Citation Classics in Asthma Research: The 100 Top-Cited Articles During 1960–2014

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To the Editor: Asthma poses a serious health problem globally. People of all ages can be affected by this chronic airway disorder that, when uncontrolled, may place severe limits on daily life and is sometimes fatal. The prevalence of asthma is increasing in most countries throughout the world, especially among children.[1] During the past decades, many scientific advances have been made to improve our understanding of asthma and our ability to manage and control it effectively. These advances are mainly reflected by related scientific articles, particularly by those most influential papers.

This study searched Institute for Scientific Information (ISI) database to identify the top 100 most-cited articles in asthma research and analyze their characteristics. The primary aim was to provide a bibliometric perspective of the progress in asthma research. It also intended to search for factors contributing to the successful citation such as journals in which the articles were published and related countries where the authors come from.

The database of the Science Citation Index (SCI) of the ISI was used to screen for the most-cited papers in asthma research from 1960 to August 2014. SCI is an index of citations produced by the ISI and is made available online through the Web of Science database, a part of the Web of Knowledge collection of databases. A search for all articles relevant to asthma (article titles containing "asthma") was conducted until August 2014 in SCI. The search results were filtered to exclude papers in proceedings, editorials, and letters (as identified in the publication type field). Then, all the yielded articles were ranked by the number of citations listed on the Web of Science. The 100 top-cited articles were selected for further analysis. Of these top-cited articles, the following information was recorded: authors, country of origin, year of publication, institution, journal name, and research field.

The 100 papers were then inputted into SPSS software version 17.0 (SPSS Inc., Chicago, IL, USA) for further analysis. A citation index was calculated for each article to control the error of citations from different publication times. The citation index was defined as the median number of citation times per year since publication. Descriptive statistics were quantified as counts or percentages of parameters. The Kruskal-Wallis test was used to compare the differences with an alpha level of 0.05.

The 100 top-cited articles were published from 1960 to 2009 and were identified among 77,217 articles published in 23 journals. The median number of citations was 655 (ranging from 473 to 2176). Eighteen papers were cited more than 1000 times, and only one paper was cited more than 2000 times. The annual average cited times of the 100 articles were correlated by total cited times ($r = 0.591$, $P < 0.0001$).

The most-cited paper, reported by Robinson *et al*.,[2] was published in *The New England Journal of Medicine* (*NEJM*) in 1992. They reported an epoch-making finding that atopic asthma was associated with activation of the interleukin-3, 4, and 5 and granulocyte-macrophage colony stimulating factor gene cluster in the bronchi, which indicating a T_{H2}-like pattern of cytokine-gene expression in allergic asthma. A landmark paper on genetic of asthma, reported by Postma *et al*.[3] in 1995, ranked 73rd in the 100 top-cited list. In their paper, authors first illustrated that a trait for an elevated level of serum total IgE was co-inherited with a trait for bronchial hyperresponsiveness and that a gene governing bronchial hyperresponsiveness is located near a major locus that regulates serum IgE levels on chromosome 5q. The most influential paper in 2008, ranked the 30th in the 100 top-cited list, was reported by Bateman *et al*.[4] It summarized the global strategy for asthma management and prevention updated by Global Initiative for Asthma, and it had been widely adopted worldwide.

The 100 top-cited articles were originated from 50 countries, with The United Kingdom ($n = 46$) and the United States ($n = 36$) contributing the majority of papers, followed by Canada ($n = 15$), Sweden ($n = 12$), Germany ($n = 11$), and France ($n = 10$). Only 13%

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of the top-cited articles came from Asian countries. The National Heart and Lung Institute was found to be the most productive institution ($n = 13$), followed by McMaster University ($n = 11$) and University of Southampton ($n = 8$). Among the 100 top-cited articles in asthma research, the majority ($n = 40$) were studies in "Medicine General Internal", followed by 34 studies in "Respiratory System". Other fields, such as "Immunology" and "Allergy", also had a considerable proportion.

The decade from 1990 to 1999 produced the most citation classics with 56 articles followed by 2000s (including the year after 2010) with 25 articles. Overall, more than 80% of the 100 top-cited articles were published after 1990, while only 4 articles were published before 1980. It has been reported that scientific papers are usually cited 1 or 2 years after publication and reach the peak citation about 10 years after publication. The citation rate has gradually risen over the last decade, which was indicative of an increasing consideration for the field of asthma. This research also supported that the peak recognition of important papers in a field can be obtained in the 10–20-year period.

Twenty-three journals covered all the 100 top-cited articles, led by *NEJM* (25 articles) and followed by the *American Review of Respiratory Disease* (13 articles), *Lancet* and *Journal of Allergy and Clinical Immunology* both shared the third with 11 articles. Table 1 presents the top 10 journals that published the highest number of top-cited papers. It was noted that majority of the top-cited papers were published in journals with high impact factors. This seemed to support that the impact factor of the original publishing journal was an effective predictor of citations each year, rather than the methodology or quality of the research.[5] However, more than half of the top-cited papers were published in asthma dedicated journals, such as the *American Review of Respiratory Disease*. This report indicated that the actual citation of the individual article might not be positively related to the impact factor of the journal.

Throughout the 100 top-cited list, majority researches were original research articles, whereas review articles or meta-analysis accounted for less than 10%, which were in contrast to the general acknowledgment that review articles had the highest number of citations. These findings might be associated with a preference for referring to clinical evidence rather than review articles or expert opinion.

By reading through the 100 top-cited articles, it was not hard to be impressed by the classic papers on the list. These were the representatives of many landmarks that had occurred in asthma research over the past decades. However, there were still many important papers relating to asthma which were not found in this 100 top-cited list. This indicated that the number of citations a paper has received might not reflect its overall importance historically.

Table 1: Top 10 Journals publishing the highest number of top-cited papers

Journals	*n*
The New England Journal of Medicine	25
American Review of Respiratory Disease	13
Lancet	11
Journal of Allergy and Clinical Immunology	11
European Respiratory Journal	7
American Journal of Respiratory and Critical Care Medicine	7
Thorax	3
Science	3
Nature	3
British Medical Journal	3

In this citation analysis, some limitations related to its inherent problems might be inevitable. First, this research was restricted to articles with the word "asthma" in the title of the papers, which might miss some significant asthma articles published with other titles. Second, the journals use different approaches to accept or reject a submitted manuscript. Thus, particular journals could have stricter selection criteria that might affect the clinical applicability or quality of their publications. The criteria could be a reason why most-cited papers were found in one journal. Third, challenges and problems might arise from citation counts, such as ignoring potential citations in book chapters, considering self-citations, peers' preference to cite papers from the journal they submit their article, and preference to cite review articles or full-length articles. Quality of work is best recognized by citation count and is a superior measure of an author's impact and originality of work compared with article count. Fourth, the number of citations and citation index of a particular paper could be influenced by its publication year because some journals check the quality of a submitted work based on the usage of recently published papers. Fifth, lack of correction for self-citations by a journal or an author was a great challenge for the citation analysis. Despite the obvious defects, the results of this study provided insight into the achievement and development of asthma research over the past decades.

This study might give an interesting insight into the history and development in asthma over the half past century. The findings indicated that studies conducted in well-developed European and North America countries, published in high-impact journals and written in English had the highest citations.

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Conflicts of interest

There are no conflicts of interest.

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