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Authors who contributed most to the fields of hemodialysis and peritoneal dialysis since 2011 using the hT-index

Bibliometric analysis

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Abstract

Background: The h-index does not take into account the full citation list of a researcher to evaluate individual research achievements (IRAs). As a generalization of the h-index, the hT-index takes all citations into account to evaluate IRAs. Compared to other bibliometric indices, it is unclear whether the hT-index is more closely associated with the h-index. We utilized articles published on hemodialysis and peritoneal dialysis (HD/PD) to validate the hT-index as a measure of the most significant contributions to HD/PD.

Methods: Using keywords involving HD/PD in titles, subject areas, and abstracts since 2011, we obtained 7702 abstracts and their associated metadata (e.g., citations, authors, research institutes, countries of origin). In total, 4752 first or corresponding authors with hT-indices >0 were evaluated. To present the author's IRA, the following 4 visualizations were used: radar, Sankey, impact beam plot, and choropleth map to investigate whether the hT-index was more closely associated with the h-index than other indices (e.g., g-/x-indices and author impact factors), whether the United States still dominates the majority of publications concerning PD/HD, and whether there was any difference in research features between 2 prolific authors.

Results: In HD/PD articles, we observed that (a) the hT-index was closer to and associated with the h-index; (b1) the United States (37.15), China (34.63), and Japan (28.09) had the highest hT-index; (b2) Sun Yat Sen University (Chian) earned the highest hT-index (=20.02) among research institutes; (c1) the authors with the highest hT-indices (=15.64 and 14.39, respectively) were David W Johnson (Australia) and Andrew Davenport (UK); and (c2) their research focuses on PD and HD, respectively.

Conclusion: The hT-index was demonstrated to be appropriate for assessing IRAs along with visualizations. The hT-index is recommended in future bibliometric analyses of IRAs as a complement to the h-index.

Abbreviations: AIF = author impact factor, AMD = absolute mean difference, AWS = author-weighted scheme, CC = correlation coefficient, HD/PD = hemodialysis and peritoneal dialysis, IMP = impact beam plot, IRA = individual research achievement, SMD = standardized mean deviation, SNA = social network analysis, VBA = visual basic for application, WOS = Web of Science.

Keywords: bibliometric analysis, hemodialysis, hT-index, impact beam plot, individual research achievement, peritoneal dialysis, radar plot, Sankey diagram.

1. Introduction

Bibliometrics continues to debate the issue of quality versus quantity when evaluating individual research achievements (IRAs).[1] A number of metrics (e.g., author impact factor, AIF = citations/publications, number of citations to the top or 10th most cited publication, and number of publications with at least ten citations) have been proposed in the past.[2] The h-index,[3] g-index,[4] and x-index[5] are other bibliometric indices that take both citations and publication counts into consideration.

1.1. Variants of the h-index proposed in the literature

A comprehensive review of the h-index and some of its variants has been provided.[6] The h-index was also compared with

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Key points

- The novel hT-index was introduced and proposed for this bibliometric analysis of hemodialysis and peritoneal dialysis articles using visualizations.
- Radar plots with the hT-index were used to visualize the individual research achievements based on the first and corresponding authors, which is rare in bibliometric studies.
- The impact beam plot provides a new and innovative method of reporting author impact with a map showing all articles in a view of the author's profile on Google Maps. This study demonstrated the effectiveness of online impact beam plot in highlighting the most influential nephrologists.
- Supplemental Digital Files (http://links.lww.com/MD/H174) contain instructions for conducting this study for readers who wish to replicate it on their own.

37 variants.[7] New variants of the h-index continue to be proposed,[8–14] and comparisons and evaluations of bibliometric indices have been conducted.[3,15,16]

The h-index and its variants, however, do not adequately take into account the full citation sequence of a researcher (e.g., h-index = 10 in 10 articles with the citation-sequence [100, 90, 80., 10]). It may be viewed as a disadvantage of the h-index.[4] The total citation count (e.g., the AIF) has the disadvantage of biasing the index in favor of researchers who have very highly cited top publications (e.g., AIF = 55 in 10 articles with the citation sequence {100, 90, 80, 10}), whereas the g-index($=\leq \frac{\sum_{i\leq g} c_i}{g}$)[5] weighted by the citations in the very highly cited top publications is 55 = AIF, and the x-index $\left(= \sqrt{\underbrace{Max}_{i}(i \times c_i)}\right)$ determined by the maximum area rectangle that fits under the descending citation curve of an author is 17.3 ($=\sqrt{(i \times c_i)} = \sqrt{(5 \times 60)} >$ h-index = 10).

In addition, the drawback of the x-index is greater than that of the h-index, particularly when dealing with highly cited top publications, similar to the AIF and g-index, as shown in the example above.

In the example above, if the sequence is replaced with [10, 9...,1], the h-index is 5, the AIF is 5.5 (=55/10), the g-index is 7, and the x-index is 5.5 ($=\sqrt{(5 \times 6)}$). There is merit in exploring whether it is possible to construct an index that is closer to and associated with the h-index than its contrasts (e.g., the g-/x-indices and the AIF) and overcomes the disadvantages of the h-index in measuring IRAs in academics.

1.2. The hT-index applied to bibliometrics

As a bibliometric index, the hT-index (also known as the Tapered h-index)[17,18] takes into account all citations with descending weights when evaluating the IRAs and generalizes the h-index. Whether the hT-index is more closely related to the h-index than other bibliometric indices remains unclear in the past literature.

Furthermore, 2 major disadvantages[12] of the h-index may be overcome through the use of the hT-index: all coauthors are weighted equally in contribution to the article bylines,[19,20] and the integer nature of the h-index makes it extremely difficult to distinguish the IRA among authors.[21] It was our intention to use the hT-index to assess author IRAs only when the first and corresponding authors are equally credited with the article.[22,23] It is hoped that the monotonically increasing h-/hT-indices (i.e., the h-core articles are identical to those in hT-core, and the contribution of the h-core is unchanged in the hT-core Durfee square[17,18]) can overcome the disadvantage of the h-index (i.e., the integer nature of the h-index makes it difficult to differentiate the IRA between authors[20]).

1.3. IRAs quantified by the first and corresponding authors using the hT-index

Bibliometric indices (e.g., h-/g-/x-indices, AIF, and hT-index) commonly do not take into account the first and corresponding authors (i.e., the Y-index[22,23] gives equal credit to them in articles, particularly in Chinese academic communities, such as those in Mainland China, Hong Kong, and Taiwan). There is an obvious problem and unfairness in the process of hiring, promoting, and funding researchers[24] if the author-weighted scheme is unfairly applied. To quantify author contributions in article bylines, IRAs in bibliometrics should be evaluated appropriately. Therefore, there is a need for 2 major components:

(1) To verify the hT-index is useful and meaningful: The differences and similarities in characteristics closer to and associated with the h-index were compared between indices (i.e., hT-/h-/g-/x-indices and AIF).
(2) To show the hT-index applicable and feasible: The hT-index was demonstrated to select the most influential nephrology authors in the fields of hemodialysis and peritoneal dialysis (HD/PD).

1.4. Publications in HD/PD are dominated by the United States

Chronic kidney disease is a major health problem due to its high prevalence, cost of treatment, significant morbidity and mortality, and substantial impact on patients and their families.[25] Patients with PD, for instance, manage their PD at home manually or by using a PD cycler to deliver dialysate fluid through a catheter placed in the peritoneal cavity, where the fluid remains for a period of time. In each cycle, they enter hydration metrics, including body weight, blood pressure, urine output, and ultrafiltration volume.

The use of bibliometrics and visual analysis has been applied in a number of disciplines,[26] including anesthesiology, ophthalmology, stomatology, and obstetrics and gynecology,[27–30] yet no bibliometric articles have been published on the authors who have contributed the most to HD/PD. Although authors from the United States were present in 30.6% of 7618 PD papers in 887 journals (6991 articles and 627 reviews)[31] and the United States was the most productive country (n = 51) of the 100 most influential papers on peritoneal dialysis,[32] IRAs (taking both publications and citations into account) dominated by the United States should be verified further.

1.5. Study aims

We aim to investigate whether the hT-index was more closely associated with the h-index than other indices (e.g., g-/x-indices and author impact factors), whether the United States still dominates the majority of publications concerning PD/HD, and whether there was any difference in research features between 2 prolific authors.

2. Methods

2.1. Data source

By searching the Web of Science core collection (WoSCC) with keywords involving HD/PD in titles, subject areas, and abstracts since 2011, we obtained 7702 abstracts and their corresponding

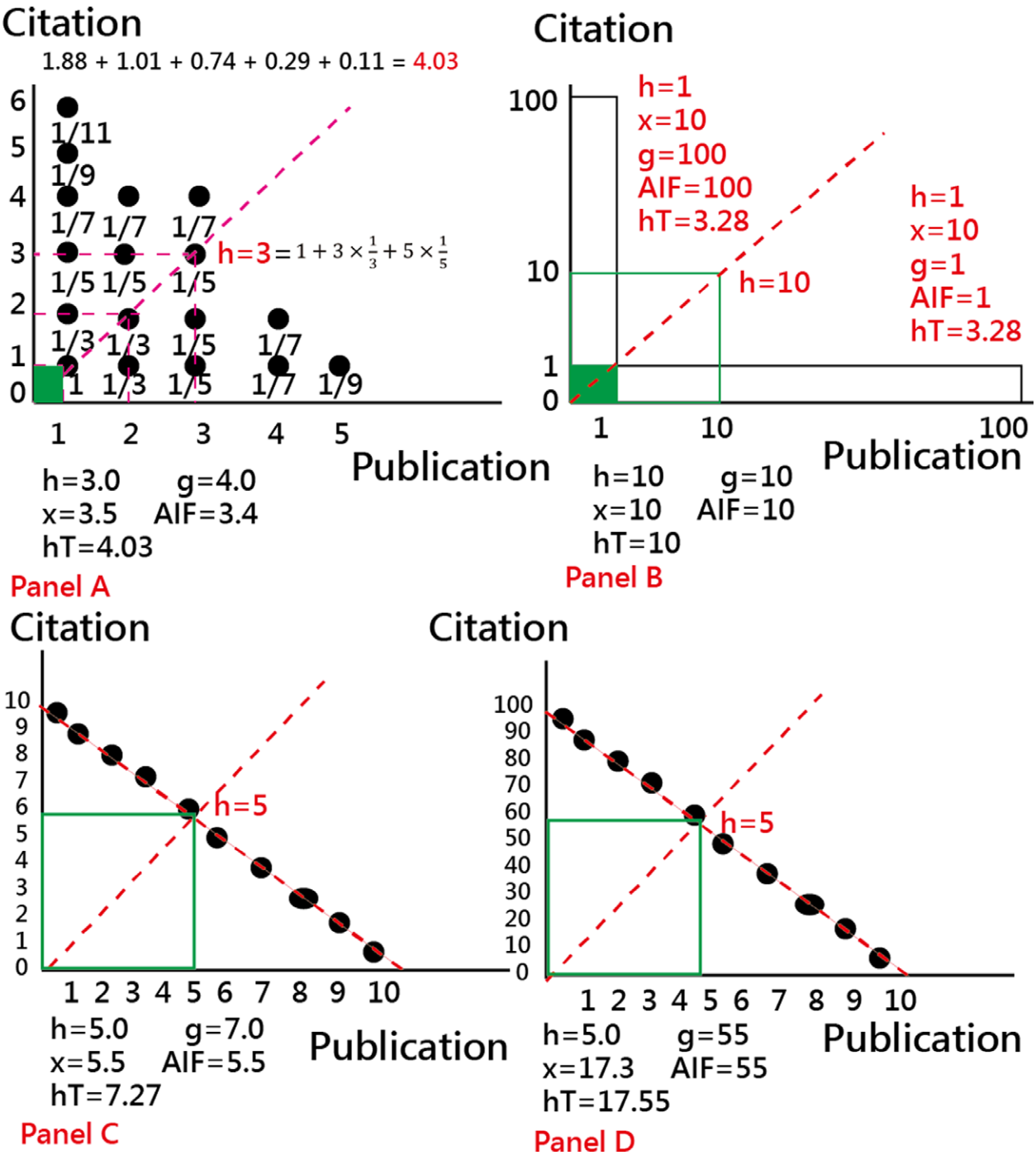

Figure 1. The hT-index is determined when plotting the number of citations (ci) in descending order.

metadata (e.g., citations, country of origin, research institutes, and authors placed in the first and corresponding positions). Only articles, reviews, and journal impact factors (JIFs) >0 were included in the analysis. There were a total of 2298 abstracts included in this study.

The data deposited in (Supplemental Digital Content 1, http://links.lww.com/MD/H173) are publicly available on the WoSCC's website. Therefore, ethical approval was not needed.

2.2. First goal: the validation of the hT-index in use

2.2.1. How to compute the hT-index. The citations denoted by a vector (e.g., {6,4,4,2,1} in descending order in 5 articles) are illustrated using Eqs. 1 to 4, as shown in panel A of Figure 1. The hT-index equals 4.03 when multiplied by 1 to 4. In mathematical terms, the hT-index is calculated by summing all weights from the starting 1 to the following of $\frac{1}{2i-1}$via Eq. 1, where i from 1 to n_1.

$$\mathrm{hT}_{(top\ 1)} = \sum_{i=1}^{n_1} \frac{1}{2i-1}, \tag{1}$$

The starting weight in the top-cited paper is determined by Eq. 2, where j = 1. Therefore, the resulting sum is 2.13 for ten citations, 3.28 for 100 citations, 4.44 for 1000 citations, and 5.59 for 10,000 citations.

$$\text{Weight}_{(top\ j)} = \frac{1}{2j-1},\ \text{n}_j \le j, \tag{2}$$

$$\text{h}_{T(j)} = \frac{j}{2j-1} + \sum_{i=1}^{n_1} \frac{1}{2i-1},\ \text{n}_j > j, \tag{3}$$

The weights of ten papers with ten citations each are shown in Table 1. In papers from 1 to 10, the hT-indices monotonically increase [2.13, 3.60, 4.80, 5.83, 6.73, 7.53, 8.25, 8.89, 9.47, 10.00], suggesting that the h-core articles are identical to those in the hT-core and the contribution of the hT-core is not changed in the hT-core Durfee square.[17,18]

A single hT score will be calculated for any paper ranked j in the list (with nj citations), denoted as hT(j) in Eq. 3, if the author has N papers with associated citations n1, n2, n3..., nN (ranked in descending order). After summarizing all the weights (allocated in Eqs. 1–3) through Eq. 4, the hT-index for all the cited papers may be calculated.

$$\text{hT} = \sum_{j=1}^{N} hT_{(j)}, \tag{4}$$

Since the computation of the hT-index is essentially the same as that of the h-index represented by the Durfee square, we note that hT = h + Δh, where Δh is the sum of citation weights in the Ferrers tableau. As an example, the h-index is equal to the length of the Durfee square (in panel A of Fig. 1, h = 3 and hT = 4.03). The Durfee square is the 3-by-3 square denoted by a dashed line. The hT-index represents the sum of all weights in the Ferrers tableau. In Figure 1, the differences between panels B, C, and D motivate us to investigate whether the hT-index is more closely related to the h-index and more closely associated with it than its counterparts (e.g., the g-/x-index and the AIF). The hT-index is computed using Microsoft Excel Visual Basic for Application, as illustrated in Figure 2 and the link.[33]

2.2.2. Comparison of differences and similarities between indices.

2.2.2.1. Differences between indices using real data. The h-index is referenced to the absolute mean differences (AMDs) (e.g., abs (h – g), abs (h – x), abs (h – AIF), and abs(h – hT)) between indices in authors with hT > 0. The AMDs based on the standardized mean difference (SMD) were compared between indices using a forest plot.[34]

2.2.2.2. Similarities between indices. The correlation coefficients (CCs) were used to measure the similarities between indices. The *t* value was calculated using the following formula.($= CC \times \sqrt{\frac{n-2}{1-CC\times CC}}$)[35]

2.2.2.3. Differences and similarities between indices using simulation data. The citations were generated from the Collatz sequence,[36] which is defined as considering an iterative method over the set of positive integers N in a range (e.g., 1–500), and we obtain the positive integer $\frac{1}{2} \times n$for the next step. In contrast, if n ∈ N is odd, we consider 3n + 1 for the next step. Thus, the Collatz conjecture states that if any positive integer is selected as the initial value for n ∈ N, eventually the number 1 will be reached.

In the Collatz sequence, the data are represented as citations based on the initial integers (i.e., from 1 to n, n = number of authors). Similar to sections 2.2.2.1 and 2.2.2.2, the forest plot[34] and the CCs[35] were used to compare the differences and similarities between indices.

2.3. Second goal: IRAs assessed by the hT-index

The Y-index[22,23] was proposed to evaluate the IRAs based on the number of publications in the positions of first and corresponding authors (denoted by J = FP and RP). Unfortunately, previous studies have not illustrated the way in which the radar diagram can be drawn based on the Y-index (=as the radius in the first quadrant).[22,23] The IRAs should not be measured solely by publications (e.g., the Y-index). To select the authors who contributed most to the HD/PD in this study, the hT-index must be used by taking into account both publications and citations.

A choropleth map[37] and radar plot[38] were used to compare the IRA across countries, research institutes, and authors in HD/PD.

2.4. Third goal: differences in research features between 2 prolific authors in comparison

From the radar plot mentioned in the previous section, the top 2 prolific authors with the highest hT-index were selected. We made 3 comparisons in IRA between the 2 authors, including publications on the IBP,[39,40] keyword plus in WoSCC using the Sankey diagram,[41,42] and comparisons of differences in research features on the forest plot.[34,43,44]

2.5. Statistics and tools

A forest plot was used to compare the SMD values. The significance level for type I error was set at 0.05.

Radar diagrams, Sankey diagrams, choropleth maps, impact beam plots (IBPs), and forest plots were used to compare differences in the hT-indices and SMDs of keyword plus in WoSCC. Google Maps was used to plot both choropleth maps and radar diagrams.

Table 1

Weights allocated to the 10 articles with 10 citations each (h_T = 10 in this case).

Weight	Citation									
Article	1	2	3	4	5	6	7	8	9	10
1	1.00	0.33	0.20	0.14	0.11	0.09	0.08	0.07	0.06	0.05
2	0.33	0.33	0.20	0.14	0.11	0.09	0.08	0.07	0.06	0.05
3	0.20	0.20	0.20	0.14	0.11	0.09	0.08	0.07	0.06	0.05
4	0.14	0.14	0.14	0.14	0.11	0.09	0.08	0.07	0.06	0.05
5	0.11	0.11	0.11	0.11	0.11	0.09	0.08	0.07	0.06	0.05
6	0.09	0.09	0.09	0.09	0.09	0.09	0.08	0.07	0.06	0.05
7	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.07	0.06	0.05
8	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.06	0.05
9	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.05
10	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05

```
The computation of ht-index interpreted with codes in Microsoft Excel VBA
(n cited articles in rows and article citations in columns from 7 to lastcol in data)
n = Sheets("data").Cells(1, 6)          ' How many authors
For jk = 2 To n + 1                     ' loop for authors
  bbcol = "fdf" & jk                    ' How many cited articles
  lastcol = Sheets("data").Range(bbcol).End(xlToLeft).Column
    ht = 0                              ' default initial ht=0
 For j = 1 To lastcol - 6               ' loop for cited articles from column=7
  ma = Sheets("data").Cells(jk, j + 6)  ' the number of citations for a article
   For i = 1 To ma                      ' loop for article weights each
    If i = 1 Then                       ' setting the starting weight
      ht = ht + 1 / (2 * j - 1)         ' summing over the ht weight each
      firstone = 1 / (2 * j - 1)        ' the strating weight
    ElseIf i <= j Then                  ' weights in i<=j equals the firstone
      If 1 / (2 * i - 1) > firstone Then
        ht = ht + firstone              ' the weight=firstone if i<=j
      Else
        ht = ht + 1 / (2 * i - 1)       ' the weight as usual if i>j
      End If
    Else
      ht = ht + 1 / (2 * i - 1)         ' the weight as usual if i>j
    End If
   Next i
 Next j
    Sheets("collaz").Cells(jk, 4) = ht  'to save ht in column 4
Next jk                                 ' VBA=visual basic for application
```

Figure 2. The computation of the hT-index interpreted with codes in Microsoft Excel VBA. VBA = visual basic for application.

3. Results

3.1. First goal: features of the hT-index

We evaluated 2298 nephrology authors with individual hT-indices (>0). In Figure 3, the hT-index was closer to the h-index. We observed that the AMDs in the hT-indices were lower than those in all other indices, except for the g-index in the HD/PD articles. There was an evident feature of h≤hT ≤x ≤g ≤AIF that was supportive in general. There may be fewer highly cited articles in HD/PD articles, which explains why the g-index is smaller in the real data than the hT-index.

The comparison of similarities was made using the CCs. Table 2 shows that the hT-index has higher associations with the h-index (i.e., 0.90 and 0.95 in the real and simulation data, respectively; $P < .001$, $t = 146.03$ and $203.85 = 0.95\times\sqrt{\frac{4054-2}{1-0.95\times0.95}}$).

3.2. Second goal: influential countries/institutes/authors in HD/PD

The United States (37.15), China (34.63), and Japan (28.09) had the highest hT-index. Sun Yat-Sen University (Chian) earns the highest hT-index (=20.02) among research institutes. The authors with the highest hT-indices (15.64 and 14.39, respectively) are David W Johnson (Australia) and Andrew Davenport (UK).

3.3. Third goal: differences in research features between 2 prolific authors in comparison

In Figure 7, the IBP was used to compare the publications of the 2 prolific authors (n = 42 and 32 in red and black dots for Drs Davenport and Johnson, respectively). Johnson published more articles in 2015 than Davenport. The articles with the most citations are displayed on the right side of the IBP. By scanning the QR code, readers will be able to click on the dot of interest and read the article displayed on PubMed.

Figures 8 and 9 illustrate 2 types of keyword plus in WoSCC for the 2 authors: associated (both have them) and unique (one has them only). In Figure 8, the clusters were separated using social network analysis[45–49] (see Supplemental Material, Supplemental Digital Content, http://links.lww.com/MD/H174). It is necessary to verify whether there are differences in proportional counts for keyword plus within articles between the 2 authors. However, the unique features of Figure 9 make it clear that Johnson research focuses on outcomes, risk, and PD as opposed to Davenport research on Mellitus, albumin, and HD. The results shown in Figure 10 indicate that there are differences in proportional counts for keyword plus only for 3 keywords (i.e., outcomes, risk, and 2015).

3.4. Online dashboards shown on Google Maps

All the QR codes in Figures are linked to the dashboards. Readers are suggested to examine the displayed dashboards on Google Maps.

4. Discussion

We observed that (a) the hT-index was closer to and associated with the h-index; (b1) the United States (37.15), China (34.63), and Japan (28.09) had the highest hT-index; (b2) Sun Yat-Sen University (Chian) earns the highest hT-index (=20.02) among research institutes; (c1) the authors with the highest hT-indices (=15.64 and 14.39, respectively) are David W Johnson (Australia) and Andrew Davenport (UK); and (c2) their research focuses on PD and HD, respectively. In this study, 3 research goals were achieved.

4.1. Additional Information

The articles published by the 2 prolific authors were doted on the dashboard-type IBP, as shown in Figure 7,[50] in lieu of the 100 articles on PD listed in a bibliometric study.[32] Using the IBP is unique and modern and never seen before in the literature. The impact IBP displays the author document profile in a single view and shows more context than a single metric, such as a citation metric (or the h-index), which provides us with bibliometrics.[40,51] The author IBP dashboard using profiles, as shown in Figure 7, rather than metrics alone is thus much different

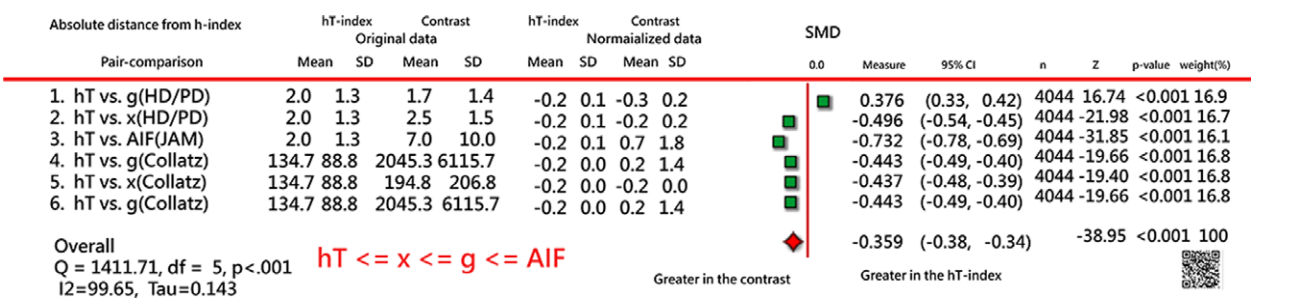

Figure 3. Comparison of differences made by observing the hT-index closer to the h-index using the forest plot for display (n = 4054).

Table 2

Similarities using CC (n = 4054).

CC	h	g	x	hT	AIF
h		0.29	0.58	0.95	0.29
g	0.86		0.71	0.89	0.41
x	0.63	0.71		0.86	0.86
hT	0.90	0.89	0.86		0.57
AIF	0.32	0.41	0.86	0.57	

The Collatz data are in the upper triangle; the HD/PD data in the lower triangle; the h_T-index is more similar to the h-index.
AIF = author impact factor, CC = correlation coefficient.

from the traditional publication list on the Internet, such as author bibliographies in Google Scholar.

The United States (37.15), China (34.63), and Japan (28.09) had the highest hT-index in HD/PD articles, indicating that the hT-index taking into account all publications and citations can be utilized in academics and practices, especially when used in conjunction with radar diagrams to compare authors and institutes at a glance. The results are consistent with the findings in previous studies: authors from the United States were present in 30.6% of 7618 PD papers in 887 journals (6991 articles and 627 reviews),[31] and the United States was the most productive country (n = 51) of the 100 most influential papers on peritoneal dialysis,[32] IRAs dominated by the United States had been verified.

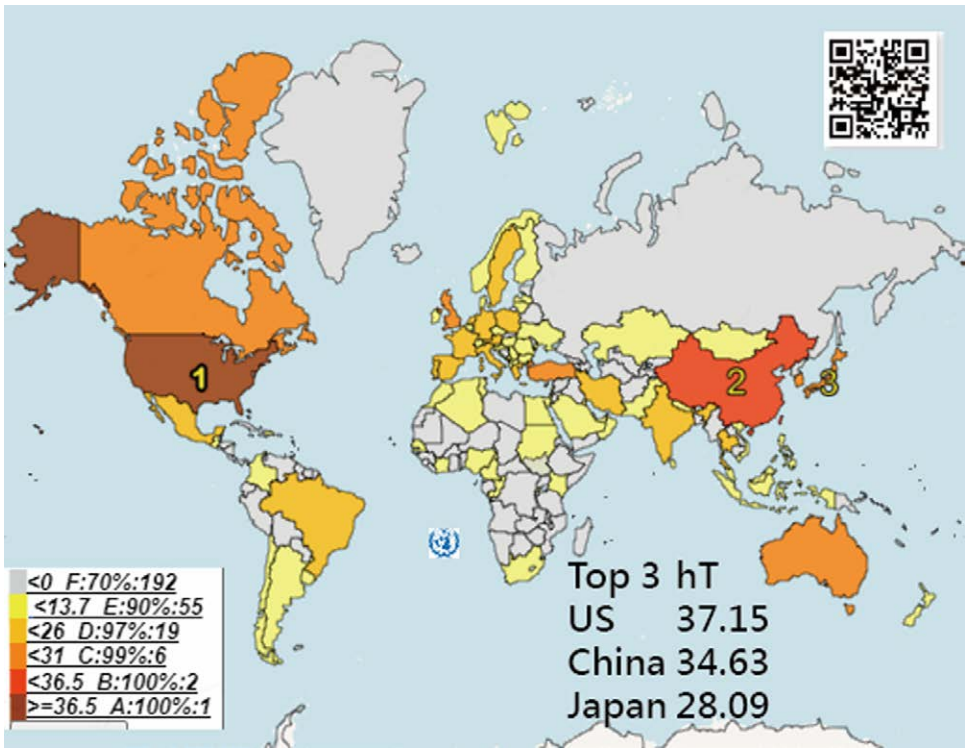

Figure 4. Top 3 countries displayed on the geographical map using the hT-index (n = 7702).

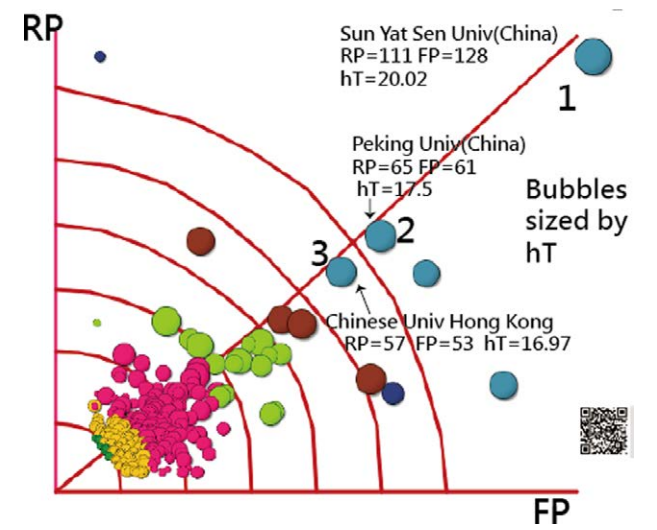

Figure 5. The most prolific research institutes based on the hT-index (n = 500).

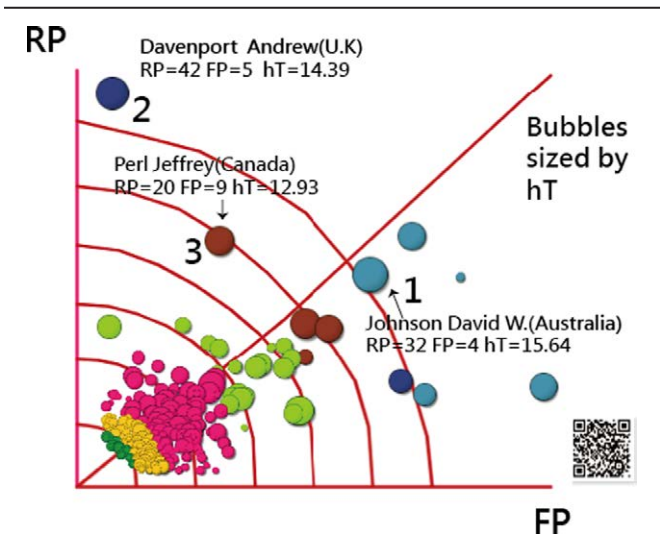

Figure 6. The most prolific authors based on the hT-index (n = 500).

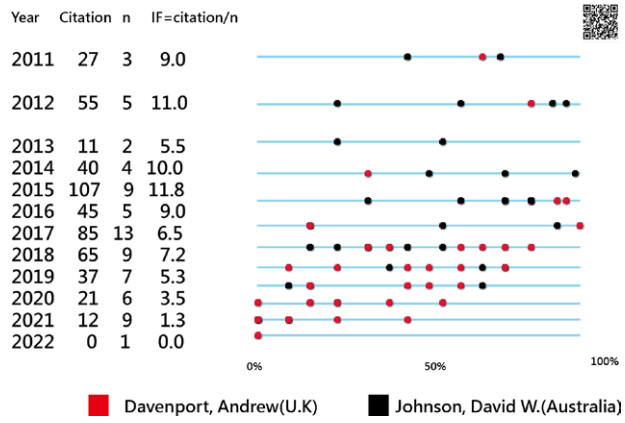

Figure 7. Publications by the top 2 authors in comparison on an impact beam plot (n = 42 and 32, respectively).

The most cited article related to HD/PD with PMID = 21,775,973,[52] entitled the effects of frequent nocturnal home hemodialysis: the Frequent Hemodialysis Network Nocturnal Trial, contains 109 coauthors and 146 citations. Following the interesting topic of frequent nocturnal hemodialysis compared to conventional hemodialysis 3 times a week, 87 patients were randomized to receive conventional hemodialysis 3 times a week or nocturnal hemodialysis 6 times a week using high-flux single-use devices. In the frequent nocturnal arm, 45 patients had a 1.82-fold higher mean weekly stdKt/V (urea), a 1.74-fold higher average number of treatments per week, and a 2.45-fold higher average weekly treatment time than the 42 patients in the conventional arm. As a result, this article has been cited by many authors.

4.2. Implications and changes

The study has several distinctive features. First, the hT-index with decimal places can be used in conjunction with the original h-index to improve the discrimination power for identifying IRA characteristics and ranking within a group.[21]

As a second feature, coauthors using the author-weighted scheme to quantify their contributions to article bylines[19,20] were demonstrated and proved to be viable in bibliometric analysis, as we did using the radar diagram and the hT-index in Figures 5 and 6.

As a third feature, IBPs[39,40] provide authors with an entirely new way to represent academic articles, particularly with links to PubMed. Furthermore, the way to draw the IBP on Google Maps is described in Supplemental Material (Supplemental Digital Content, http://links.lww.com/MD/H174).

The study also presents 3 visual representations on Google Maps, including a choropleth map based on the hT-index, a forest plot to identify the SMD in pair comparison, and a Sankey diagram showing research features in comparison between the 2 prolific authors.

The hT-index is more complex in computation than the h-index, but a dedicated software program can handle this issue. The hT-index computation has been interpreted in Table 1 and Figure 1, particularly Figure 2, which provides readers with the programming codes to understand how the hT-index is calculated within a second. Therefore, we can say that the hT-index resolves many of the problems associated with the h-index. We can easily obtain the hT-index in seconds by using computers to evaluate the author IRAs where there is no precision problem. As shown in Figures 5 and 6, the hT-index can be complemented with a coordinate, such as p(FP, RP), in the description. Therefore, it is easy to identify the author IRAs by using a dedicated software program to overcome the potential problem of computation time.

4.3. Limitations and suggestions

Further research should consider a number of issues in detail. The first concern is that only the 3 g-/x-indices/AIF were compared to the hT-index, which is closer to and associated with the h-index. It is recommended that future studies include a wider range of bibliometric metrics in comparison with the h-index.

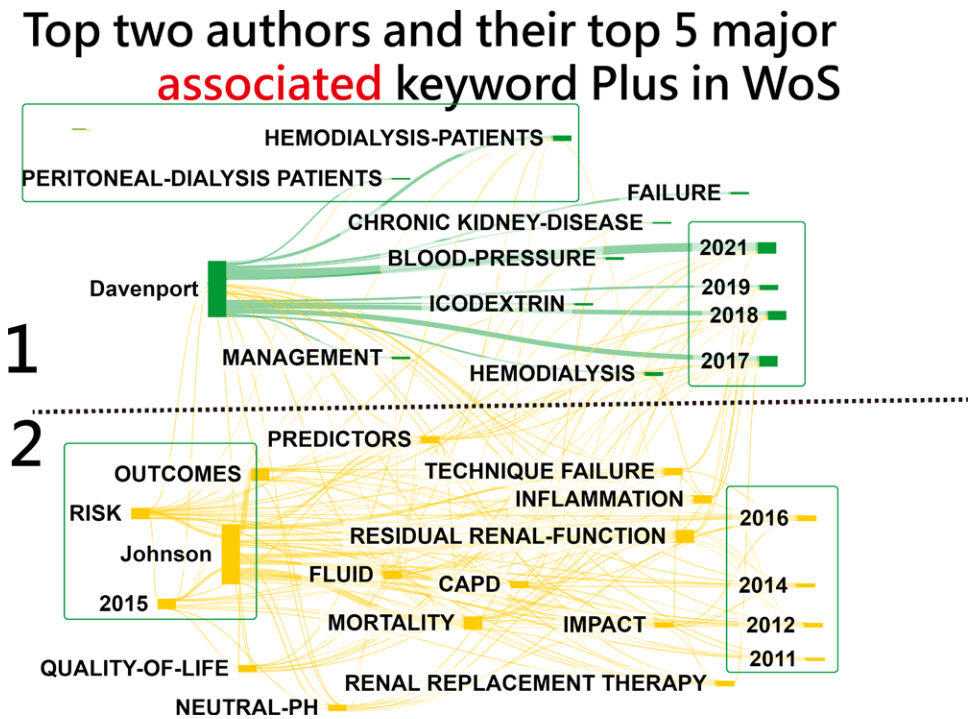

Figure 8. Study features of the top prolific authors with their top 5 major keyword plus in WoS. WoS = Web of Science.

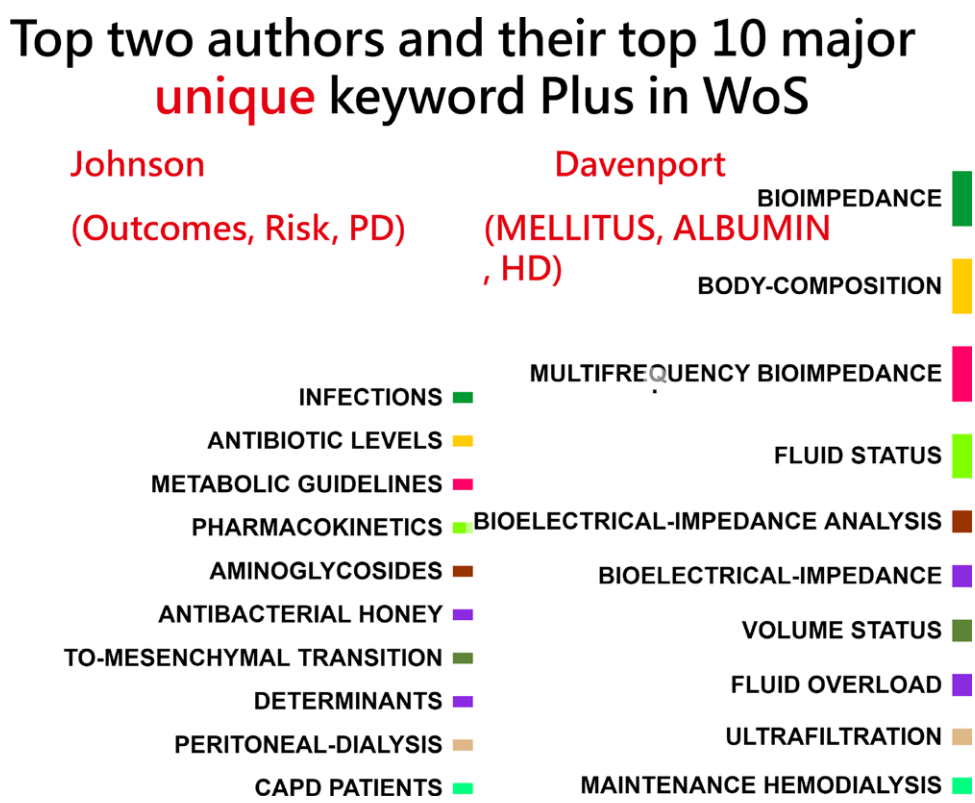

Figure 9. Research areas of the 2 prolific authors using their unique features of keyword plus.

Second, even though the Y-index and hT-index have been considered to be fair measures of IRA contributions, it is assumed that the first and corresponding authors contribute equally to the articles. The results regarding the authors who contributed the most to HD/PD fields will be biased if authorship does not follow the rule as designed.

Third, calculating the hT-index based on the summation of weights in the Ferrers tableau (that is, all cited papers in the list) requires some time. With the advancement in hardware, the time-consuming task has become trivial, comparable to computing h-/x-/g-indices and AIF using a dedicated software program, as shown in the reference.[33]

Fourth, the hT-index based on author citations was proposed in this study; however, the IRA is determined by many other factors (e.g., the JIF) that should be considered when calculating the hT-index (e.g., using the JIF to replace the citations in computing the hT-index).

Fifth, Figure 4 compares only countries/regions with higher hT-indices. Readers may also be interested in the countries and regions with the Y-index shown on the radar plots. A future

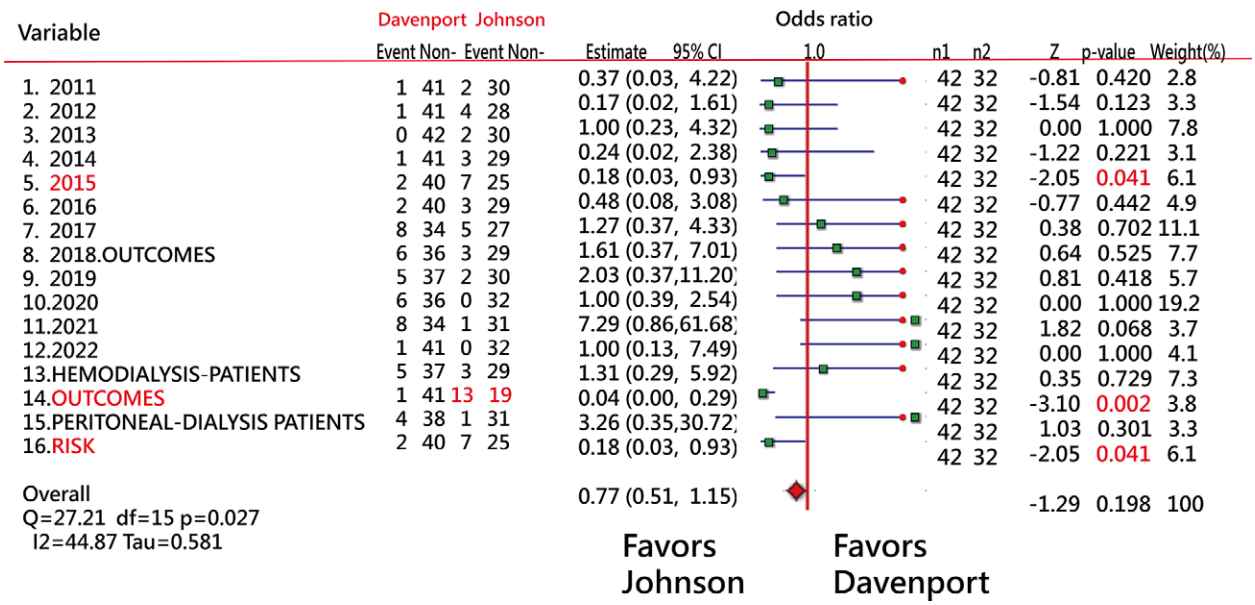

Figure 10. Comparison of proportional counts in major keyword plus between the 2 prolific authors.

study should include this type of influential country/region using the radar plot for display.

Finally, although the hT-index is considered useful and applicable, it should be used with caution when comparing the difference between groups, as it does not always follow a normal distribution. Readers were recommended to use the bootstrapping method[53–55] when comparing IRAs between groups, particularly with 95% confidence intervals.

5. Conclusion

Using the radar plot with the hT-index based on the number of publications in first and corresponding authors, it was shown that the hT-index generalized the h-index for evaluating author IRAs from both quality and quantity perspectives. In future relevant bibliometric analyses of academic disciplines or specific research topics, the hT-index and the IBP should be considered, rather than just the HD/PD, as we did in this study.

Author contributions

HY and WCK provided the concept and designed this study, CY and WCK interpreted the data, and WC monitored the process and the manuscript. TW and HY drafted the manuscript. All authors read the manuscript and approved the final manuscript.

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