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World scientific collaboration in coronary heart disease research ☆

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ABSTRACT

Background: Coronary heart disease (CHD) will continue to exert a heavy burden for countries all over the world. Scientific collaboration has become the only choice for progress in biomedicine. Unfortunately, there is a scarcity of scientific publications about scientific collaboration in CHD research. This study examines collaboration behaviors across multiple collaboration types in the CHD research.

Methods: 294,756 records about CHD were retrieved from Web of Science. Methods such as co-authorship, social network analysis, connected component, cliques, and betweenness centrality were used in this study.

Results: Collaborations have increased at the author, institution and country/region levels in CHD research over the past three decades. 3000 most collaborative authors, 572 most collaborative institutions and 52 countries/regions are extracted from their corresponding collaboration network. 766 cliques are found in the most collaborative authors. 308 cliques are found in the most collaborative institutions. Western countries/regions represent the core of the world's collaboration. The United States ranks first in terms of number of multi-national publications, while Hungary leads in the ranking measured by their proportion of collaborative output. The rate of economic development in the countries/regions also affects the multi-national collaboration behavior.

Conclusions: Collaborations among countries/regions need to be encouraged in the CHD research. The visualization of overlapping cliques in the most collaborative authors and institutions are considered "skeleton" of the collaboration network. Eastern countries/regions should strengthen cooperation with western countries/regions in the CHD research.

1. Introduction

Coronary heart disease (CHD) mortality has been continuously decreasing in many countries as a result of changes in risk factors and evidence based treatments over the past three decades [1–5].

Nevertheless, because of population aging and lifestyle changes, such as long work time, unhealthy nutrition habits, stress and lack of recreation, CHD will continue to exert a heavy burden for countries all over the world. According to the data from the WHO [6], cardiovascular diseases (CVDs) are the number one cause of death globally: more people die annually from CVDs than from any other causes. An estimated 17.3 million people died from CVDs in 2008, representing 30% of all global deaths. Of these deaths, an estimated 7.3 million were due to CHD.

This situation has always been a major issue of global concern, and has mounted a serious challenge for researchers in life sciences worldwide to prevent and control CHD and for governments to allocate funding to CHD research. However, no single individual can perform all of the specialist tasks with the increasing specialization and professionalization in biomedicine. Scientific collaboration becomes the only choice for progress in biomedicine because it allows sharing resources and promotes synergies to achieve the necessary critical mass of knowledge.

Unfortunately, few scientific publications about scientific collaboration in CHD research were reported. Our aim is therefore to examine collaboration behaviors across multiple collaboration types in the CHD research.

2. Methods

2.1. Materials

The documents which contain the word "coronary" in their title, abstract or keywords were collected from the scientific literature database, known as "Web of Science". The scope was limited to the years 1981 through 2010. All documents regardless of type (e.g., article, meeting abstract, proceedings paper, review, editorial material, book review, letter, note, etc.) were processed. Only documents from the Science Citation Index

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Expanded (SCI-Expanded) were taken into account. The query yielded 294,756 records, each of which has author names, affiliations, titles, sources, abstracts, total citations, keywords and cited references. The dataset contains 368,601 authors, 60,762 affiliations and 161 countries/regions. All of the processes in all steps were accomplished automatically.

Document coauthored by authors from more than one institution was classified as inter-institutional collaboration. A paper coauthored by authors from different countries/regions was considered an international paper.

2.2. Co-authorship

Despite the limitations [7,8], co-authorship measure is still the most effective method for analyzing as it is inexpensive and practical. In the past few years, the rates of research collaboration measured by co-authorship have soared [9–13].

2.3. Social network analysis

A social network is defined as a set of social entities, such as people, organizations, and countries, with some pattern of relationship between them [14]. These networks are usually modeled by graphs, where nodes represent the social entities and lines represent the ties established between them. The underlying structure of such networks is the object of study of social network analysis (SNA). In this present study, SNA helps to reveal the connection among authors, institutions and countries/regions in CHD research.

Network Workbench, a visualization toolkit for large-scale networks, was applied to map the collaboration links.

2.4. Connected component

A connected component of an undirected network is a sub-network in which any two nodes are connected to each other by paths.

2.5. Clique analysis

A clique in an undirected network is a sub-network of its nodes such that every two nodes in the subnetwork are connected by a line. Obviously, a clique is a much more cohesive group than connected component, because it guarantees that every node in it is connected directly to every other node. The clique analysis refers to any of the problems related to find the maximum number of nodes who have all possible lines present among themselves.

Both connected component and clique can help us extract cohesive research groups from the collaboration networks.

2.6. Betweenness centrality

Betweenness centrality rests on the idea that a node is more central if it is more important as an intermediary in the network. The betweenness centrality of a node is the proportion of all geodesics between pairs of other nodes that include the node.

2.7. Performance indicators of country/region

The performance of a country/region is measured along two dimensions: productivity and quality of the research output. The first one of the following indicators concern productivity and the second and third ones concern quality:

a) Productivity (P): total number of publications by one country/region as first author in the period under observation;
b) Times cited (TC): the number that one country/region as first author cited by the other country/region in the period under observation;
c) Average times cited (ATC): TC/P.

2.8. Indicators for country/region collaboration

The international collaborations by country/region are calculated by three indicator:

a) Multi-national collaboration intensity (MCI): total number of multi-national publications by one country/region first author in the period under observation;
b) Multi-national collaboration rate (MCR): MCI/P;
c) Multi-national collaboration amplitude (MCA): total number of collaborators of one country/region as first author in the period under observation.

2.9. Classifying countries/regions

Countries/regions were economically categorized into five groups, as classified by the World Bank: high income OECDs, high income non-OECDs, upper middle incomes, lower middle incomes and lower incomes.

The authors of this manuscript have certified that they comply with the Principles of Ethical Publishing in the International Journal of Cardiology.

3. Results

3.1. Scientific productivity

There has been a substantial increase in the total number of papers in CHD research over the past three decades, as depicted in Fig. 1. Fig. 1 shows distribution of publications per year. The number of publications in CHD research remained approximately constant during the 1980s, then started to shoot upward since 1989. Overall, the number of papers has increased more than eightfold, from 2436 in 1981 to 20,741 in 2010.

3.2. Collaboration trend analysis

3.2.1. Multi-author collaboration

Collaboration among scientists in CHD research has significantly grown over the past three decades. Fig. 2 demonstrates the percentage of papers with multi-authored, multi-institutional and multi-national patterns and Fig. 3 shows the average number of authors, institutions and countries/regions over the past 30 years. The percentage of multi-authored papers has steadily increased from 87% in 1981 to 93% in 2010 (Fig. 2). Similar increases were also seen for both multi-institutional and multi-national publications. However, the percentage of multi-authored papers is significantly higher than both multi-institutional and multi-national ones. The average number of authors per paper have climbed from 4.2 in 1981 to 6.4 in 2010 (Fig. 3). For all the publications, 9.7% are single-authored and 6.3% are results of collaboration involving more than ten authors (Table 1). The largest number of coauthors in our dataset was 2458.

3.2.2. Multi-institutional collaboration

As noted above, multi-institutional collaborations (i.e. publications written with authors from different institutions) in CHD research rose from 23% in 1981 to 56% in 2010 (Fig. 2). The majority of the publications in the entire time period are written within a single institution (Fig. 3, Table 1). Approximately 80% of publications are written between one or two institutions. The largest collaboration in our sample involved 139 institutions.

Collaborations within single institution still represent the majority of the research output.

3.2.3. Multi-national collaboration

As described in Fig. 2, multi-national collaborations (i.e. publications written with authors from different countries) in CHD research have seen a rise from 2% in 1981 to 19% in 2010. As shown in Fig. 3 and

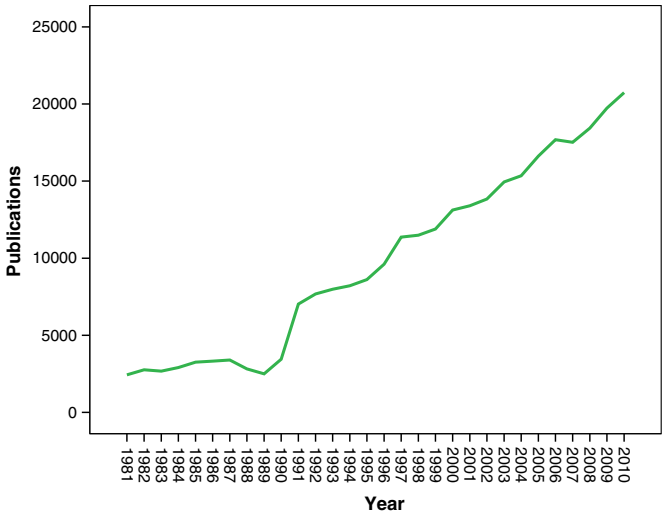

Fig. 1. Evolution of publications in CHD research.