleep bruxism” was the search word “temporomandibular disorders.” It would rather be strange if the search word “temporomandibular disorders” was not among the top four since bruxism is closely related to TMD and one of the most common etiological factors, and secondly since the search term “bruxism” was one of the most common in a previous bibliometric analysis on TMD.<sup>11</sup>

#### 4.8 | Study limitations

Although citation analysis is considered a reasonable technique for article recognition and evaluation, there are some limitations to be raised. First, it does not consider the occurrence of self-citation, nor negative citations regarding the published article.<sup>60</sup> Neither does it consider the level of contribution made by each author. Secondly, it does not provide any information regarding the quality of the publications included in the analysis, although it is well known that the quality may vary greatly among different publications.<sup>61</sup> Thirdly, the most recently published articles are at a disadvantage, regardless of the quality and the content of the paper, since it takes approximately 10 years before you can evaluate which impact an article has in its field.<sup>50</sup>

#### 4.9 | Conclusion

The most used keywords by the authors in publications within the research-field of bruxism are shown, in the present bibliometric analysis, to be ‘bruxism/sleep bruxism’, ‘electromyography’, ‘temporomandibular disorders’ and ‘masticatory muscles’. Although the relatively newly published paper on the definition of bruxism does not have the most citations, in the year 2021 it had the greatest impact among all bruxism-related paper. Therefore, it is important not just to consider the amount of citation, but also to analyse the citation history. Finally, the most productive authors and those with the highest performance have some common features, they have several national and international collaborations, and they have published articles about the definition, aetiology/pathophysiology and prevalence of bruxism, and are all senior researchers in the field of TMD. Hopefully, based on this study, researchers and clinicians will have information to be stimulated to outline future research projects on bruxism-related aspects, and to initiate new international or multinational collaborations.

#### AUTHOR CONTRIBUTIONS

Essam Ahmed Al-Moraissi, Yuh-Shan Ho and Nikolaos Christidis contributed to conceptualization and methodology. Essam Ahmed Al-Moraissi and Nikolaos Christidis wrote the original draft. Yuh-Shan Ho contributed to data collection and analysis and reviewing

the manuscript. Finally, all authors read and revised the manuscript prior to submission.

### CONFLICT OF INTEREST STATEMENT

The authors declare that they have no conflicts of interest.

### PEER REVIEW

The peer review history for this article is available at <https://www.webofscience.com/api/gateway/wos/peer-review/10.1111/joor.13544>.

### DATA AVAILABILITY STATEMENT

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

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#### SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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