The Most Cited Articles, Authors, Journals, and the Affiliated Countries on the Topic of Cardiology from 2016 to 2018 in Pubmed Central

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Introduction

Cardiology is a branch of medicine that deals with the disorders of the heart as well as some parts of the circulatory system for human beings [1-5]. The field includes medical diagnosis and treatment of congenital heart defects, coronary artery disease, heart failure, valvar heart disease and electrophysiology [6-8]. Physicians who specialize in this field of medicine are called cardiologists as a specialty of internal medicine. Similarly, pediatric cardiologists are pediatrics who specialize in cardiology. Alternatively, physicians who specialize in cardiac surgery are called cardiothoracic surgeons or cardiac surgeons as a specialty of general surgery.

Although the cardiovascular system is inextricably linked to blood, cardiology is relatively unconcerned with hematology and its diseases [9,10]. Some obvious exceptions that affect the function of the heart would be blood tests (electrolyte disturbances, troponins), decreased oxygen-carrying capacity (anemia, hypovolemic shock), and coagulopathies [11-14].

Many previous types of research [15-17] have inspected the patterns of coauthor collaboration in the past in literature. The most number of articles in science are from the U.S. and Europe [18,19]. Whether the dominant nation on the topic of cardiology is similar to other science is worthy of study and investigation.

As of September 20, 2019, more than 189 papers were published on PubMed Central (PMC) by searching the keywords of "cardiology" [Title] from 2016 to 2019 as of September 20, 2019. A total number of 12789 citing articles matching the citable papers in PMC were attained. The number of 559 articles was cited by at least one publication in PMC. All data were downloaded from PMC, which means the study is not necessary for ethical approval according to the regulation promulgated by the Taiwan Ministry of Health and Welfare.

The x-index proposed in this study

The x-index \( (\sqrt{\max(i \times c_i}) \) [26] can be divided into three parts: toward citation, neutral and the publications, which is suitable for using Kano model to display.

The weighted author scheme (AWS) for quantifying coauthor contributions

One of the drawbacks for h-index was proposed without fairly quantifying coauthors’ credits in an article byline [27,28]. Many bibliometric indices ignore the coauthor contributions to the article with an equal credit size. For instance, some used the alphabet ordering of author names [29] in the mathematical discipline and assumed all coauthor with equal credits, we particularly applied the author-weighted scheme [30,31], i.e.,

\[
\gamma_\alpha = \frac{\exp(\gamma_\alpha)}{\sum_{\gamma_\alpha} \exp(\gamma_\alpha)} - \frac{2.72^\gamma_\alpha - 1}{\sum_{\gamma_\alpha} 2.72^\gamma_\alpha}
\]

for this study for quantifying coauthor contributions, where m-1 is the number of authors in an article byline, the first author has the most credit with the power \( \gamma = m - 1 \), the corresponding author placed at the last position has the second larger credit with the power \( \gamma = m - 2 \) last one has the power \( \gamma = 0 \)

Kano model used in this study

The Kano model [20] is applied to classify the IRA features for each entity, all author-based x-indexes with similar quantities of citations and publications will locate on the one-dimensional zone. That is the plot along a 45-degree line that runs from the left-bottom to the right-top. Otherwise, the IRAs will be on either the upper side or bottom side in the Kano diagram. That is to say that if the x-index [26] is applied to the Kano model, the other two features of the citation-oriented and the production-oriented might be highlighted in the chart when the publications (i) are on the X-axis and citations (ci) on the Y-axis. As a result, the x-index is truly suitable for Kano model [20] in the assessment of entity IRA characteristics.

Creating dashboards on Google Maps

We applied the author-made modules in MS-Excel and the Kano diagrams to draw dashboard on Google Maps. The pages of Hyper Text Mark-up Language (HTML) used for Google Maps were created. All relevant bibliometric indices were linked to dashboards on Google Maps.

Results

TASK 1: Which countries/areas dominate the topic of cardiology around the world

We observed the most number of papers on the topic of cardiology are from the United States (311, 29.37%) and Italy (84, 7.93%), see Table 1 based on the first authors whose affiliated countries/areas are listed in the corresponding abstract.
The most cited countries using the x-index to measure are Poland, the US, and Italy, see Figure 1 with a choropleth map to present. The Kano diagram in Figure 2 clearly and definitely displays that the citation-originated countries are Poland and Italy, the US is located in the one-dimensional region and Spain in the publication-originated area.

**Figure 1**: The most cited affiliated countries/areas on cardiology in PubMed using x-index to measure (Poland, the US, and Italy)

**Figure 2**: The most affiliated countries/areas on cardiology in PubMed using x-index to display on the Kano diagram.

**TASK 2: selecting the most cited authors**

The most cited author are (1) Piotr Ponikowski from Poland with x-index= 25.84, Cited=333.76, and Citable=2; (2) Peter van der Meer from the Netherlands with x-index=15.67, Cited=122.78, and Citable=2. Others can be seen in Figure 3 when QR-code has been scanned and clicked on the bobble of interest.

**Figure 3**: The most authors on cardiology in PubMed using x-index to display on the Kano diagram.

**TASK 2: selecting the most cited authors**

The most cited author are (1) Piotr Ponikowski from Poland with x-index= 25.84, Cited=333.76, and Citable=2; (2) Peter van der Meer from the Netherlands with x-index=15.67, Cited=122.78, and Citable=2. Others can be seen in Figure 3 when QR-code has been scanned and clicked on the bobble of interest.

**Figure 4**: The most journals on cardiology in PubMed using x-index to display on the Kano diagram.

**Table 1**: Publications on cardiology in PubMed across years.

<table>
<thead>
<tr>
<th>Continent</th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
<th>2019</th>
<th>Total</th>
<th>%</th>
</tr>
</thead>
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<td>8</td>
<td>9</td>
<td>2</td>
<td>25</td>
<td>2.36</td>
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<td>1</td>
<td>5</td>
<td>1</td>
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<tr>
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<td>7</td>
<td>8</td>
<td>2</td>
<td>20</td>
<td>1.89</td>
</tr>
<tr>
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<td>29</td>
<td>55</td>
<td>4</td>
<td>111</td>
<td>10.48</td>
</tr>
<tr>
<td>Turkey</td>
<td>2</td>
<td>4</td>
<td>13</td>
<td>19</td>
<td>1</td>
<td>1.79</td>
</tr>
<tr>
<td>Japan</td>
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<td>4</td>
<td>5</td>
<td>15</td>
<td>1</td>
<td>1.42</td>
</tr>
<tr>
<td>China</td>
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<td>5</td>
<td>4</td>
<td>2</td>
<td>12</td>
<td>1.13</td>
</tr>
<tr>
<td>India</td>
<td>1</td>
<td>3</td>
<td>7</td>
<td></td>
<td>11</td>
<td>1.04</td>
</tr>
<tr>
<td>South Korea</td>
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<td>2</td>
<td>6</td>
<td>1</td>
<td>11</td>
<td>1.04</td>
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<tr>
<td>Others</td>
<td>11</td>
<td>11</td>
<td>20</td>
<td>1</td>
<td>43</td>
<td>4.06</td>
</tr>
<tr>
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<td>162</td>
<td>152</td>
<td>178</td>
<td>23</td>
<td>515</td>
<td>48.63</td>
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<tr>
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<td>32</td>
<td>24</td>
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<td>84</td>
<td>7.93</td>
</tr>
<tr>
<td>Spain</td>
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<td>19</td>
<td>20</td>
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<td>69</td>
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<tr>
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<td>9</td>
<td>15</td>
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<tr>
<td>Others</td>
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<td>72</td>
<td>5</td>
<td>208</td>
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<tr>
<td>N. AMERICA</td>
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<td>120</td>
<td>114</td>
<td>14</td>
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<tr>
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<td>104</td>
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<td>12</td>
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<td>14</td>
<td>11</td>
<td>2</td>
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<td>2</td>
<td>1</td>
<td></td>
<td>4</td>
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</tr>
<tr>
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<td></td>
<td></td>
<td></td>
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<td>0.09</td>
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<tr>
<td>OCEANIA</td>
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<td>5</td>
<td>11</td>
<td>2</td>
<td>26</td>
<td>2.46</td>
</tr>
<tr>
<td>Australia</td>
<td>6</td>
<td>4</td>
<td>11</td>
<td>2</td>
<td>23</td>
<td>2.17</td>
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<tr>
<td>New Zealand</td>
<td>2</td>
<td>1</td>
<td></td>
<td></td>
<td>3</td>
<td>0.28</td>
</tr>
<tr>
<td>S. AMERICA</td>
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<td>12</td>
<td>6</td>
<td>1</td>
<td>30</td>
<td>2.83</td>
</tr>
<tr>
<td>Brazil</td>
<td>4</td>
<td>7</td>
<td></td>
<td></td>
<td>11</td>
<td>1.04</td>
</tr>
<tr>
<td>Chile</td>
<td>3</td>
<td>4</td>
<td>2</td>
<td></td>
<td>9</td>
<td>0.85</td>
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<tr>
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<td>4</td>
<td>1</td>
<td>4</td>
<td>1</td>
<td>10</td>
<td>0.94</td>
</tr>
<tr>
<td>Total</td>
<td>314</td>
<td>326</td>
<td>373</td>
<td>46</td>
<td>1059</td>
<td>100</td>
</tr>
</tbody>
</table>

The most cited countries using the x-index to measure are Poland, the US, and Italy, see Figure 1 with a choropleth map to present. The Kano diagram in Figure 2 clearly and definitely displays that the citation-originated countries are Poland and Italy, the US is located in the one-dimensional region and Spain in the publication-originated area.
The most cited article regarding cardiology is the one [32] with the number of citations = 883 in PMC till September 27, 2019. The article is related to the written guidelines on cardiology for the diagnosis and treatment of acute and chronic heart failure linked at https://www.ncbi.nlm.nih.gov/pubmed/?term=27206819

Discussion

We observed that (1) the most number of papers on the topic of cardiology are from the the United States (311,29.37%) and Italy (84,7.93%); (2) the most cited countries, authors, and the journals are from Poland, Piotr Ponikowski (Poland), and Eur Heart J.

As for the h-index [33], an author-level metric that attempts to measure both the productivity and citation impact of the publications of a scientist or scholar, proposed for determining IRA, both citations and publications should be combined, as h-index and other complementary metrics, to determine the IRA. However, the newest bibliometric index is the x-index [26] proposed in 2018. The first feature in this study is that we demonstrated the x-index sophisticatedly applied to measure IRAs for authors and affiliated countries/areas because the x-index can clearly indicate the attributes in tree parts better understanding the properties of the IRA for entities than other bibliometric [35-38], see Figures from 2 to 4. Another feature in this study is about the choropleth maps applied to present the results, see Figure 1, which imply that choropleth maps are great to show a clear regional pattern for the disparity of the data. If our data doesn’t show a clear regional pattern, consider other chart types, e.g., bar chart or line chart, readers would prefer to find themselves on a map. If we are mapping an area in which our readers live, do consider a choropleth map even if they do not live in those regions [34]. Accordingly, the top two countries of Poland and Italy are most in x-index, particularly on citation-originated in Kano diagram on cardiology by the keyword “cardiology [Title] in PMC.

The most cited author is Piotr Ponikowski form Poland who gains x-index= 25.84, Cited=333.76 using the x-index to measure the IRAs which can fairly allocate credits in an article. Otherwise, all coauthors who enjoy an equal size of contributions to the article are unfair when calculating the bibliometrics [27, 28].

A total of 233 articles were extracted from PMC using the keyword “most cited articles” in the paper title. Only four [35-38] referred Pubmed as the citations database. Other famous major citation databases, such as the Scientific Citation Index (SCI; Thomson Reuters, New York, NY, USA) and Scopus (Elsevier, Amsterdam, The Netherlands), are paid for use [39]. We applied the web crawler technique and obtained the citations from PMC, which is rarely seen in the previous research. The most cited article with PMID= 27206819 in 2016 was, thus found. A total of 883 citations was extracted from PMC.

Although the h-index [33] being a popular author-level metric that can measure both the productivity and citation impact of the publications of a scientist, one of its shortcomings is less discriminative power [40] was criticized. Even the h-plus index is proposed to complement the h-index because both parts of excess and h-tail citations have been considered [41,42], the x-index [26], particularly incorporated with the Kano model, is the best for better understanding the IRAs on a diagram according to the findings in the current study.

Another feature is about the AWS used for quantifying co-author contributions in an article byline. Even many concepts have already been proposed in the past [27,28,43], but none has been applied to the scientific disciplines in use successfully as we did with the Eq. (1).

The reason we applied x-index in this study is the strength of the index in practice. According to the illustration in the study of Fenner and his colleagues [26], the x-index can truly extend the feature of an author with quality and quantity achievements in academics as mentioned above.

Although findings are based on the above analysis, there are still several potential limitations that may encourage further research efforts. First, all data were extracted from PMC. There might be some biases when matching author names because of some with identical names, which will affect the result of author clusters.

Second, many definitions that can be determined on the topic of cardiology. We merely applied the keyword “cardiology [Title] in this study. The findings regarding the most cited countries, authors, journals or the articles cannot be generalized to the true topic of cardiology. The future studies are encouraged to broaden the definition as to completely investigate the true IRAs on cardiology.

Third, the data extracted from PMC cannot be generalized to other major citation databases. Such as the most cited articles and authors might be disparate if others were applied.

Conclusion

In conclusion, Kano diagrams on Google Maps with citation analyses provide wide and deep insight into the relationships on authors’ publications and citations. The results can provide readers with knowledge and concept diagram for the future submissions to journals and authors referred to the topic of cardiology.

Authors’ Contributions

HYL developed the study concept and design. TWC and HYL analyzed and interpreted the data. WC monitored the process of this study and helped in responding to the reviewers’ advice and comments. TWC drafted the manuscript, and all authors provided critical revisions for important intellectual content. The study was supervised by WC. All authors read and approved the final manuscript.

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