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Predicting the number of citations of polycystic kidney disease with 100 top-cited articles since 2010
Bibliometric analysis

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Abstract

Background: Polycystic kidney disease (PKD) is a genetic disorder in which the renal tubules become structurally abnormal, resulting in the development and growth of multiple cysts within the kidneys. Numerous studies on PKD have been published in the literature. However, no such articles used medical subject headings (MeSH terms) to predict the number of article citations. This study aimed to predict the number of article citations using 100 top-cited PKD articles (T100PKDs) and dissect the characteristics of influential authors and affiliated counties since 2010.

Methods: We searched the PubMed Central® (PMC) database and downloaded 100PKDs from 2010. Citation analysis was performed to compare the dominant countries and authors using social network analysis (SNA). MeSh terms were analyzed by referring to their citations in articles and used to predict the number of article citations using its correlation coefficients (CC) to examine the prediction effect.

Results: We observed that the top 3 countries and journals in 100PKDs were the US (65%), Netherlands (7%), France (5%), J Am Soc Nephrol (21%), Clin J Am Soc Nephrol (8%), and N Engl J Med (6%); the most cited article (PMID = 23121377 with 473 citations) was authored by Vicente Torres from the US in 2012; and the most influential MeSH terms were drug therapy (3087.2), genetics (2997.83), and therapeutic use (2760.7). MeSH terms were evident in the prediction power of the number of article citations (CC = 0.37; t = 3.92; $P < .01$, n = 100).

Conclusions: A breakthrough was made by developing a method using MeSH terms to predict the number of article citations based on 100PKDs. MeSH terms are evident in predicting article citations that can be applied to future research, not limited to PKD, as we did in this study.

Abbreviations: CC = correlation coefficients, CD = centrality degree, IF = impact factor, MeSH = medical subject headings, mTOR = mammalian target of rapamycin, PKD = polycystic kidney disease, PMC = PubMed Central®, RC = research achievements, SNA = social network analysis, T100PKD = top-cited PKD articles.

Keywords: bibliometric, citation analysis, correlation coefficient, polycystic kidney disease, social network analysis

1. Introduction

Polycystic kidney disease (PKD) is an autosomal dominant kidney disorder that cannot be cured during clinical treatment.[1] The disease is common in both children and adults and leads to the progressive loss of kidney function.[2,3] Common symptoms, including arterial hypertension, recurrent urinary tract infection, and nephrolithiasis, cause structural abnormalities as a result of increased dysfunction and abdominal pain in patients with PKD.

1.1. Publications regarding PKD in the literature

Approximately 0.1% of people worldwide are affected by PKD.[4] More than half of the patients developed end-stage PKD. Recently, an increasing number of patients have been diagnosed with PKD without any symptoms due to other coexisting problems and diseases.[5]

However, patients with PKD are not easily cured.[1] This is because of the lack of human in vitro assays for compound testing, and the development of drugs has become difficult

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in clinical tests.[6] Advanced documents for assisting patients in alleviating their PKD condition are urgently required for investigations. For instance, research[7] reported that when patients get older, the glomerular filtration rate is lower than that in normal people. Similarly, an increasing number of articles on PKD have been published in the past. These research works are helpful in providing deeper insights to clinical physicians and researchers for better understanding the modern advancement of PKD. As such, the top-cited articles should be collected and predicted using bibliometric analysis. Nonetheless, we have not seen any that are about the top-cited PKD articles reported in PubMed Central® (PMC), although 995 papers have been searched using the keyword Polycystic + kidney + disease (MeSH + Major + Topic)[8] as of August 4, 2021.

1.2. Bibliometric analysis of the top-cited PKD articles

Bibliometry is a technique that analyzes articles with quantity and quality in a disciple (or on a specific topic) through a series of statistical methods.[9] In addition, bibliometrics can also present the relationship between authors, research institutions, and affiliated countries of orientation.[10] The citation analysis regarding the number of articles predicted by factors (e.g., MeSH terms) was addressed in the literature.[11] The most influential and productive authors and countries in the medical discipline were also found in the past.[12] Thus, we are motivated to investigate whether the number of article citations on the PKD topic can be predicted.

1.3. Study aims

Although numerous influential articles and eminent authors have been reported, such as lung cancer,[13] ophthalmic epidemiology,[14] cardiovascular,[15] and asthma.[16] None of them were regarding PKD. This study aims to predict the number of article citations using 100 top-cited PKD articles (T100PKDs) and dissect the characteristics of influential authors and affiliated counties since 2010.

2. Methods

2.1. Data sources

We programmed Microsoft Excel's Visual Basic for Applications modules to extract the downloaded abstracts published on PKD within the article title since 2010. The search terms were defined as (PKD [MeSH Major Topic]). All the top 100 cited articles from the 2608 downloaded articles were published between 2010 and 2019.[17,18] Because the data of this study were based on published literature, ethical approval and patient consent were not needed.

Only articles labeled journal articles were included in the analyses. Others, such as those marked as "Published Erratum, Editorial, or conference proceedings," were excluded. Article citations were extracted and matched to the T100PKDs to compare author individual research achievements (RCs) and impact factors based on MeSH terms in T100PKDs.

2.2. Data arrangement to fit the SNA requirement

Before visualizing our results using social network analysis (SNA), we organized the data in compliance with the format and guidelines defined by the Pajek software. Microsoft Excel's Visual Basic for Applications routines were used to fit the data to the SNA requirements.

The number of connections for a MeSH term in an article was computed using the weight (W_j) shown in Equation (1), where L denotes the number of MeSH terms in an article, and

j represents the location in an article. In SNA, each MeSH term defined as a note earns the centrality degree (CD) computed using Equation (2), where n denotes the journal sample size, and the CD for a given MeSH term is determined by using the summed weights in the given journal.

$$W_j = j/L,$$

$$\sum_{i=1}^{n} \sum_{L=1}^{L-1} W_{iL},$$

Cluster analyses combined with article citations were performed to observe the author and MeSH RCs. Absolute density was used to denote the important role of a specific cluster. In contrast, the relative density was used to represent the role of the RCs in the authors and MeSH terms using Equation (3).

$$\text{WCD}_i = \sum_{i=1}^{n} \left(c_i \times \frac{1}{j} \times (j-1) \right),$$

WCD_i is the weighted RCs for entities (i.e., authors and MeSH terms in this study) computed by citations and the CD in networks. c_i is the citation of the articles. J is the number of entities in an article.

2.3. Data presentations using tables and figures

2.3.1. Two tables on affiliated countries and journals. The publications of T100PKDs have been tabulated across countries and journals over the years. The impact factor (IF = citations/publications) was calculated for each country and journal in tables.

2.3.2. Two figures for affiliated countries on choropleth maps. The 2608 downloaded data were counted by country/region and individual US states and China's provinces displayed on choropleth maps.

2.3.3. Two figures for authors and mesh terms using SNA. The authors and MeSH terms for T100PKDs were analyzed using Equation (3). The influential entities denoted by impacted factors based on T100PKDs were highlighted on the dashboards. The author-weighted CD in Equation (3) was adjusted by an author-weighted scheme.[19,20] The first authors earn the most credit (approximately 63%) in their articles. The second (approximately 12%) is given to the corresponding authors (assigned to the last author in the article byline in this study), while the other middle authors are allocated with the remaining credits according to the author order in article bylines. In contrast, the weighted CDs in the MeSH terms are equal, based on Equations (1) and (2), respectively.

2.3.4. The prediction of article citations associated with the weighted IFs of mesh terms. The IFs of MeSH terms were computed based on equal-size proportions and citations in an article. The weighted scores yielded by MeSH weights (i.e., the number of citations per article) in each article were used to predict the original citations. The computation of the weighted MeSH citations is presented in Equation (4).

$$\text{WMeSH}_i = \sum_{i=1}^{n} \left(c_i \times \frac{1}{j} \right) \div \sum_{i=1}^{n} \left(\frac{1}{j} \right),$$

2.4. Statistics

The correlation coefficient (CC) was used to determine the predictive power between weighted MeSH terms and original article citations. The CC t value was calculated using the following formula: $\text{CC} \times \sqrt{\frac{n-2}{1-\text{CC}\times\text{CC}}}$. A prediction equation

Table 1

Distribution of 100 top-cited articles in polycystic kidney disease in PubMed database since 2010.

Country	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	n	Ci	IF
U.S	12	13	5	9	6	6	7	3	2		63	5087	80.7
Netherlands	1	2			2		1	1			7	487	69.6
France	1		1	1			1			1	5	423	84.6
Germany	1	1				2			1		5	521	104.2
Italy	2			2			1				5	424	84.8
U.K		2			1	2					5	384	76.8
China		1							1		2	102	51.0
Colorado					1						1	92	92.0
Japan		1									1	52	52.0
Norway		1									1	105	105.0
Saudi Arabia							1				1	44	44.0
Singapore								1			1	46	46.0
South Korea							1				1	51	51.0
Sweden	1										1	63	63.0
Switzerland	1										1	211	211.0
Total	19	21	6	12	10	10	12	5	4	1	100	8092	80.9

IF = n/Ci.

Table 2

Distribution of 100 top-cited journals in polycystic kidney disease in PubMed database since 2010.

Journal	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	n	Ci	IF
J Am Soc Nephrol	6	2	1	2	2	2	5		1		21	1637	78.0
Clin J Am Soc Nephrol	2	3	1		1		1				8	508	63.5
N Engl J Med	2		1		2			1			6	1266	211.0
Nat Genet		1	1	2				1			5	481	96.2
Am J Hum Genet		2					1		1		4	353	88.3
J Clin Invest			1	1	2						4	373	93.3
Kidney Int				1		3					4	360	90.0
Am J Kidney Dis	1	1					1				3	156	52.0
Am J Physiol Renal Physiol		3									3	175	58.3
Biochim Biophys Acta		3									3	165	55.0
Lancet				1		1				1	3	256	85.3
Nat Med	2		1								3	287	95.7
Nat Rev Nephrol	1	1				1					3	208	69.3
Nephrol Dial Transplant					1		1	1			3	213	71.0
Adv Chronic Kidney Dis	2										2	125	62.5
Gastroenterology	1			1							2	97	48.5
J Cell Biol	1					1					2	165	82.5
Proc Natl Acad Sci U S A		1		1							2	173	86.5
Cell							1				1	85	85.0
Dis Model Mech	1										1	59	59.0
Drug Saf						1					1	71	71.0
EBioMedicine							1				1	45	45.0
Genome Biol							1				1	44	44.0
Hepatology				1							1	48	48.0
Hum Mol Genet		1									1	64	64.0
Hum Mutat			1								1	65	65.0
J Pathol		1									1	58	58.0
Mod Pathol					1						1	58	58.0
Mol Cell				1							1	64	64.0
Nat Commun								1			1	53	53.0
Nat Mater								1			1	65	65.0
Nat Rev Dis Primers									1		1	64	64.0
Pediatr Nephrol						1					1	52	52.0
PLoS Genet		1									1	53	53.0
Science									1		1	53	53.0
Stroke		1									1	49	49.0
Kidney Int					1						1	44	44.0
Total	19	21	6	12	9	10	12	5	4	1	100	8092	80.9

IF = n/Ci.

was produced through simple regression analysis using MedCalc statistical software, version 9.5.0.0 (MedCalc, New York). The significance level was set at a type I error (0.05). The study process, data, and content are presented in Supplemental Digital Content 1, http://links.lww.com/MD/H357.

3. Results

Since 2010, 2608 publications have been retrieved from the PubMed database. The T100PKDs are listed with a link.[18] The total citation counts ranged from 44 to 473, as of July 30, 2021, in PMC, with a total of 8092 citations. The mean number of citations was 80.92.

3.1. The most productive countries/journals

The most productive countries in the T100PKDs were the US (65%), the Netherlands (7%), and France (5%). Most articles were published in J Am Soc Nephrol (21%), Clin J Am Soc Nephrol (8%), and N Engl J Med (6%) (see Tables 1 and 2). The most cited countries and journals were Switzerland (211) and N Engl J Med (211).

3.2. The most cited countries

Of the total 2608 PKD articles, the top 3 countries were the US (719), China (186), and Japan (163) (Fig. 1). If US states and China's provinces are applied to compare their counterparts, the top 3 are Italy (123), Germany (114), and Minnesota (US) (101) (Fig. 2).

3.3. The most cited article and authors

The most cited article with 473 citations (PMID = 23121377) was authored by Vucente E Tirres from the US in 2012.[21] The most highlighted authors (with larger bubbles in Fig. 3) in SNA were Vicente Torres from the US, followed by Arlene B Chapman (US), and Emilie Cornec-Le Gall (France), linked by 3 blue lines in Figure 3. Readers are invited to scan the QR code and click on the bubble of interest to read the author's articles shown in PubMed.

3.4. The most cited mesh terms in SNA

Through the citation analysis, the major topics denoted by MeSH terms were clustered, as shown in Figure 4. Equations (3) and (4) were applied to highlight the most influential MeSH terms in SNA. We can see that the top 3 with larger bubbles denoted by WCD in Equation (3) were drug therapy (3087.2), genetics (2997.83), and therapeutic use (2760.7), indicating that the 3 had frequently cited citations in T100PKDs. Several other major clusters constructed by the associations between MeSH terms are presented in Figure 4.

3.5. Using MeSH terms to predict the number of article citations in T100PKDs

After using the MeSH weights to associate with article citations based on the scheme of equal weight in article (i.e., different AWS based on author order[19,20]), MeSH terms are evident in the predictive power of the number of article citations (CC = 0.37; t = 3.92; $P < .01$, n = 100) (Fig. 5). The regression equation is defined as article citation (y) = y = 4.5229 + 1.0206 × weight (x) of MeSH terms. The slope coefficient was statistically significant (F = 3.92, $P < .002$), as shown in Figure 5.

3.6. Online dashboards shown on Google maps

All dashboards in the figures would appear once the QR code is clicked on the links.[22–25] Readers are advised to examine the details of each entity's information.
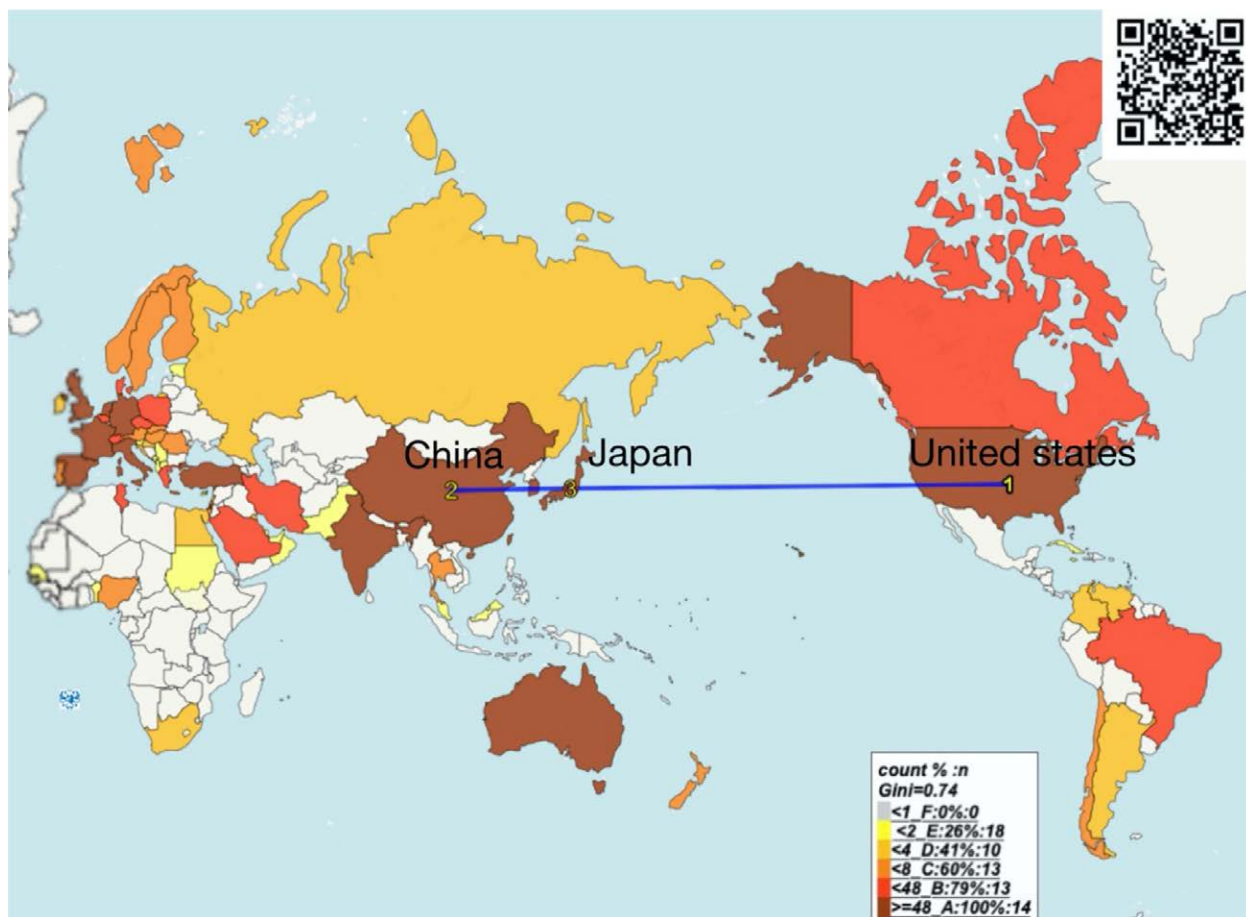

Figure 1. Geographical distribution of 2608 articles in polycystic kidney disease in PubMed database since 2010.
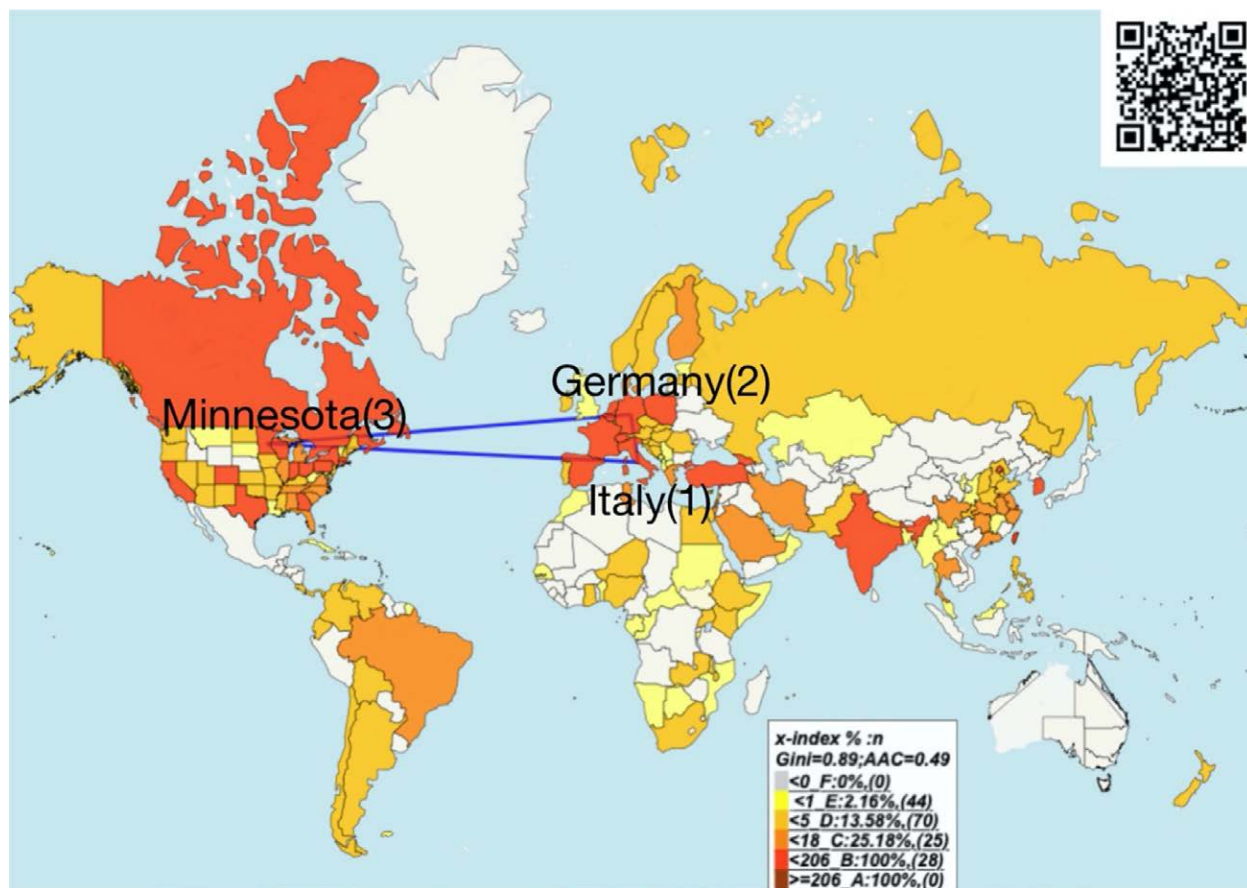
Figure 2. Geographical distribution of 2608 articles in polycystic kidney disease in PubMed database since 2010 based on US states and China's provinces.

4. Discussion

Bibliometric analysis explores the characteristics of previously published articles based on specific features, which provides readers with important information for understanding trends and primary research concerns in certain fields.[26,27] In this study, we conducted a bibliometric analysis and identified the T100PKDs published since 2010 in PMC.[28] Our study establishes a prediction model using MeSH terms to predict the number of citations based on 100 top-cited articles downloaded from the PMC. We found that the prediction model can provide information about which MeSH terms with higher weights (i.e., the prediction power) are related to the article receiving the most citations. Such a model offers a way to recognize the influence of recent work and the value of the articles on PKD.

4.1. Dominant countries and journals on PKD

In this study, we found that more than half of the T100PKDs were from the US (n = 63). This can be attributed to the fact that the US spent many research grants on PKD. A study[29] reported that the estimated total annual costs attributed to ADPKD in 2018 ranged from $7.3 to $9.6 billion in sensitivity analyses, equivalent to $51,970 to $68,091 per individual with PKD.

There were 37 journals in the T100PKDs. Among them, J Am Soc Nephrol (n = 21) ranked first, followed by Clin J Am Soc Nephrol (n = 8) and N Engl J Med (n = 6). We found that these 3 deserve achievements when referring to journal impact factors, reaching 10.121, 8.237, and 91.245, respectively, in 2020.

4.2. The most-cited articles

The most cited article[30] was published in 2012, and it is titled "Tolvaptan in patients with autosomal dominant polycystic kidney disease" and was authored by Vicente Torres et al It was cited 471 times. Studies of animal models have shown that tolvaptan, a vasopressin V2-receptor antagonist, can reduce the cyst burden and protect kidney function. The research progressed to a clinical trial with 63 patients with PKD and successfully demonstrated that tolvaptan can reduce the rates of worsening kidney function.

The second most cited article[4] was published in 2010, and it is titled "Everolimus in patients with autosomal dominant polycystic kidney disease" authored by Gerd Walz et al Mammalian target of rapamycin (mTOR) is hypothesized to promote cyst formation. mTOR inhibitors are used to reduce the volumes of both the kidney and liver. After a 1-year experiment, the PKD patients treated with mTOR inhibitors had a smaller kidney volume than the placebo group but did not slow the progression of renal impairment.

The third-ranked article[31] was published in 2010, and it is titled "Sirolimus and kidney growth in autosomal dominant polycystic kidney disease" authored by Andreas L Serra et al The study also tested whether sirolimus (an mTOR inhibitor) can slow down kidney volume growth in adult PKD patients. The study showed that using sirolimus for 18 months did not prevent the growth of polycystic kidneys in adult patients with PKD and early chronic kidney disease.

4.3. Strengths and limitations

The strength of this study is that MeSH terms were classified into research topics using SNA displaying dashboards on Google Maps, which highlighted the most dominant entities in
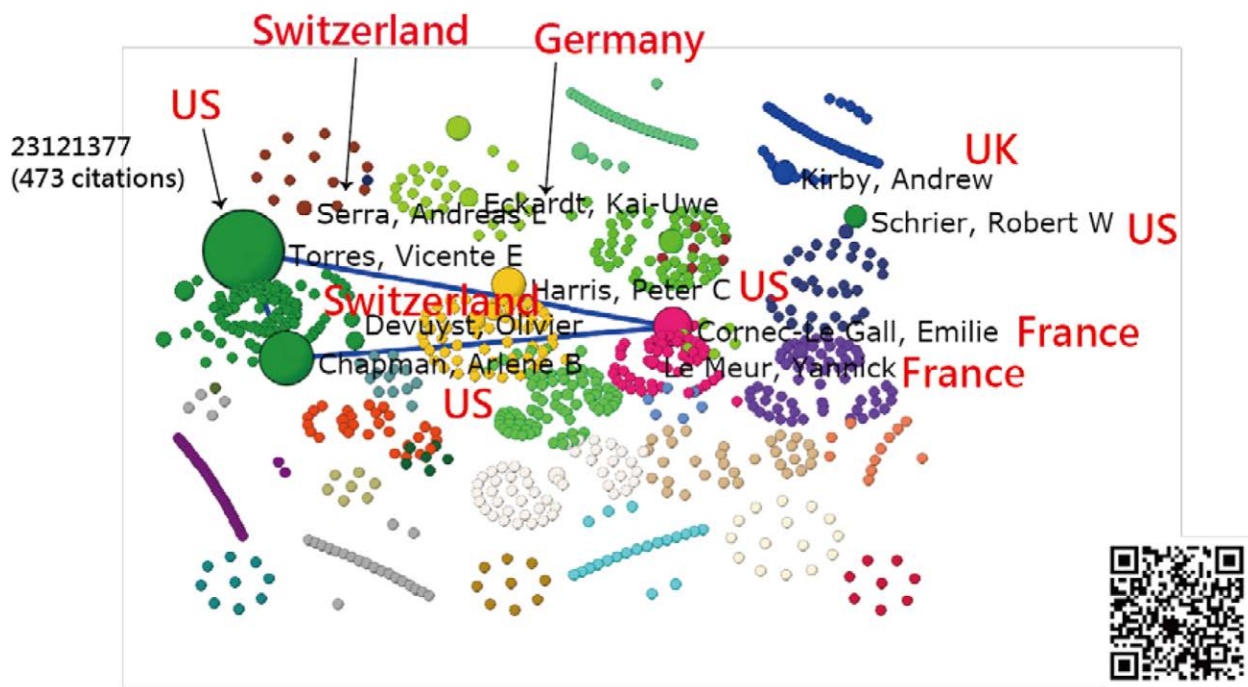
Figure 3. The most influential authors and their research teams in 100 top-cited articles.
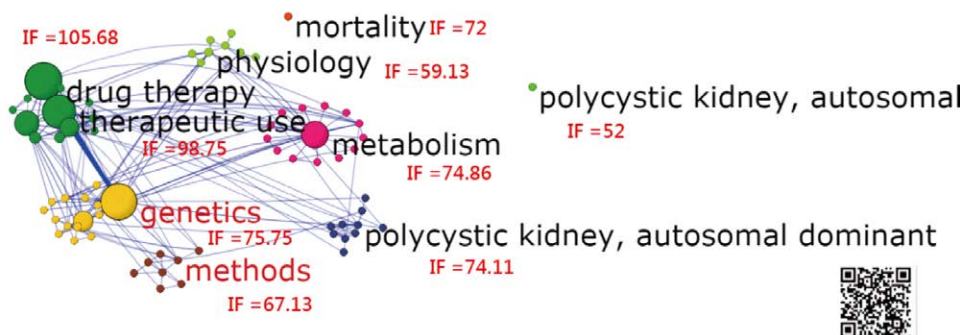

Figure 4. The most influential MeSH terms and their clusters in 100 top-cited articles. MeSH = medical subject headings.

which the PKD authors were interested. Readers can manipulate the links[27–30] independently to better understand the association between the entities the authors are concerned with in this study. In addition, applying MeSH terms to predict the number of article citations is a useful and viable way to identify the most dominant research topic in the field of PKD, which will help future academic pursuits in the PKD field. The research approach used in this study has the potential for application to other topics or disciplines in the future.

However, this study has some limitations. First, we used only a single database to extract the top 100 articles. The results of this study might be different if the articles were retrieved from other major citation databases, such as Scopus, Web of Science, and Embase.

Second, the authors used total citations as the measurement of impact as of August 2, 2021. Total citation counts were significantly associated with the age of the article. The older the articles, the more citations they may receive from citing articles. The most recently published articles are at a disadvantage in terms of the number of citations owing to the time effect.

Third, citation count does not directly reflect the quality of an article but enables a quantitative evaluation of the scientific impact of an article in a designated field. Thus, although citation statistics have been frequently criticized, analyses of citation rates provide current academic development in a certain field and may offer a historical perspective on its scientific progress.

Fourth, the number of article citations might be affected by several extrinsic factors, such as journal impact factors and authors' achievements. Using MeSH terms to predict future citation counts based on T100PKD might have some limitations and biases. More factors should be considered to reach a more valid prediction in the future.

Fifth, there were only 3 articles with a huge number of citations describing possible reasons in discussions due to space limitations. Readers are invited to read other articles in detail on PubMed by clicking on the link[23] we collected in this study.

Finally, dashboards in the figures are shown on Google Maps.[27–30] These installments are not free of charge because the Google Maps application programming interface requires a paid project key for the Google cloud platform. Thus, the limitations of the dashboard are that it is not publicly accessible, and it is difficult for other authors to mimic its use in a short period of time. Nonetheless, the process of making dashboards with MP4 video using Microsoft Excel[32] is provided to help readers
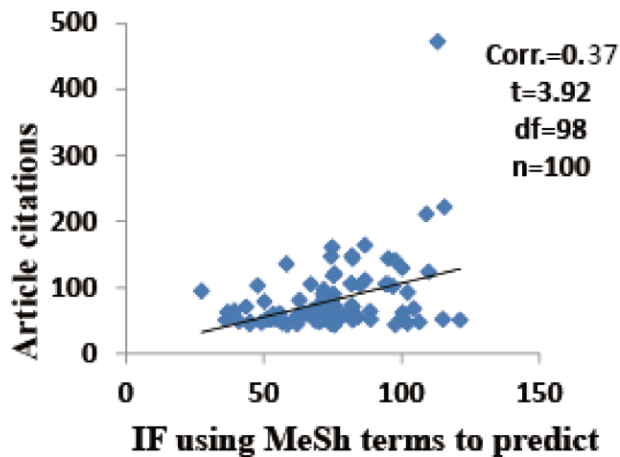
Figure 5. Predicting the number of articles using weights of impact factor on MeSH terms. MeSH = medical subject headings.

apply the procedures to other topics, not just limited to the PDK as we did in this study.

5. Conclusions

The US and Netherlands occupied the dominant places on T100PKD since 2010, accounting for 63% and 7%, respectively. Most articles were published in Clin J Am Soc Nephrol (8%) and N Engl J Med (6%). The most frequently occurring MeSH terms were drug therapy, therapeutic use, and genetics. MeSH terms can be used to predict the number of article citations (F = 3.92; $P < .002$).

Our study made a breakthrough to report the characteristics of the T100PKD by using SNA displaying dashboards on Google Maps and provided deep insight into the T100PKD. Most articles focused on drug therapy, therapeutic use, and genetics with a better understanding of treatment targets for PDK in the past.

We suggest using similar approaches to identify the most dominant entities in article topics, authors, and research institutes using SNA. Researchers are encouraged to exploit the characteristics and spot bursts on other topics in the future using bibliometric analysis, not limited to the PKD as we did in this study.

Author contributions

Conceptualization: Chen-Yu Wang, Willy Chou, Hsien-Yi Wang.
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Supervision: Hsien-Yi Wang.
Validation: Hsien-Yi Wang.
Visualization: Tsair-Wei Chien.
Writing – original draft: Chen-Yu Wang.
Writing – review & editing: Hsien-Yi Wang.

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