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# The use of radar plots with the Yk-index to identify which authors contributed the most to the journal of Medicine in 2020 and 2021

## A bibliometric analysis

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**Abstract**

**Background:** A consensus exists that the first author and corresponding author make the most contribution to the publication of an article. The Y-index has been proposed to assess the scientific achievements of authors, institutions, and countries/regions (AIC/R for short) based on the number of first-author publications (FPs) and corresponding-author publications (RPs). Nonetheless, the Y-index is defined in terms of count and radian (represented by j and h) instead of using the relative radius and angle degree to simplify understanding. In the literature, a method for drawing radar diagrams online with the Y-index is also lacking. This study was conducted to enhance the Y-index with an additional relative radius denoted by k and the angle degree represented by h* (named Yk-index), include easy-to-use features (e.g., copying and pasting) for the delivery of the online Radar-Yk, and identify which one of AIC/R contributed the most to a scientific journal.

**Methods:** From the Web of Science (WoS) database, we downloaded 9498 abstracts of articles published in the journal of *Medicine (Baltimore)* in 2020 and 2021. Three visual representations were used, including a Sankey diagram, a choropleth map, and a radar diagram, to identify the characteristics of contributions by AIC/R to *Medicine (Baltimore)* using the Yk-index (j, k, h*). A demonstration of Rada-Yk with easy-to-use features was given using the copy-and-paste technique.

**Results:** We found that Qiu Chen (China), Sichuan University (China), China, and South Korea (based on regions, e.g., provinces/metropolitan areas in China) were the most productive AIC/R, with their Yk equal to 27,715, 12415.1, and 2045, respectively; a total of 85.6% of the published articles in *Medicine (Baltimore)* came from the 3 countries (China, South Korea, and Japan); and this method of drawing the Radar-Yk online was provided and successfully demonstrated.

**Conclusion:** A breakthrough was achieved by developing the online Radar-Yk to show the most contributions to *Medicine (Baltimore).* Visualization of Radar-Yk could be replicated for future academic research and applications on other topics in future bibliographical studies.

**Abbreviations:** AIC/R = author, institute, country, and regions, FP = publications based on first authors, RP = publications based on responding authors, WoS = web of science.

**Keywords:** choropleth map, forest plot, radar diagram, radar-Yk, Sankey diagram, Y-index

## 1. Introduction

The publication of articles in peer-reviewed journals is one of the primary criteria for evaluating and comparing contributions made by authors, institutions, and countries/regions (AIC/R, for short)[1–5] to a specific community or journal. The name of a person should be included as a coauthor only if he/she has substantially contributed to the writing of the article.[6] The International Committee of Medical Journal Editors[7] recommended that authorship credit should be based on substantial contributions such as conception and design, analysis and interpretation of data, and drafting or reviewing the article. One of the most commonly used indicators to assess scientific productivity is the total number of journal publications.[8]

### 1.1. Scientific productivity assessed using the y-index

During the last few decades, there has been an increase in the number of multi-author articles published in scientific journals.[9–11] Multiauthorship is becoming the norm.[11] The percentage of single-authored articles has decreased, while the

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**Key points:**

1. The Yk-index was proposed to be effective in comparing contributions from authors, institutions, and countries (regions) to *Medicine (Baltimore)*.
2. Radar-Yk was demonstrated to visualize the contributions by 7 strata and has not been illustrated in the past literature.
3. The other 3 visual displays are also unique at 1 glance and can be used to display important information with numerous tables and graphs in traditional biometrics.

percentage of multiauthored articles and the number of authors per publication have increased.[12] It has been reported in the literature of the health sciences and ethics about problems related to publication practices (e.g., ghost- and gift-authorships, conflicts of interest),[13] but there has been relatively little practical guidance developed to help researchers determine how to fairly assign credit for the multiauthored publications. Multiple authorship has been found to absolve responsibility and dilute accountability.[14,15] Popular indicators, such as the number of publications, citations, citations per publication, h-index,[16] g-index,[17] A-index,[18] R-index,[18] AR-index,[18] and x-index,[19] did not take authorship into consideration.[8]

For assessment of research productivity and impact,[5] some fractional counting by the first or corresponding author was applied (e.g., author weighted scheme).[6,20,21] First-author articles have been used as a measure of authors' performance in general surgery journals,[22] anesthetic journals,[23] ophthalmology journals,[24] rehabilitation journals,[25] biomedical research journals,[26] urology journals,[27] and orthopedic surgery journals.[28] The number of coauthored articles by Chinese authors was also noted as a reflection of their research responsibility.[29] Recent attempts have been made to evaluate the performance of authors with the use of the Y-index[30] by using indicators related to both first author articles and corresponding author articles, including studies in the fields of medicine,[31] environmental science,[32] risk assessment,[33] desalination,[34] global climate change,[35] university comparisons,[36] country characteristics,[37] and emergency medicine.[38] The Y-index, including both first authorship and corresponding authorship, has also been applied to evaluate the top-cited research articles in the Science Citation Index Expanded (SCI-Expanded[39,40]) and in the independent research of China.[41] The first research question aims to evaluate the Y-index (or enhanced Y-index called Yk-index) in relation to AIC/R for a specific journal.

### 1.2. Drawbacks of the Y-index

The Y-index is calculated based on Equation (1),[39,42] which are derived from the number of first-author publications (FPs) and corresponding-author publications (RPs).

$$j = FP + RP \text{ from 1 to } \propto,$$

*radius of each element location denoted by k = normalized J* from 0 to 1,

where *j* refers to the publication potential and equals Y-index. The greater the value of *j* is, the greater the contribution of the corresponding and first (co-first) authors to the science community.[38] The first disadvantage of the Y-index is the J(=FP + RP) from 1 to $\propto$instead of normalizing $j = \sqrt{RP^2 + FP^2}$ to be a radius equal to 1.0 based on the maximal j in Equation (2). Therefore, the Yk-index was proposed to enhance the Y-index.

A second disadvantage of the Y-index is the lack of a method for drawing the online radar diagram using the Y-index. Thus, the second research question aims to demonstrate how to draw the online Radar-Yk for readers in this study.

### 1.3. Study aims

Based on the 2 research questions (i.e., application of the Yk-index and development of the online Radar-Yk for readers), this study was conducted to enhance the Y-index using the Yk-index, include easy-to-use features (e.g., copying and pasting) for the delivery of the online Radar-Yk, and identify which one of AIC/R contributed the most to a scientific journal.

## 2. Methods

### 2.1. Data source

The study data were organized in 2 steps. First, we searched the Web of Science (WoS) database using the keyword *SO="Medicine" and (PY = 2020 or PY = 2021)* based upon the document types of articles and review articles. In total, 9498 abstracts of articles published in 2020 and 2021 were downloaded (see Supplemental Digital File 1, http://links.lww.com/MD/H567). Next, data related to the fields of AIC/R (i.e., author, institute, country, and regions in reference to provinces/metropolitan cities in China and states in the US) by first and corresponding authors were extracted from the Excel-format dataset.

Because all data were obtained from a publicly available database, this study does not require ethical approval.

### 2.2. Study designs and approaches

Two parts were involved in dealing with the data:

***2.2.1. Part I: Data presentations using 2 visualizations.*** Two visualizations were prepared to present the data characteristics, including frequency of year, document type, author, and research institute on the Sankey diagram[43] and values of the Yk-index for each country/region on the choropleth map.[44] The method of how to draw the 2 visualizations are described in Supplemental Digital File 2,[45] http://links.lww.com/MD/H568. China and the United States are divided based on the size of their research populations into provinces/metropolitan cities in China and states in the US to avoid having the dominant productivity always imposed on the 2 large countries, as has been shown in numerous bibliographical studies.

***2.2.2. Part II: The online radar-yk drawn for AIC/R.***

*2.2.2.1. How to draw the radar diagram.* The online Radar-Yk was developed using the copy & paste method:

Step 1: to draw the online Radar-Yk, we require 2 datasets, namely, coordinates of AIC/R based on the Yk-index and categories of AIC/R based on the j value in Equation (1).

Step 2: Paste the 2 datasets from Step 1 onto the website,[46] select the radar plot in the combo box, and click the submit icon if no such adjustments are needed.

Step 3: The radar diagram is automatically created, or the coordinates are manually adjusted if necessary after returning to the input website.

Detailed information about the radar diagram based on the Yk-index is available in references.[45,47]

*2.2.2.2. Yk-index to represent the strength of contribution.* Based on Equations (1) and (2), j and k represent the absolute and relative contribution or performance to the journal. The normalization of j into the range from 0 to 1 in Equation (2) is performed according to the following procedure:

Step 1: set n to be the maximum of j in one of the AIC/R groups and then obtain the ratio of each AIC/R via Equation (3). The radius refers to the member with the highest j. Other radiuses would be smaller or equal to the dominant member according to Equation (3).

$$ratio_i = \frac{j_i}{n},$$

$$h_i^* = degrees(tan^{-1}\left(\frac{RP}{FP}\right)) \text{ from 0 to 90},$$

Step 2: Transform RP of the AIC/R(i) each into the coordinate of sin value (denoted by Vsini) between 0 and 1 based on the known angle degree(h*) in Equation (4) via the formula (= sin(radians($\frac{RP}{FP}$)) in trigonometric functions of Microsoft Excel.

Step 2: Transform FP of the AIC/R(i) into the coordinate of the consin value (denoted by Vconi) with the formula (= cos(radians($\frac{RP}{FP}$)).

Step 3: Compute k of the AIC/R(i) each via Equation (5).

$$k = ratio_i \times \sqrt{Vsini^2 + Vconi^2},$$

$$\begin{matrix} k = ratio_i \times \sqrt{Vsini^2 + Vconi^2}, \\ = radius_i \end{matrix}$$

where the ratio for each element is derived from Equation (3). As such, Yk(27, 1, 45) means that the AIC/R has a total number of publications (or contributions) of j = 27, the relative value of k = 1.0 (i.e., the top one with the highest j among the computed members) in a radius unit, and the feature of publications denoted by h = $45^0$, indicating equal RP and AP for a scholar author.

*2.2.2.3. Features of Radar-Yk.* In Radar-Yk, bubbles were colored and sized according to k in Equation (3). A total of 7 strata were identified. The strata can be viewed as the annual rings formed in trees by the growth layers of wood that appear in the stems and roots of trees and shrubs each year. The Yk-index can be drawn via Equation (6).

$$\frac{x^2}{k} + \frac{y^2}{k} = 1$$

Where k is set at 0.10, 0.28, 0.46, 0.64, 0.82, and 1.0 with 7 strata when h* from 0 to 90. Similarly, the Y-index under the condition of j = RP + FP can be drawn as a rotated oval with the rotated $\theta$ at degree(= $45^0$) via Equation (7).

$$\frac{(x'cos\theta - y'sin\theta)^2}{a} + \frac{(x'sin\theta - y'cos\theta)^2}{1} = 1$$

Where $a$ is greater than 1.0 and h is from 0 to $\frac{\pi}{2}$ based on Equation (8), which is defined by the Y-index in references[39,42]; see the visual comparison of Y/Yk-indices in Figure 1.

$$h = tan^{-1}(\frac{RP}{FP}) \text{ from 0 to } \frac{\pi}{2},$$

*2.2.2.4. Comparison of y-index and yk-index.* There have been 2 definitions of j in previous studies[40,48] as scenarios A and B in Table 1. It is obvious that scenario B for the Y-index is inconsistent with the others when compared to scenario A and the Yk-index (on the right-hand panel in Table 1). The computation of the Yk-index is based on Equation (1) to achieve different distances in radius (e.g., 1, 1, and 0.71 or 36.06, 36.06, and 35.36 in scenario A) rather than equal distances (e.g., 50, 50, and 50) in scenario B.[48] The difference in visual features between the 2 scenarios is presented in Figure 1.

Furthermore, the Yk-index (j, k, h*) includes the Y-index (j, h) and provides more information (e.g., the proportion sized by k and characteristic denoted by degree(=h*) are easier and clear to understand) than the Y-index by the value of j alone and the radius from 0 to $\frac{\pi}{2}(= 1.57)$ that is unfamiliar to the ordinary readers. For instance, when an author had the same number of first author articles and corresponding author articles, he or she would be positioned in the diagonal line with an h* value of 45° (denoted by the Yk-index) which is easier to understand than the value of 0.7854 (= $\frac{\pi}{4}$in radians) denoted by the Y-index.

### 2.3. Visualizations in this study

The Sankey diagram illustrates the frequency of document types, authors, and research institutes in this study. On the choropleth map, the Yk-indexes of countries/regions were displayed. The authors with identical names are based on their respective countries (regions) of origin, particularly with states in US states and provinces/metropolises in China. Otherwise, there would be many identical names among article authors. Four types of radar Yk (=RP + FP) were provided based on authors, institutes, regions, and countries.

### 2.4. 4-quadrant Radar plot

To simplify the individual radar plot for each entity of AIC/R, 4-quadrant radar plot was designed (e.g., top 10 countries, institutes, departments, and authors were dispersed in quadrants I, II, III, and IV, respectively). Bubbles were sized by the CJAL-score.[49]

$$CJA\ score = \sum_{i=1}^{n} C_i \times J_i \times A_i,$$

$$CJAL\ score = \sum_{i=1}^{n} C_i \times J_i \times A_i \times L - index_i,$$

$$\text{L} - \text{index} = \text{round}(\log(\frac{Citation}{A_n \times Age} + 1), 0), \quad >= 1$$

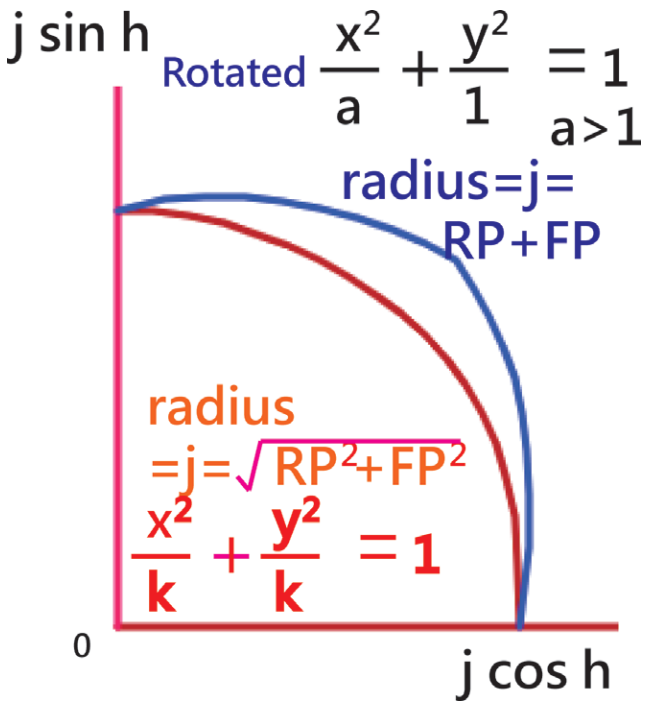


**Figure 1.** Visual comparison of the meanings and characteristics between the Yk-index and the Y-index.

**Table 1**

**Comparison of features between the Y-index and Yk-index.**

| Scenario | | | Y-index (j, h) | | Scenario | Yk-index (j, k, h*) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Author | RP | FP | j | h | Author | h* | sin | cos | radius | ratio | k |
| A.j = $\sqrt{RP^2 + FP^2}$ | | | | | C.j = $\sqrt{RP^2 + FP^2}$ | | | | | | |
| 1 | 20 | 30 | 36.06 | 0.59 | 1 | 33.69 | 0.55 | 0.83 | 1 | 1 | 1 |
| 2 | 30 | 20 | 36.06 | 0.98 | 2 | 56.31 | 0.83 | 0.55 | 1 | 1 | 1 |
| 3 | 25 | 25 | 35.36 | 0.79 | 3 | 45.00 | 0.71 | 0.71 | 1 | 0.71 | 0.71 |
| B.j = RP + FP | | | | | D.j = RP + FP | | | | | | |
| 1 | 20 | 30 | 50 | 0.59 | 1 | 33.69 | 0.55 | 0.83 | 1 | 1 | 1 |
| 2 | 30 | 20 | 50 | 0.98 | 2 | 56.31 | 0.83 | 0.55 | 1 | 1 | 1 |
| 3 | 25 | 25 | 50 | 0.79 | 3 | 45.00 | 0.71 | 0.71 | 1 | 0.71 | 0.71 |

Note. The maximum of j is 50 to gain a radius equal to 1.0(=k); ratio is referred to Equation (5) and k is referred to Equation (6); The results generated by scenarios C and D are identical, while those produced by scenarios A and B are not.

The CJA is computed by the CJA score[49] in Equation (9) via adding additional L-index[50] in Equation (11) to compose the CJAL in Equation (10).

Here, 3 factors are considered in the CJA scores for a published article: the Category (C; e.g., review, original article, case report, etc), the journal "quality" (J; e.g., impact factor, JIF, or ranking of the journal), and the authorship order denoted by A). A publication's final score is calculated by multiplying each of these 3 aspects (Eq. 9). CJA scores original research articles higher than other types of manuscripts; co-first authors score higher than other collaborators; for the journal's quality assessment, they use the JIF or SCI/SSCI journal rankings for SCI/SSCI-indexed papers.[49] SCI/SSCI journal rankings are based on JIF in each research domain; therefore, domain-specific journal rankings are usually not significantly different from those based on JIF.[49]

In the 4-quadrant radar plot, bubbles were sized by the CJAL score and colored by the perspective (i.e., countries, institutes, departments, and authors, respectively).

### 2.5. Statistical tools and data analysis

In the event that there is only 1 author in an article, the corresponding author is assigned to that author as well. Therefore, the summation of j(=RP + FP) might be greater than the number of publications according to the definition of the Y-index and the Yk-index in Table 1.

The absolute advantage coefficient)[51,52] based on j or k in Equations (1), (2), and (5) was used to measure the strength of contributions compared to the next 2 big AIC/R.

$$ACC = (R_{12}/R_{23}) / (1 + (R_{12}/R_{23})),$$

where $R_{12}$ is the ratio between the values from top 1 and top 2. $R_{23}$ is the ratio between the values from the top 2 and top 3.

The cutting point is set at 0.7.[51,52] Higher values indicate a greater role of dominance within the group. Three effect sizes are assigned: large (>=0.7), medium (between 0.5 and 0.7), and small (<0.5).

Visual representations of the Sankey diagram, the choropleth map, and the radar diagram were created using the author-made MS Excel modules.[45–47] To determine the momentum of association between RP and FP, the Pearson correlation coefficient (r) was used. The $t$ value was calculated based on the following formula ($= r \times \sqrt{\frac{n-2}{1-r \times r}}$).[53,54] It can be expected that authors have the least association between RP and FP, followed by institutes and countries.

## 3. Results

### 3.1. Part I: Data presentation using 2 visualizations

***3.1.1. Frequency of year, types, authors, and institutes.*** Based on the total number of 9498 articles, the most frequent was observed in 2021 (n = 4418), articles (6535), author names starting with Zhang Y (156), and Sichuan University (China) (432); see Figure 2. The counts are derived from the WoS, where the authors are counted in all positions of each article. Therefore, identical names within the same region or institute were not excluded from WoS.

***3.1.2. Region-based geographics of the Yk-index.*** The Yk-indexes denoted by k in Equation (5) are distributed in Figure 3. The highest value is in South Korea (k = 1.0), followed by Sichuan (0.9) and Zhejiang (0.55). The publications of countries/regions are displayed on the choropleth map[26] in Figure 3. The majority of articles in *Medicine (Baltimore)* came from South Korea, Sichuan (China), and Zhejiang (China). The ACC is 0.40 for South Korea [=((1/0.9)/(0.9/0.55))/(1+((1/0.9)/(0.9/0.55)))]. It appears that South Korea has a small effect size of dominance (<0.50).

### 3.2. Part II: the online radar-Yk drawn for AIC/R

***3.2.1. Author contributions based on regions.*** A total of the top 500 authors with a higher Yk-index are illustrated in Figure 4. We can see that authors Qiu Chen (27, 1, 90), Chunguang Xie (20, 0.74, 90) from China, and Sung-Ho Jang (South Korea) (14, 0.39, 15.26) have higher Yk-index values. The ACC for Qiu Chen is 0.49 [=(27/20)/(20/14)/(1 + (27/20)/(20/14))]. It appears that Qiu Chen has a small effect size of dominance (<0.50). The former 2 have more RP than FP based on their h* at $90^0$. The association between RP and FP was -0.55 (t = -14.7, df = 498).

***3.2.2. Institute contributions based on regions.*** A total of the top 500 institutes with the highest Yk-indexes are illustrated in Figure 5. We can see that Sichuan University (China) has the highest Yk-index (715, 0.99, 44.28), followed by Zhejiang University (394, 0.55, 43.26), and Hospital Chengdu University of Traditional Chinese Medicine (359, 0.5, 47.07). The ACC for Sichuan University is 0.62 [=(715/394)/(394/359)/(1 + (715/394)/(394/359))]. It appears that Sichuan University has a medium effect size of dominance (between 0.5 and 0.70). The association between RP and FP was 0.95 (t = 71.09, df = 498).

***3.2.3. Region contributions based on regions.*** A total of the top 500 regions with higher Yk-indexes are illustrated in Figure 6. We can see that South Korea has the highest Yk-index (2045, 1, 45.08), followed by Sichuan Province (China) (1842, 0.9, 44.74) and Zhejiang Province (China) (1123, 0.55, 45.26). The ACC for Sichuan Province is 0.40 [=(2045/1842)/(1842/1123)/(1 + (2045/1842)/(1842/1123))]. It appears that Sichuan has a small effect size of dominance

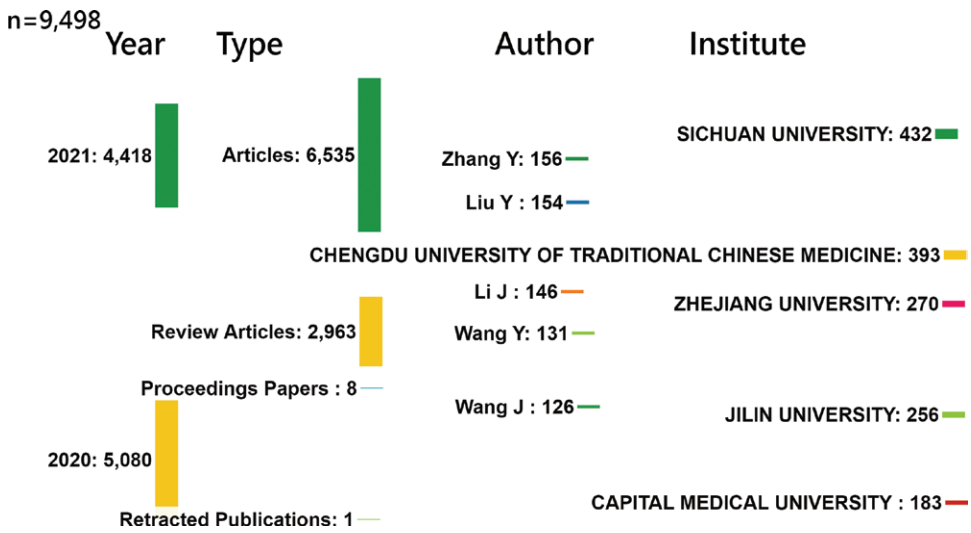


**Figure 2.** Frequency of important categories in the 9498 articles using the Sankey diagram.

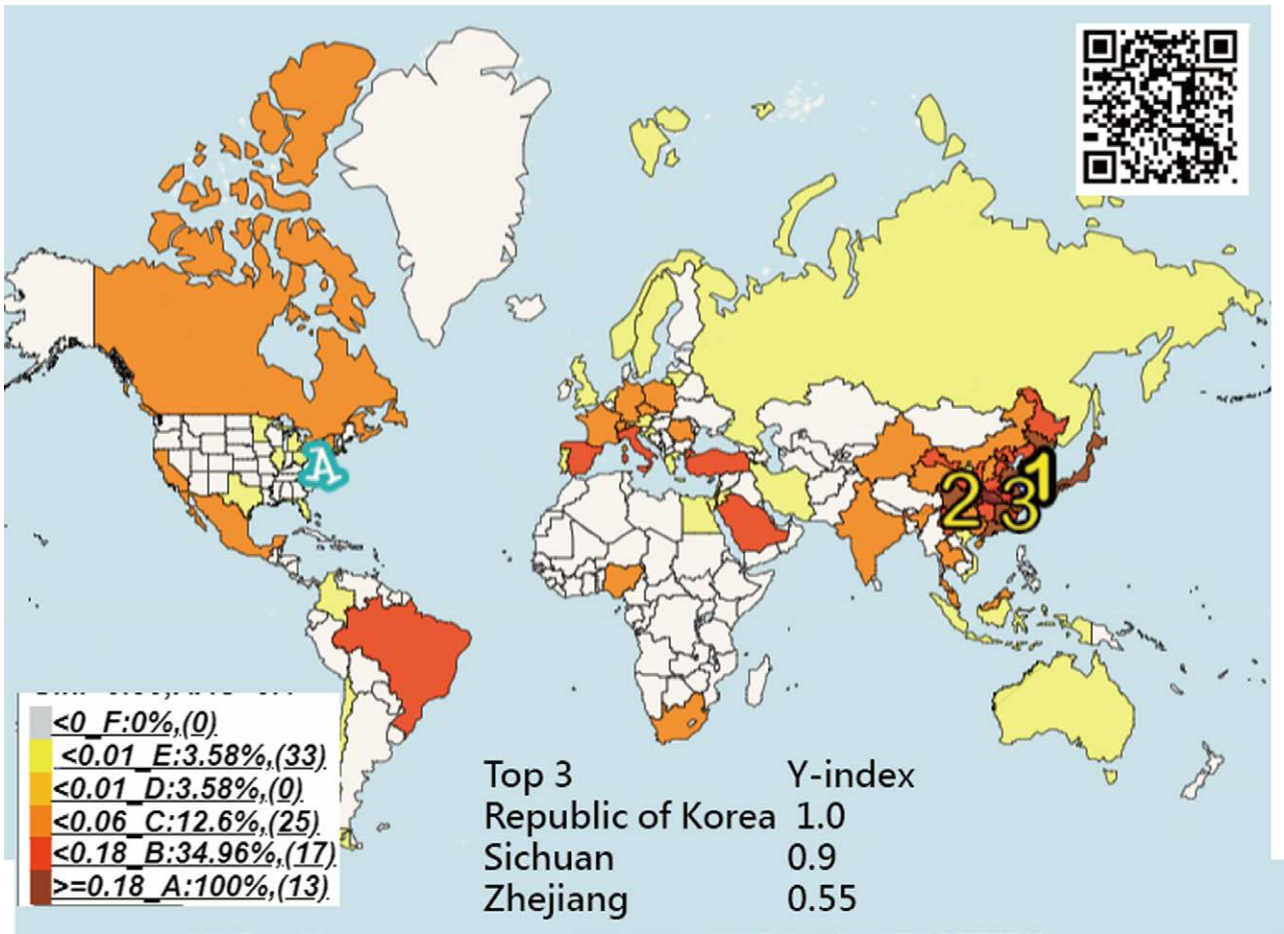


**Figure 3.** Geographical distribution of the Yk-index in the journal of Medicine since 2020 on the choropleth maps.

(<0.50). The association between RP and FP was 0.99 (t = 202.8, df = 498).

***3.2.4. Country contributions based on regions.*** A total of the top 500 countries with higher Yk-indexes are illustrated in Figure 7. We can see that China has the highest Yk-index (12415, 1, 44.93), followed by South Korea (2045, 1, 45.08) and Japan (943, 0,08, 44,94). The ACC for China is 0.74 [=(12415/2045)/(2045/943)/(1 + (12415/2045)/(2045/943))]. It appears that China has a large effect size of dominance (>0.70) over the next 2 countries in counts. The association between RP and FP was 0.99 (t = 67.25, df = 90).

### *3.3. 4-quadrant Radar plots*

Figure 8 illustrates a 4-quadrant radar plot. To save article space, a radar plot presents 4 entities simultaneously. Bubbles are sized by the CJAL scores.

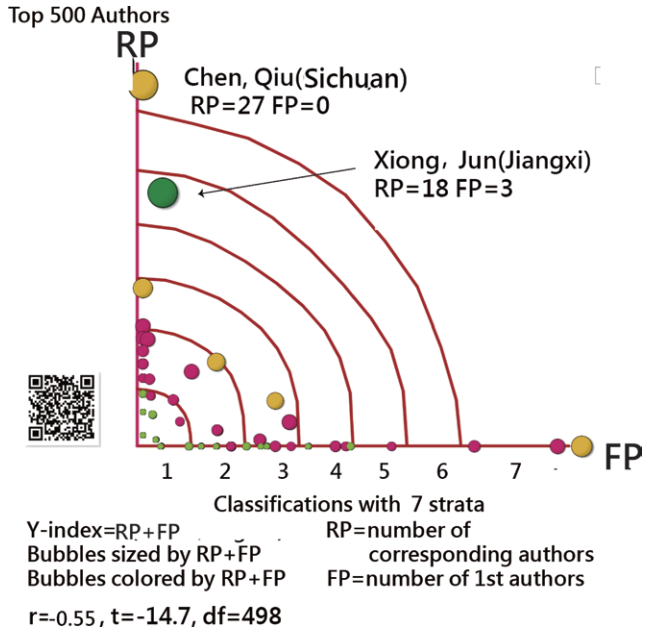


**Figure 4.** Using the one-quadrant radar plot to display author contributions to the journal of *Medicine* based on provinces of China in 2020 and 2021.

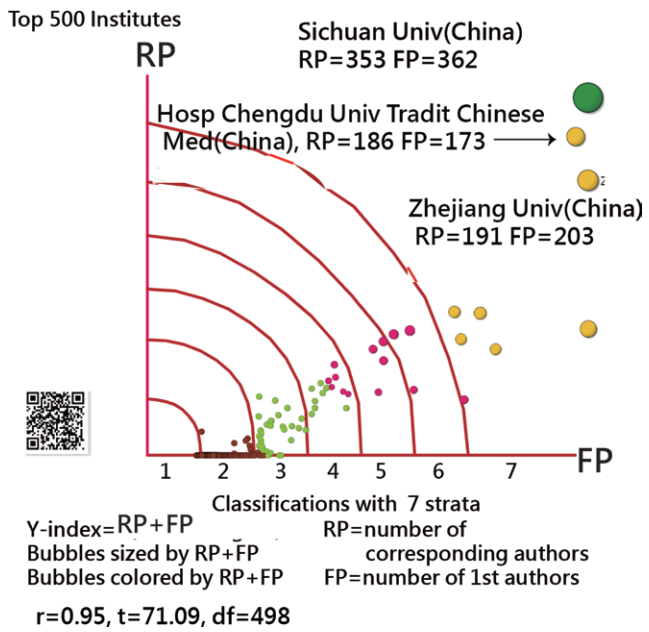


**Figure 5.** The research institutes with higher Yk-indexes to the journal of Medicine using the one-quadrant radar plot.

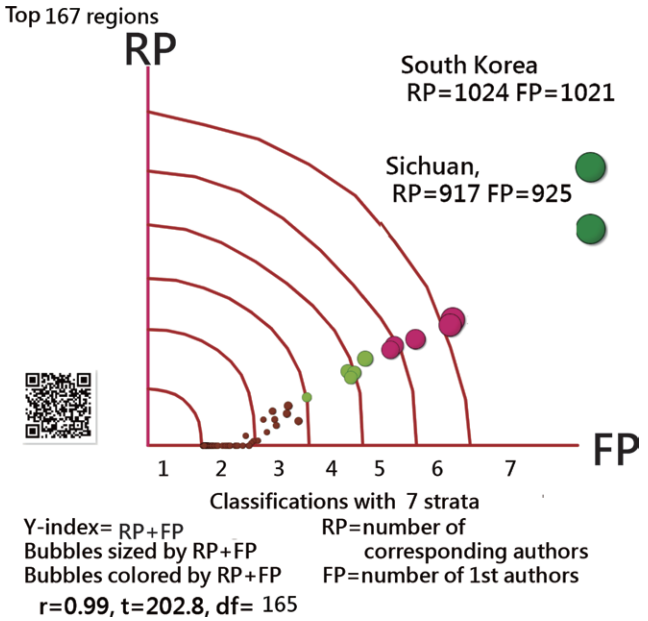


**Figure 6.** The regions with higher Yk-indexes in the journal of Medicine using the one-quadrant radar plot.

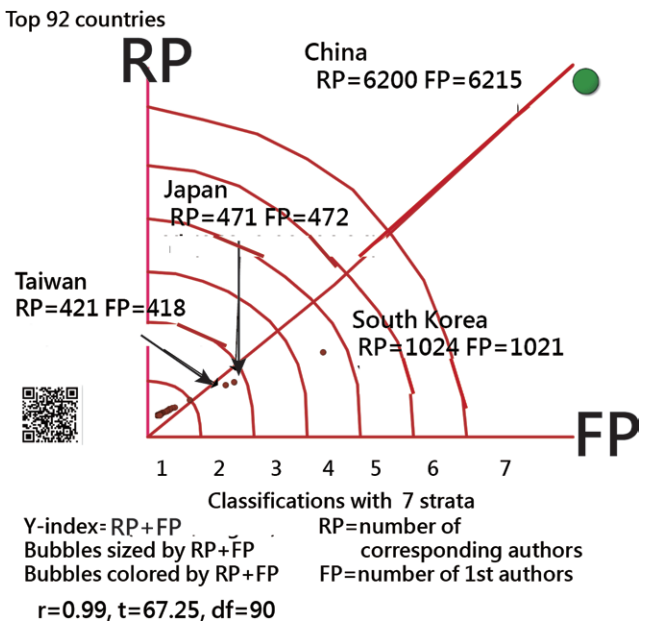


**Figure 7.** The countries with higher Yk-indexes in the journal of Medicine using the one-quadrant radar plot.

### *3.4. Online dashboards shown on google maps*

All dashboards in Figures (except 2) appear once the QR code is scanned and clicked. It is recommended that readers examine the details regarding each element in entities on the dashboard.

## 4. Discussion

### *4.1. Principal findings*

We observed that Qiu Chen (China), Sichuan University (China), China, and South Korea (based on regions, e.g., provinces/metropolitan areas in China) were the most productive AIC/R, with their Yk equal to 27,715, 12415.1, and 2045, respectively; a total of 85.6% of the published articles in *Medicine (Baltimore)* came from the 3 countries (China, South Korea, and Japan); the ACC for China is 0.74 (>0.70) and indicates that China has a significant lead over the next 2 countries in counts; and this method of drawing the Radar-Yk online was provided and successfully demonstrated. Consequently, the 2 research questions (i.e., the application of the Yk-index to a specific journal and the development of an online Radar-Yk) were verified and answered.

### *4.2. What this study adds to what was known*

There is widespread agreement that the first author and the corresponding author are of primary importance.[55,56] The first author has contributed most to the work, including conducting research and writing the manuscript.[57,58] It was noted that the corresponding author was responsible for the

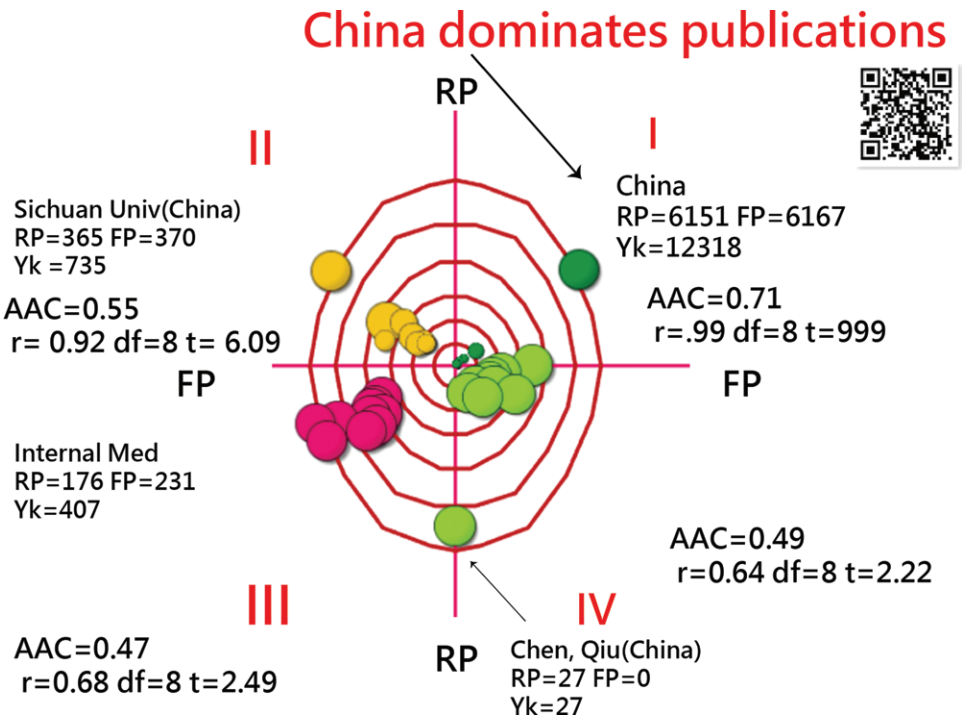


**Figure 8.** The 4-quadrant radar plot used to display 4 entities simultaneously (details about how to draw the graph are referred to Supplemental Digital Content 1).

planning and execution of the study and for the writing of the paper.[6]

Increasing the number of authors of a paper is associated with unethical practices such as gift authorship.[59,60] Gift or honorary authorship is defined as the inclusion as author of a person who has not adequately contributed to the article.[61,62] It is still considered a minor digression, and honorary or gift authorship is not acceptable under journal guidelines. In this study, the Y-index (or the Yk-index) is correlated with important positions. Specifically, the number of FP and corresponding author publications (RP) are exclusively included in the computation of author performances and credits, which can prevent the inclusion of honorary or gift authorships in article bylines.

The number of publications in *Medicine (Baltimore)* was dominated by publications from China. China has an ACC of 0.74 (>0.70), which indicates a significant advantage over the next 2 countries. According to a previous study,[52] citations were used to compute the ACC (0.85) for China, which has a strong dominance in *Medicine (Baltimore)*.

The Sankey diagram[63,64] was used to identify important information quickly and has recently been applied to bibliometrics,[43,54,65] as we have done with Figure 2 in this study. For readers to practice it on their own, a method to draw the Sankey is provided in MS Excel,[45] in lieu of using the package networkD3 in R language.[66]

As usual, we report the most productive AIC/R in bibliometrics. One noteworthy difference is that both China and the USA were divided into provinces/metropolitan cities and states in comparison with other countries with smaller populations for research, which is similar to previous studies[51,67–69] illustrating the geographical distribution of indicators on a choropleth map for readers to easily comprehend the study results. Otherwise, the most productive countries would be located in either the United States or China.

### 4.3. What it implies and what should be changed?

The Y-index with 2 parameters (j, h) is constructed to assess both the number of publications and the nature of contribution.[70] In contrast, the Yk-index utilizes 3 parameters (j, k, and h*) to identify the academic contributions and the ratio of RP and FP using k and h*(=angle degree instead of radian in Y-index). The parameter k is derived from j(=RP + FP), but in relation to the reference of the top member in a group via Equations (4) and (5). In Table 1 and Figure 1, we verify the incorrectness of $j(= RP + FP)$ in the study.[48] The distance in radius should be calculated from Equation (6) or $j(= \sqrt{RP^2 + FP^2})$ in scenario A,[40] as shown in Table 1 and Figure 1.

Next, Radar Yk was applied to visualize the AIC/R contributions to the journal of *Medicine (Baltimore)*. For readers who would like to replicate the study on their own in the future, a video and tutorial are provided with the instructions for drawing the Radar Yk; see the links.[45–47]

Thus, the 2 research objectives were met (i.e., development of the Yk-index and demonstration of the use of Radar-Yk).

Furthermore, this study provides a better understanding of the differences among bibliographical studies compared with the current study.[71–78] In Table 2, we highlight the 3 unique characteristics of the Yk-index, the radar plot, and the absolute advantage coefficient (i.e., absolute advantage coefficient for the top 1 entity against the next 2 in counts). On the 4-quadrant radar plot, we illustrate the top 10 elements of 4 entities, simultaneously, in terms of publications (i.e., locations denoted by the Y-indexes and RAs (bubble sizes denoted by the CJAL scores). It is possible to save more than 8 tables or graphs in comparison to the traditional bibliographical studies (i.e., in contrast to traditional bibliometrics which require more than 8 tables or graphs to display study results, only Figures 2 and 8 are used to illustrate entities with more publications and higher RA demonstrated in this study). The method of how to draw the 4-quadrant radar plot is described in Supplemental Digital File 3, http://links.lww.com/MD/H569.

### 4.4. Limitations and suggestions

Although the findings are based on the above analysis, there are still several potential limitations that may encourage further research efforts. First, the data were retrieved exclusively from WoS in 2020

**Table 2**

**Comparison of article features in comparison with this study.**

| Feature | A0 | A1 | A2 | A3 | A4 | A5 | A6 | A7 | A8 |
|---|---|---|---|---|---|---|---|---|---|
| Tables & figures | 9 | 8 | 12 | 8 | 10 | 13 | 15 | 17 | 4 |
| Citation | √ | √ | √ | | | | | | |
| Publication | √ | | √ | √ | √ | √ | √ | √ | √ |
| World map | √ | √ | √ | √ | √ | | | √ | |
| Co-word | | | | √ | √ | √ | | √ | |
| Co-laboration | | √ | √ | | | | | | |
| RA | Yk | h/g | h | JIF | n(%) | ESCI | h/g | | |
| Countries | √ | √ | √ | √ | √ | | √ | √ | |
| Institutes | √ | √ | √ | | | | | | |
| Departments | √ | | | | | | | | |
| Authors | √ | | √ | | | | | √ | |
| Journals | | | √ | √ | | | √ | | |
| Keywords | | √ | | √ | √ | | | √ | |
| Subject area | | | | | √ | √ | | √ | √ |
| Radar plot | √ | | | | | | | | |
| AAC | √ | | | | | | | | |

Note: RA = research achievement; Articles from A1 to A8 are noted in references 74 to 81; AAC = absolute advantage coefficient for the top one entity against the next two in counts.

and 2021. These results cannot be generalized over a long period of time. Furthermore, the contributions cannot be solely based on publications. Citations will be useful for future research.

Second, to measure the research contributions using the Yk-index, the assumption is based on the equal weights in both the first and corresponding authors. If the assumption is not held, the Yk-index and the Radar Yk would not be meaningful and useful in application.

Third, except for Figure 2, all dashboards in Figures are displayed on Google Maps. Google Maps may not be used for free unless you use the application programming interface with a paid project key. In the absence of an application programming interface, the dashboard limitation is not publicly accessible. The process of making dashboards with MP4 video using Microsoft Excel is provided in the following link[47] that helps readers apply the procedures to other topics, not just that of the given journal as we did in this study.

Fourth, while dealing with the extraction of article metadata from WoS, the data arrangement can be complicated and tedious. The tutorial material is available,[45–47] but the Excel module to extract author data from the WoS can be requested from the corresponding author.

Fifth, there may be some bias in understanding author contributions to *Medicine (Baltimore)*, since there could be multiple authors with the same name or abbreviation who are affiliated with different institutions. Therefore, the result of contributions made by identical author names to *Medicine (Baltimore)* would be influenced by the accuracy of the indexing author, even though the name association with regions is adjusted and matched in this study. In references,[79,80] we list the different contributions from authors based on the country name and most confidential names found in this study. For instance, this study[79] has 12 authors with the name Wei Zhang from different provinces and metropolitan cities in China.

Finally, it is not simple and easy to draw a sophisticated diagram, as the Sankey diagram shown in Figure 2. The computer program is required to make adjustment and then fit the format of the software[81] applied to this study.

## 5. Conclusion

We made a breakthrough by developing an online Radar-Yk for showing the most contributions to the journal of *Medicine (Baltimore)*. The 3 countries (China, South Korea, and Japan) contributed 85.6% of the published articles in *Medicine (Baltimore)*. China has an ACC of 0.74 (over 0.70), showing that it has a significant lead over the next 2 countries in terms of article counts. We demonstrated how to draw the Radar-Yk online in details (see Supplemental Digital Contents 2 and 3). Radar-Yk visualization could be replicated for use in academic research and applications on other topics in future bibliographical studies.

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## Author contributions

YS and TWC initiated the research, collected data, conducted the analysis, and wrote the manuscript. FL contributed to the design of the study and provided critical reviews of the manuscript, and TWC contributed to the interpretation of the results.
Conceptualization: Yang Shao.
Investigation: Fong-Lin Jang.
Methodology: Tsair-Wei Chien.

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