Systematic Review
An Analysis of Bibliometric Research on Sumatriptan (Imitrex, Tosymra) Linked to Migraine Relief

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ABSTRACT
Episodic headaches are a common neurovascular disorder called migraine characterized by a throbbing pain that is typically felt on one side of the brain, however it can occasionally affect both sides. However, no visual bibliometric analysis has been conducted on the effects of sumatriptan on migraine over the past 10 years. Objective: To identify the current status and emerging trends of the global use of sumatriptan associated with the relief of migraine from 2011 to 2022. Methods: Approximately 3154 publications (500 from PubMed and 2654 from dimensions) in CSV format were exported from PubMed and dimensions to VOS viewer. The keywords applied for searching were “sumatriptan” and “sumatriptan in migraine”. Results: The results of bibliometric analysis of the occurrence of keywords by VOS viewer revealed the top four most occurring keywords as “effect”, “relief”, “model”, and “mechanism”. The bibliometric analysis for the graphical distribution of a maximum number of articles by countries in 2011-2022 reveals Germany, the US, and Australia as the top three countries. The analysis for a maximum number of publications by organizations in 2011-2022 showed the top three organizations with a maximum number of articles are “Headache Core Center, Springfield, USA”, “Montefiore Medical Center, USA”, and “Experimental Medicine Research Center, Tehran University”. Conclusions: The compiled data of this exploration will make it easier for other academic research work to find authentic and fruitful results for complex future studies.

INTRODUCTION
The Greek words Biblion (book) and Merton were used to create the term “bibliometrics” (to measure) [1]. The article “Statistical bibliography or bibliometrics” introduced this term and defined it as “the application of mathematical and statistical methods to books and other media of communication” [2, 3]. To measure and analyze the productivity of literature in a particular field or journal, the field of library and information science uses a research methodology called bibliometrics [4]. It measures a research field’s contribution using statistical indicators, taking into account various nations, organizations, journals, or authors, and it forecasts trends or hotspots in the field [5-7]. The Centre for Science and Technology Studies at Leiden University in the Netherlands offers VOSviewer, a free Java-based program. It enables researchers to build and visualize bibliometric networks using information from bibliometric searches of significant databases to produce a citation map [8, 9]. Episodic headaches are a common neurovascular disorder called migraine characterized by throbbing pain that usually affects one side of the head (but can affect both sides) [10, 11]. It frequently manifests as severe, unilateral, pulsating headache attacks that are accompanied by other symptoms like photophobia, phonophobia, nausea,
vomiting, tingling or numbness in the extremities, and extreme sensitivity to sound, light, and smell [12, 13]. If untreated, a migraine attack typically lasts from 4 hours to 72 hours [12]. Globally, acupuncture therapy has been used to treat migraines [14]. A 2016 study on the global burden of disease estimates that 1.04 billion people worldwide experience migraines, with a 14.4% global prevalence rate [15-17]. Women are three times more likely than men to experience migraines, and the likelihood of migraine in children rises with age [18]. Additionally, about 10% of elderly people experience migraines annually [19]. The majority of disabilities in the world are caused by migraines, which account for one-third of lost years of disability-adjusted life [20].

Sumatriptan nasal spray (Tosymra; Promius Pharma/Dr. Reddy’s Laboratories) was approved by the US Food and Drug Administration (FDA) on January 27, 2019, for the immediate treatment of migraine in adults with or without aura [21]. Aura is a selective 5-hydroxytryptamine1B/1D (5-HT1B/1D) receptor agonist is a sumatriptan nasal spray [22]. In 1992, the FDA approved Imitrex, a subcutaneous injection form of sumatriptan, to treat migraines [23]. If the patient does not respond to the first treatment for the migraine attack before using sumatriptan nasal spray for subsequent migraine attacks [24], the diagnosis should be reevaluated [25]. It is not advised to use sumatriptan nasal spray to treat or prevent cluster headaches [26]. Sumatriptan is a selective 5-HT1B/1D receptor agonist [27, 28]. Sumatriptan exerts agonist effects on 5-HT1B/1D receptors found on intracranial blood vessels and trigeminal sensory nerves [29]. This causes constriction of the cranial vessel and inhibits the release of pro-inflammatory neuropeptides [28].

Therefore, a comprehensive bibliometric analysis of sumatriptan in migraine from 2011 to 2022 using PubMed and VOSviewer was performed after extracting the data from the databases. The total number of publications available online for retrieval was 3154 (500 from PubMed and 2654 from dimensions) were exported in CSV format to the VOS viewer. The bibliometric analysis of keywords showed “effect”, “relief”, “model”, and “mechanism” as the top four keywords. The graphical analysis of countries reveals Germany, the US, and Australia as the top three countries with the maximum number of publications from 2011-2022. While the bibliometric analysis of organizations reveals “Headache Core Center, Springfield, USA”, “Montefiore Medical Center, USA”, and “Experimental Medicine Research Center, Tehran University” as the top three centers for publishing a maximum number of articles.

RESULTS

Bibliometric Analysis of Publication Output

The Bibliometric analysis on sumatriptan in migraine using VOSviewer was performed after extracting the data from dimensions and PubMed. The total number of publications available online for retrieval was 3154 (2654 from dimensions and 500 from PubMed from 2011-2022). The figure 2 shows 2015 has the highest number of publications as compared to other years.

Figure 1: Flowchart for bibliometric analysis of sumatriptan in migraine from the year 2011-2022

A total of 3154 publications (500 from PubMed and 2654 from dimensions) were excluded in the search technique applied. The following keywords were used in a comprehensive examination of PubMed: “migraine”, “headache”, “neurology”, etc. To ensure that only peer-reviewed articles published between 2011 and 2022 were included, filters were implemented. Articles that were published in English and had a primary focus on migraines were included. Excluded studies were those without peer review or those unrelated to migraine. To facilitate analysis, relevant data was extracted, such as the abstract, journal information, authors, title, and year of publication. VOSViewer was used to import the data for the bibliometric study. The citation network visualization and analysis, co-authorship patterns, and keyword occurrences capabilities of this software led to its selection. Keywords like “migraine”, “epidemiology”, “treatment”, and “pathophysiology” were chosen in accordance to the objectives of the study. A second researcher independently analyzed a random sample of 3154 articles to verify the accuracy of the data (figure 1).

METHODS

The PubMed and Dimension databases were implemented and the search technique applied. The following keywords were used in a comprehensive examination of PubMed: “migraine”, “headache”, “neurology”, etc. To ensure that only peer-reviewed articles published between 2011 and 2022 were included, filters were implemented. Articles that were published in English and had a primary focus on migraines were included. Excluded studies were those without peer
part in research was set to 10. Out of 12053 organizations, 357 met
the threshold criteria. The top three keywords that appeared were
"effect" (occurrence= 2016 , relevance= 0.47), "relief" (occurrence= 100 , relevance= 0.26), "model" (occurrence= 87 , relevance= 0.15), "mechanism" (occurrence= 97 , relevance= 0.84) (table 1).

Table 1: Bibliometric Analysis of co-occurrence of top 10
keywords in Publications on sumatriptan in migraine

<table>
<thead>
<tr>
<th>Sr. no</th>
<th>Keywords</th>
<th>Occurrence</th>
<th>Links</th>
<th>Total link strength</th>
<th>Relevance</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Effect</td>
<td>206</td>
<td>212</td>
<td>2253</td>
<td>0.47</td>
</tr>
<tr>
<td>2</td>
<td>Relief</td>
<td>100</td>
<td>191</td>
<td>1251</td>
<td>0.26</td>
</tr>
<tr>
<td>3</td>
<td>Mechanism</td>
<td>97</td>
<td>187</td>
<td>1324</td>
<td>0.84</td>
</tr>
<tr>
<td>4</td>
<td>Model</td>
<td>87</td>
<td>169</td>
<td>1059</td>
<td>1.05</td>
</tr>
<tr>
<td>5</td>
<td>Day</td>
<td>73</td>
<td>180</td>
<td>820</td>
<td>0.63</td>
</tr>
<tr>
<td>6</td>
<td>Level</td>
<td>73</td>
<td>192</td>
<td>889</td>
<td>0.53</td>
</tr>
<tr>
<td>7</td>
<td>Injection</td>
<td>69</td>
<td>171</td>
<td>763</td>
<td>0.74</td>
</tr>
<tr>
<td>8</td>
<td>Adult</td>
<td>69</td>
<td>172</td>
<td>1165</td>
<td>0.54</td>
</tr>
<tr>
<td>9</td>
<td>Development</td>
<td>68</td>
<td>179</td>
<td>826</td>
<td>0.80</td>
</tr>
<tr>
<td>10</td>
<td>Rat</td>
<td>68</td>
<td>120</td>
<td>856</td>
<td>0.6</td>
</tr>
</tbody>
</table>

Graphical Analysis of Countries

Bibliometric analysis of countries indicates which countries have published maximum and minimum articles on the required topic which is a way to analyze the role of any country in certain research. The intensity between the countries and the frequency of their co-authorship publications are indicated by the distance between the clusters on the map and the lines linking them. This provides a decent indication of the power of collaborations between nations in the research of tourism and sustainability as shown in figure 4. The minimum number of documents published by a country required to take part in research was set to 3. Out of 33 countries, 21 met the threshold criteria. The top three countries for publishing the maximum number of articles were Germany with 436 publications (citations= 3554, total link strength =38), the U.S with 93 publications (citations=3109, total link strength=35), and Australia with 40 publications (citations=105, total link strength =3). The total 19 keywords (items) were distributed into a total of 7 clusters, of which cluster 1 has 4 countries (red color), cluster 2 contains 4 countries (green color), cluster 3 contains 3 countries (dark blue color), cluster 4 has 3 keywords (yellow color), cluster 5 has 2 keywords (purple color), cluster 6 has 2 countries (light blue), and cluster 7 has 1 country (orange color) as shown in figure 4. The list of all countries divided into clusters is mentioned in table 2.

Table 2: Bibliometric Analysis of countries in Publications on sumatriptan in migraine

<table>
<thead>
<tr>
<th>Sr. no</th>
<th>Countries</th>
<th>Documents</th>
<th>Links</th>
<th>Total Link Strength</th>
<th>Citations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cluster 1 (4 items) Red Color</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Australia</td>
<td>40</td>
<td>3</td>
<td>3</td>
<td>105</td>
</tr>
<tr>
<td>2</td>
<td>Belgium</td>
<td>5</td>
<td>2</td>
<td>4</td>
<td>53</td>
</tr>
<tr>
<td>3</td>
<td>India</td>
<td>7</td>
<td>1</td>
<td>1</td>
<td>166</td>
</tr>
<tr>
<td>4</td>
<td>Netherlands</td>
<td>13</td>
<td>6</td>
<td>12</td>
<td>842</td>
</tr>
</tbody>
</table>
were distributed into a total of 2 clusters, of which cluster 1 has 4 organizations (red color), and cluster 2 contains 3 organizations (green colors shown in figure 5. The list of all countries divided into clusters is mentioned in table 3.

Table 3: Bibliometric Analysis of organizations who published data on sumatriptan in migraine

<table>
<thead>
<tr>
<th>Sr. no</th>
<th>Organizations</th>
<th>Documents</th>
<th>Links</th>
<th>Total Link Strength</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Albert Einstein College of Medicine, Department of Epidemiology and Population Health, Bronx, NY, USA</td>
<td>4</td>
<td>13</td>
<td>28</td>
</tr>
<tr>
<td>2</td>
<td>Albert Einstein College of Medicine, Department of Neurology, Bronx, New York, USA</td>
<td>4</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>3</td>
<td>US-based Vector Psychometric Group, LLC, Chapel Hill, North Carolina</td>
<td>6</td>
<td>13</td>
<td>28</td>
</tr>
<tr>
<td>4</td>
<td>Avanir Pharmaceuticals, Inc., Aliso Viejo, CA, USA</td>
<td>3</td>
<td>4</td>
<td>10</td>
</tr>
</tbody>
</table>

Figure 4: Network Visualization of Countries.

The figure is a representation of the geographical analysis of countries for publications on sumatriptan use in migraine from the data extracted from dimensions 2011-2022. The top 3 countries with the maximum number of publications include Germany, U.S., and Australia.

Bibliometric Analysis of Organizations

The minimum number of documents published by an organization required to take part in research was set to 3. Out of 1053 institutions, 15 met the threshold criteria. The top three institutions for publishing a maximum number of articles were Headache Core Center, Springfield, MO, USA with 7 publications (total link strength =2), Montefiore Medical Center, Bron X, NY, USA with 6 publications (total link strength=12), and Experimental Medicine Research Centre, Tehran University with 5 publications (total link strength =2). The total 7 organizations keywords (items) were distributed into a total of 2 clusters, of which cluster 1 has 4 organizations (red color), and cluster 2 contains 3 organizations (green colors shown in figure 5. The list of all countries divided into clusters is mentioned in table 3.

Table 3: Bibliometric Analysis of organizations who published data on sumatriptan in migraine

<table>
<thead>
<tr>
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<td>Albert Einstein College of Medicine, Department of Epidemiology and Population Health, Bronx, NY, USA</td>
<td>4</td>
<td>13</td>
<td>28</td>
</tr>
<tr>
<td>2</td>
<td>Albert Einstein College of Medicine, Department of Neurology, Bronx, New York, USA</td>
<td>4</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>3</td>
<td>US-based Vector Psychometric Group, LLC, Chapel Hill, North Carolina</td>
<td>6</td>
<td>13</td>
<td>28</td>
</tr>
<tr>
<td>4</td>
<td>Avanir Pharmaceuticals, Inc., Aliso Viejo, CA, USA</td>
<td>3</td>
<td>4</td>
<td>10</td>
</tr>
</tbody>
</table>

Figure 7: Network Visualization of Organizations.
The figure is a representation of network visualization of organizations who have publications on sumatriptan use in migraine from the data extracted from dimensions and PubMed 2011-2022. Greater number of associations come under the red cluster zone.

Discussion

We conducted a scientometric analysis of migraine research published between 2011 and 2022 as part of our investigations, and we created a knowledge map comprising the nations and territories, organizations, writers, keywords, and cited references. After analyzing the development trend of the total number of publications, we found an interesting phenomenon: The past 20 years analysis showed that the overall development trend of the total number of migraine research publications has been increased year by year. The average total number of publications available online were 3154 (2654 exported from dimensions from 2011-2-22 and 500 exported from Pubmed from 2011-2022), whereas data analysis of 2010 to 2019 (2013.9) showed that it was greater than the data analysis published in 2000-2009 (1271.0). However, the
average growth rate for 2000-2009 (7.999\%) is greater than the growth rate analysis in the years of 2010-2019 (5.348\%). The slope of the linear regression equation is also compared with 2000-2009. It was also observed that the highest number of publications were reported in 2014 as compared to other years [30]. It is worthwhile to note that in the era of COVID-19, about 50\% of migraine sufferers said that their regular discomfort got worse during the lockdown. A worsening of the migraineurs’ clinical course was associated with altered triggers and psychological effects of the lockdown. In 2011-2022, out of 33 countries, 21 met the threshold criteria. The top three countries for publishing the maximum number of articles were Germany with 436 publications (citations= 3554, total link strength =38), the U.S with 93 publications (citations=3109, total link strength=35), and Australia with 40 publications (citations=105, total link strength =3). The top 3 countries with a maximum number of publications on sumatriptan use in migraines from 2011-2022 include Germany, the U.S., and Australia [31]. In 2011-2022, the top three organizations for publishing the maximum number of articles were Headache Core Center, Springfield, MO, USA with 7 publications (total link strength =2), Montefiore Medical Center, Bron X, NY, USA with 6 publications (total link strength=12), and Experimental Medicine Research Centre, Tehran University with 5 publications (total link strength =2). This investigation has a number of limitations. First, despite the fact that the search technique looks for MeSH subject word synonyms in PubMed, it can still overlook certain material. Furthermore, the capacity of the dimension to eliminate duplication is constrained, which could skew the findings of the study. Just a Pubmed analysis was done, therefore the general trend may not be accurately represented. Furthermore, the criteria we apply need to be further enhanced because part of the material will be published online ahead of time, which will lead to inconsistencies between the date of collection and publication.

**CONCLUSIONS**

In this paper, we used Pubmed and VOSviewer to conduct a bibliometric analysis of sumatriptan on migraine from 2011 to 2022 and acquired the knowledge mapping of countries, institutions, authors, keywords, and Cited references. This study provides a new perspective on the trend of using sumatriptan for the relief of migraine. Although this study has some limitations, it fully reveals the global trend of migraine. The overall trend of publications is increasing year by year, and the growth rate in 2011-2022 is greater than that in 2010-2019.

**Authors Contribution**

Conceptualization: MU  
Methodology: MU  
Formal analysis: MU, MOM, AS, MTT  
Writing-review and editing: AO, SI, SSZ

All authors have read and agreed to the published version of the manuscript.

**Conflicts of Interest**

The authors declare no conflict of interest.

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