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The most cited articles in coronary heart disease: A bibliometric analysis between 1970 and 2015

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ABSTRACT

Background: Research on coronary heart disease (CHD) remains one of the major concerns in the medical and health fields in recent decades, yet data on the circumstances of CHD are unsatisfying. We aimed to evaluate the situations and trends of the most cited articles in CHD via bibliometric approaches.
Methods and results: The Web of Science database was used to identify the 100 most cited articles concerning CHD. General and bibliometric information was collected and analyzed. The total citations ranged from 7829 to 1157. Clinical trial was the largest proportion in article type while risk factor was the most preferred study content. The *New England Journal of Medicine* published the most T100 articles ($n = 31$), followed by *Lancet* ($n = 21$), *Circulation* ($n = 19$) and *JAMA* ($n = 12$). The USA and UK were the leading countries in the field of CHD, and contributed enormously in combating CHD.
Conclusions: This study presented a detailed analysis of the 100 most cited articles focused on CHD in recent decades, which provides insights into the circumstances and trends in preventing and treating CHD.

1. Introduction

With the accelerating process of population aging, the risk factors of coronary heart disease (CHD) are continuously rising worldwide. The Global Burden of Disease Study (GBD) 2013 [1] had published the mortality and causes of death during 1990 to 2013. Death caused by ischemic heart diseases had increased from 5.74 million in 1990 to 8.14 million in 2013, with a growth rate of 41.7%. The medical and social burden of CHD has caused significant deleterious economic impact to both national economies and households [2,3].

Bibliometric analysis is an approach to evaluate the circumstances and trends in a specific research field over time and to provide inspiration in future research and policy. Bibliometric studies have produced insights into various subspecialties, including hypertension [4], diabetes [5], digestive system diseases, [6] respiratory system diseases [7], obstetric and gynecological diseases [8] and integrative and complementary medicine [9]. Yet there is still no comprehensive summary of CHD researches in recent decades via bibliometric approaches. Those articles of significant findings that have contributed great impact on preventing and treating CHD have not been identified and assembled.

In this study we aimed to provide detailed evaluation of the 100 most cited articles (T100) in CHD using bibliometric analysis, and hoped to get insights into CHD accumulated over the past decades by analyzing the publication year, journal, authorship, country and interactions, type of study, total citations, h-index, citation density and funding source.

2. Materials and methods

The Web of Science database was used to identify the top articles concerning CHD from the beginning of the database (1970) to December 31, 2016. Coronary heart disease was used as search term. The 100 most cited articles were obtained and reviewed.

Every identified article was evaluated to guarantee that CHD was the major subject of the research, regardless of the article type. Researches focused on CHD complicated with other diseases such as hypertension and diabetes were included as well.

The following publication information and bibliometric indicators were collected from the included articles: (1) publication information, including authors, journal, year of publication, article type, country of authors' affiliation; (2) study contents, including main subjects of study, funding source; and (3) bibliometric indicators, including total citations and h-index. Citation density which was defined as citations per year after publication was calculated.

3. Results

The total citations of T100 varied from 7829 to 1157, and mean citations per article was 2158.2. Most of the articles ($n = 83$) received 1000 to 3000 citations, and only 8 articles had citations over 4000. The citation density varied from 459.7 to 28.4, with a mean density of 143.9. The correlation between total citations and citation density is significantly strong (Pearson's correlation coefficient = 0.750, $p = 0.00$). Articles with a higher citation density tend to have more total citations in T100. The

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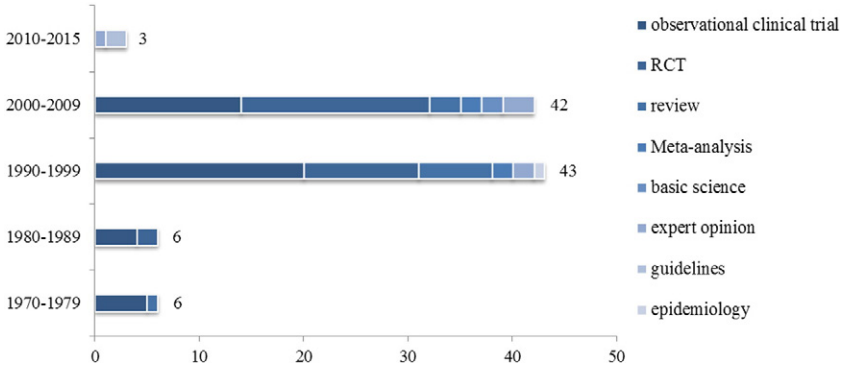

Fig. 1. Distribution of article type in T100 divided by decade.

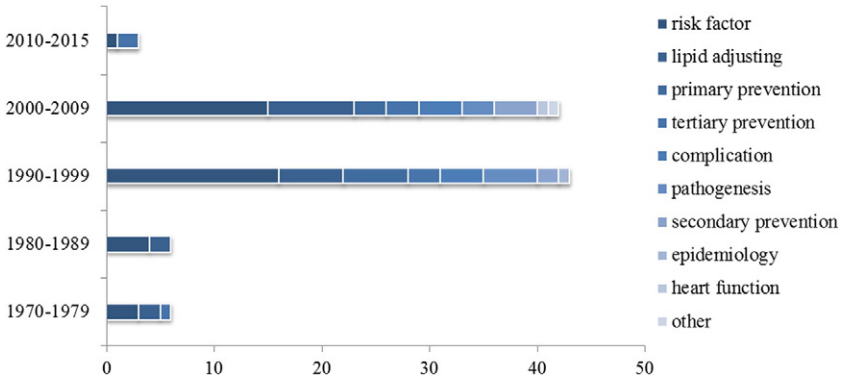

Fig. 2. Distribution of study contents in T100 divided by decade.

H-index of each article was obtained in WOS. It varied from 259 to 32, with a mean of 130.43. The correlation between h-index and total citations were also significantly strong (Pearson's Correlation coefficient = 0.681, $p = 0.00$).

Most of the T100 articles were published in 1990–2009 ($n = 85$). The most recent one was published in 2012, with 1379 citations (ranked 75th in T100) and a citation density of 459.67 which was the highest. It is an ESC Guideline for the management of acute myocardial infarction with ST-segment elevation, published in the *European Heart Journal* by Ph. Gabriel Steg and Stefan K. James.

The article types of T100 were divided into observational clinical trial, RCT, review, meta-analysis, basic science, expert opinions, guidelines and epidemiology. Observational clinical trial and RCT contributed the largest proportion of T100 articles (43 and 31 articles respectively), distantly followed by review ($n = 11$). Fig. 1 shows the distribution of T100 article types by decade of publication.

The study contents of T100 could be categorized into risk factor, lipid adjusting, primary prevention, secondary prevention, tertiary prevention, complication, heart function, pathogenesis, epidemiology and other. Risk factors took the largest proportion of the T100 articles ($n = 39$), followed by lipid adjusting ($n = 18$). Fig. 2 shows the distribution of T100 study contents by decade of publication.

The T100 articles were published in 16 journals, led by the *New England Journal of Medicine* ($n = 31$), *Lancet* ($n = 21$), *Circulation* ($n = 19$) and *JAMA* ($n = 12$), which are the top journals in the medical and cardiology fields (Table 1).

The authors of T100 articles were from 41 countries in total. 61 articles shared the same country respectively, 17 articles had 2 countries and 22 articles had 3 countries or more. The USA contributed the most articles ($n = 61$), followed by the UK ($n = 30$), Finland ($n = 14$), Germany ($n = 13$) and Canada ($n = 12$). The countries with more than 5 T100 articles were listed in Table 2.

International cooperation was documented and analyzed. Among these countries, the cooperation between the USA and UK was the most frequent ($n = 11$), followed by USA–Canada ($n = 9$), UK–Sweden ($n = 8$), UK–Finland ($n = 7$), UK–Germany ($n = 7$) and UK–Italy ($n = 7$). Fig. 3 shows the interactions between countries of T100 articles.

Harvard University in the USA produced 18% of the T100 articles, followed by the University of Oxford in UK (6%), National Institutes of Health in the USA (5%), and the University of Sydney in Australia (4%). The majority of institutions collaborated with other institutions within the same country.

Table 1
Journals of the 100 most cited articles.

Journal	No. of article(s)
New England Journal of Medicine	31
Lancet	21
Circulation	19
JAMA	12
European Heart Journal	3
Nature	3
British Medical Journal	2
American Journal of Epidemiology	1
American Journal of Medicine	1
American Journal of Respiratory and Critical Care Medicine	1
Annals of Internal Medicine	1
Archives of Internal Medicine	1
Diabetes Care	1
Journal of Clinical Investigation	1
Preventive Medicine	1
Proceedings of The National Academy of Sciences of The United States of America	1

Table 2
Countries with more than 5 T100 articles.

Rank	Country	No. of articles
1	USA	61
2	UK	30
3	Finland	14
4	Germany	13
5	Canada	12
6	Italy	10
7	Netherlands	10
8	Sweden	10
9	France	8
10	Norway	8
11	Denmark	7
12	Ireland	5

There were 10 authors who contributed more than 1 top cited article and were listed as the first author or correspondence author. This list is led by Ridker PM, who authored 5 of the T100 articles. These 10 authors were listed in Table 3.

52 of the T100 articles stated their funding source. 15 of them were funded by the National Heart, Lung, and Blood Institute (NHLBI), and 13 of them were funded by the National Institute of Health (NIH). Pharmaceutical companies had supported 14 of the T100 articles.

4. Discussion

In this study, we identified and analyzed the 100 top-cited articles in CHD. The aim of this bibliometric analysis is to provide insights into the development and evolvement of CHD research over time, and to demonstrate the circumstances of the researches on CHD.

The number of citations for the T100 articles varied from 7829 to 1157, which was more than those in other subspecialties [4–10]. Citations vary in different subspecialties and depend on the size of the research fields. Such results reflect the fact that CHD is one of the major concerns in medical and health fields.

73% of the T100 articles were clinical trials, which was more than other subspecialties such as diabetes, [5] showing the significant role of clinical trials to CHD researches. The main body of clinical trials identifies the risk factors and optimizes the treatment of CHD and its complications. Of all the T100 articles, 39 articles focused on the risk factors for the development, progression and prognosis of CHD, including age, sexuality, blood pressure, blood glucose, lipid, C-reactive protein, inflammatory factors, plasma homocysteine and so on. These findings helped construct the comprehensive and practical CHD diagnosis and stratification system. The remaining clinical trials concentrated on the treatment of CHD and its complications such as hypertension and diabetes. These researches contributed to the optimization of the medication in different aspects of CHD treatment.

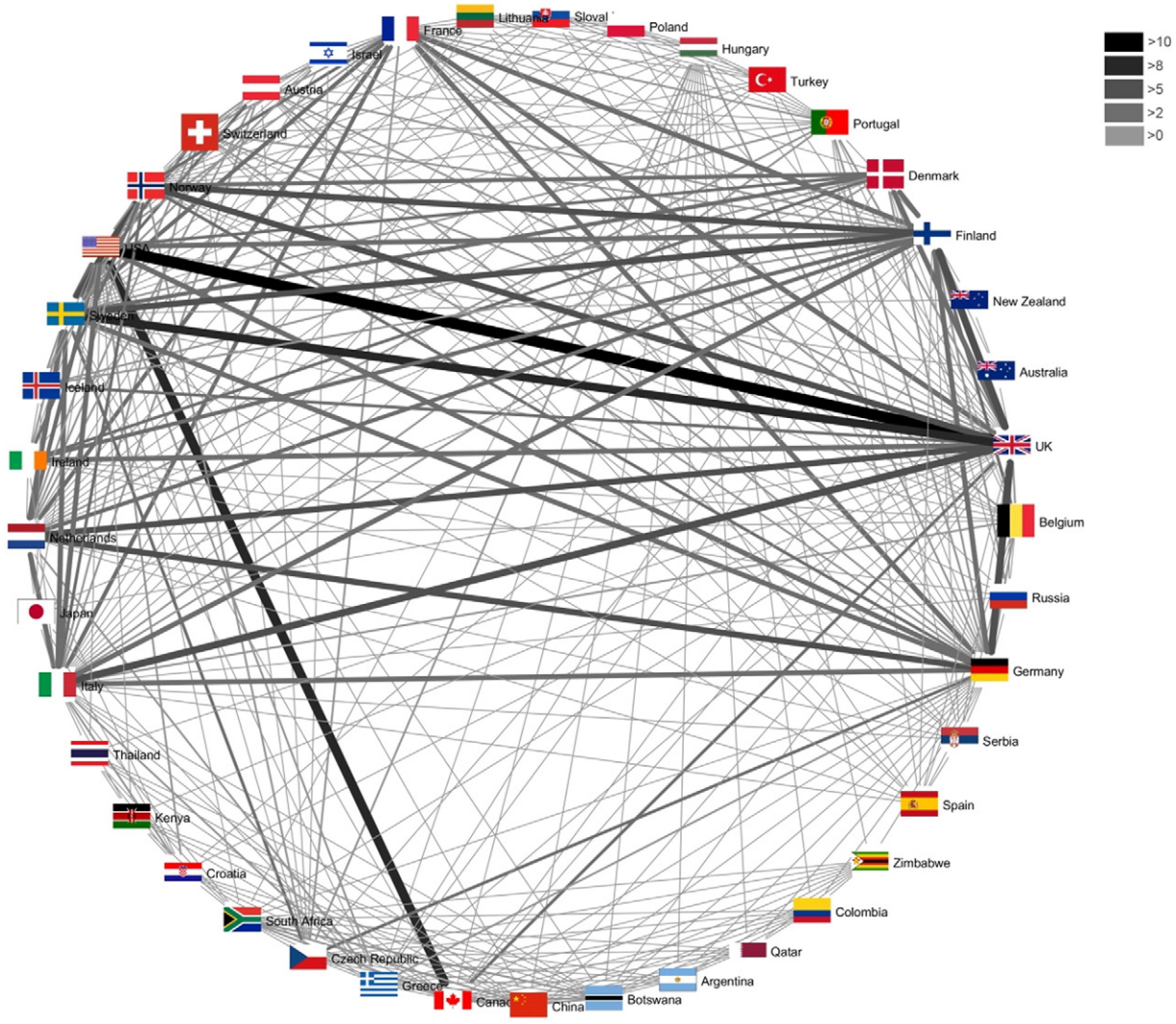

Fig. 3. Interactions between countries of T100 articles.

Table 3
Authors with more than 1 T100 article.

Author	No. of articles	Affiliation	Country
Ridker PM	5	Harvard University	USA
Stampfer MJ	4	Harvard University	USA
Yusuf S	3	McMaster University	USA
Anversa P	2	New York Medical College	USA
Castelli WP	2	National Institutes of Health	USA
Collins R	2	University of Oxford	UK
Danesh J	2	University of Cambridge	UK
Moss AJ	2	University of Rochester	USA
Orlic D	2	National Institute of Health	USA
Stamler J	2	Northwestern University	USA

As for the study contents, there were 18 articles that studied lipid adjusting, which showed its importance in the management of CHD. What is worth noticing is that 10 out of the 18 lipid adjusting researches were funded or co-founded by pharmaceutical companies. Other study contents included primary prevention ($n = 9$), tertiary prevention ($n = 9$), complication (including hypertension, diabetes, metabolic syndrome and arrhythmia, $n = 8$) and secondary prevention ($n = 6$). Risk factors and lipid adjusting were the major contents through different periods of time. Basic science researches were relatively few ($n = 2$), and we speculated that the preference for a large-scaled clinical trial is prominent in the field of CHD.

The T100 articles were published in 16 journals. Among them, 4 journals published 83% of the T100 articles, including the *New England Journal of Medicine*, *Lancet*, *Circulation* and *JAMA*. These 4 journals were either the top journals in medical researches with an impact factor (IF) over 30, or the peak journal in the subspecialty. It is well known that outstanding articles tend to be published in journals with high IF, and high IF journals help spread the articles' academic influence. [11].

Similar to the journals that published T100 articles, most were contributed by authors and affiliations located in the USA and UK. Those authors who contributed more than 1 article in T100 were all in the USA or UK. The NHLBI and NLH in the USA had funded 28 researches in T100. Such circumstances indicate that the USA and UK are the leading countries in the field of CHD, and contribute enormously in preventing and treating CHD. European countries have contributed much in T100, and the communications between them were more frequent, such as Finland, Germany, Italy, Netherlands and Sweden. The voice from Asia, Africa and South America is relatively low in this study. They participated in T100 as associating affiliations or branch centers. Knowing that the prevalence and the treatment of CHD are not so exceedingly satisfying in these continents with a larger population [1], we hope that the CHD related researches hosted in these countries would produce excellent and influential results and benefit the prevention and treatment of CHD in their mainland and worldwide in the future.

The Schubert h-index (h-index) was introduced by András Schubert in 2009 [12]. It has been widely used to measure the direct and indirect citation influence of a single publication. The h-index was used in our analysis of T100 to study the academic influence along with the total citations. 97% of all the T00 articles have an h-index ≥ 65. It meant that these articles were cited by at least 65 articles which had at least 65 citations. There was a significantly strong correlation between total citations and h-index (Pearson's correlation coefficient = 0.681, $p = 0.00$).

The citations of each article would grow with increasing age, so we calculated the citations per year as citation density to measure the interest of T100 articles. Articles with a high citation density tend to be published in the recent decade, which made them accumulate high citations with relatively less time. This include articles by Steg PG et al. [13] (2014), Hansson GK [14] (2005) and Wijns William et al. [15] (2010). This reflects the high interest for them and their promising academic influence in the foreseeable future.

We acknowledged that there were some limitations in this study. Our results were influenced by our choice of search database, search terms and inclusion/exclusion criteria, and we did not include the citation count from the Pubmed Center, textbooks or the Internet. Some articles with high influence might have been missed in our analysis [16]. There may be many factors that affect the total citations received by an article, and the academic influence of an article could not be reflected by citations alone. Moreover, a citation is logically dependent on its publication year because citations accumulate over time; older articles are likely to be cited more frequently than recent articles [17]. Hence the academic influence should be comprehensively judged with other parameters, such as h-index and citation density. Publication and language bias also exist in our study. Despite these limitations, we provided insight into the development and characteristics of CHD in the past 45 years.

5. Conclusion

In this study we analyzed the 100 most cited articles focused on CHD via bibliometric approaches. Most of the T100 articles were published during 1990 to 2009. Clinical trials were the majority of the T100 articles, which aided the development and optimization of preventing and treating CHD. The USA and UK are the leading countries in the CHD research field, especially the former. This report provides insights into historical developments and characteristics of the most cited articles in the field of CHD over the past decades.

Conflict of interest

None.

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