

How to Cite:

Vardhan, C. M. V., Bhomesh, S., Ravindra, V., & Ramaganesh, M. (2022). Outdoor air pollution and respiratory health: A bibliometric analysis. *International Journal of Health Sciences*, 6(S3), 11240–11249. <https://doi.org/10.53730/ijhs.v6nS3.9240>

Outdoor air pollution and respiratory health: A bibliometric analysis

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Abstract---Outdoor air pollution is a major threat to global public health that needs responsible participation of researchers at all levels. Assessing research output is an important step in highlighting national and international contribution and collaboration in a certain field. Therefore, the aim of this study was to analyze globally-published literature in outdoor air pollution – related respiratory health. Outdoor air pollution documents related to respiratory health were retrieved from Scopus database. The study period was up to 2017. Mapping of author keywords was carried out using VOSviewer 1.6.6. Search query yielded 3635 documents with an h-index of 137. There was a dramatic increase in the number of publications in the last decade of the study period. The most frequently encountered author keywords were: air pollution (835 occurrences), asthma (502 occurrences), particulate matter (198 occurrences), and children (203 occurrences). The United States of America ranked first (1082; 29.8%) followed by the United Kingdom (279; 7.7%) and Italy (198; 5.4%). Annual research productivity stratified by income and population size indicated that China ranked first (22.2) followed by the USA (18.8). Analysis of regional distribution of publications indicated that the Mediterranean, African, and South-East Asia regions had the least contribution. Harvard University (92; 2.5%) was the most active institution/organization followed by the US Environmental Protection

Agency (89; 2.4%). International collaboration was restricted to three regions: Northern America, Europe, and Asia. The top ten preferred journals were in the field of environmental health and respiratory health. Environmental Health Perspective was the most preferred journal for publishing documents in outdoor pollution in relation to respiratory health. Research on the impact of outdoor air pollution on respiratory health had accelerated lately and is receiving a lot of interest. Global research networks that include countries with high level of pollution and limited resources are highly needed to create public opinion in favor of minimizing outdoor air pollution and investing in green technologies.

Keywords---outdoor air pollution, respiratory health, bibliometric analysis.

Introduction

Outdoor air pollution is defined as the presence of one or more substances in the atmospheric air at concentrations and duration above the natural limits [1]. Such substances include ozone [O₃], airborne lead [Pb], carbon monoxide [CO], sulphur oxides [SO_x] and nitrogen oxides [NO_x] [2]. Recently, air pollution with particulate matters (PM), especially those with less than 2.5 µm, has been the focus of most outdoor air pollution studies due to its ability to penetrate the lung tissue and induce local and systemic effects [2]. Air pollution has been described as one of the “great killers of our age” and as “major threat to health” due to its tremendous and various health effects on humans of all ages and in both genders [3, 4]. In 2014, the World Health Organization (WHO) estimated that 92% of the world population was living in places with less than optimum outdoor air quality. Furthermore, WHO reported that in 2012, outdoor air pollution caused around 3 million deaths worldwide and 6.5 million deaths (11. 6% of all global deaths) were associated with indoor and outdoor air pollution together [5].

Air pollution was linked to cancer, respiratory diseases, negative pregnancy outcomes, infertility, cardiovascular diseases, stroke, cognitive decline, and other adverse medical conditions [6–13]. Nearly 90% of air-pollution-related deaths occur in low- and middle-income countries, with nearly 2 out of 3 occurring in South-East Asia and Western Pacific regions. The problem of outdoor pollution is not a new one, but the rapid urbanization, particularly in Asia, made the problem of air pollution more visible and its health burden more tangible [14–17]. Bibliometric analysis is the application of statistical methods on published literature to analyze publication trends with time and to shed light on influential researchers, countries, and institutions in the field. In the past decade, at least seven bibliometric studies on air pollution were published [18–24]. However, none of the published bibliometric studies have shed light on the air pollution - related respiratory health. Therefore, in the current study, we aim to analyze literature pertaining to outdoor air pollution and respiratory health. The size of the literature and research productivity in this field is a good indicator of national and international efforts to improve air quality and to decrease the health and economic burden of air pollution. Furthermore, the quality of the air we breathe is

the responsibility of everyone including researchers and academics. This study comes in line with perceived personal responsibility toward better air quality.

Method

Search strategy This study aimed to analyze the documents about outdoor air pollution – related respiratory health. Scopus database was used to retrieve relevant documents because of its advantages over other databases [25–28]. The search strategy developed for this study consisted of nine steps (Additional file 1). The first six steps utilized various keywords and search queries to retrieve the maximum number of documents. Keywords included in search queries were those found in recent relevant systematic reviews [6, 12, 13, 29, 30].

Data analysis and visualization

In this study, Hirsch-index (h-index) was used as a measure of impact of publications [36]. Graphs were created using Statistical Package for Social Sciences (SPSS). Hirsch - index is defined as the number of articles (n) that have received at least n citations [36]. VOSviewer software was used to create visualization maps while ArcMap 10.1 was used to create geographical distribution of the retrieved documents [37–39]. For VOSviewer mapping of most frequent author keywords, a minimum occurrence of 10 was used as a cut-off point for inclusion of the keyword in mapping analysis. Analysis also included distribution of publications based on World Health Organization (WHO) regions.

Types and growth of publications

The search strategy yielded 3635 documents. The earliest document in this field was published in 1943 in American Journal of Epidemiology [40]. The analysis of the types of documents showed that research articles (2935, 80.7%) were the most common type followed by review articles (359; 9.9%). The remaining documents (341; 9.4%) were conference papers, letters, editorials, short surveys, and notes. English (2923, 80.4%) was the primary language of documents followed by French (156; 4.3%) and German (124; 3.4%). The subject areas of the documents were medicine (2772; 76.3%) followed by environmental science (1038; 28.6%) and biochemistry/ genetics/ molecular biology (317; 8.7%) with the possibility of overlap among different subject areas. The growth of publications showed a dramatic increase in the past decade. Figure 1 shows the annual growth of publications. There was a 72% increase in number of publications in 2017 compared to that in 2008.

Author keywords

Analysis of author keywords showed that the most frequently encountered author keywords were: air pollution (835 occurrences), asthma (502 occurrences), particulate matter (198 occurrences), and children (203 occurrences) (Fig. 2a). Further mapping of types of pollutants most commonly encountered in author keywords showed that particulate matter (198 occurrences), ozone (192 occurrences), nitrogen oxide (95 occurrences), PM10 (75 occurrences), PM2.5 (57

occurrences), and Sulfur dioxide (54 occurrences), were the most frequently encountered author keywords (Fig. 2b).

Discussion

Growth of publications

In this study, we analyzed global research output in outdoor air pollution – related respiratory health. The results showed a noticeable increase in the number of publications in the last decade of the study period. This indicates that the level of air pollution and its health consequences reached serious levels. In 2012, air pollution was responsible for 3 million deaths, representing 5.4% of the total global deaths. In the same year, about 25% were due to lung cancer deaths, 8% were due to chronic obstructive pulmonary disease (COPD) deaths, and about 17% of respiratory infection deaths were caused by outdoor air pollution [41]. A study indicated that the contribution of outdoor air pollution to global premature mortality could double by 2050 [42]. Another study concluded that outdoor air pollution contributes to the increase in global burden of COPD and that an increase of 10 $\mu\text{g}/\text{m}^3$ in PM₁₀ produced significant increase in COPD deaths and exacerbations that can be substantially reduced by controlling air pollution [43]. A cohort Chinese study concluded that the risks of mortality and years of life lost were elevated corresponding to an increase in current ambient concentrations of the air pollutants [44]. The contribution of researchers from different scientific fields led to an acceleration in the growth of publications in this field. Scientists in the fields of the environment, respiratory health, public health, and even molecular biology/genetics contributed to the retrieved documents [45–49]. The fact that air pollution is a multidisciplinary field created a large number of readers from different scientific fields and thus leading to large number of citations, reflected in the relatively high h-index value of documents. For example, the h-index of literature in global carbapenem resistance was 102 and that for literature in resistant tuberculosis was 76 [50, 51].

Active countries and institutions

Our results showed that China had the highest research productivity in terms of GDP per capita per year. In China, air pollution was previously estimated to contribute to 1.2 to 2 million deaths annually [52]. In its list of the world's deadliest countries for air pollution, the WHO ranked China first followed by India, Russian Federation, Indonesia, Pakistan, Ukraine, Nigeria, Egypt, USA, and Bangladesh [53]. Out of the top 10 countries that have high total annual number of deaths from PM_{2.5} and PM₁₀, only China and USA were among the top ten active countries in research output. The deadliest effects of air pollution in China led to the adoption of the Ambient Air Quality Standard in China in 2012 [54]. This system started a national Air Reporting System that now includes 945 sites in 190 cities.

Highly cited documents

The top cited documents in the field was about the relationship between outdoor air pollution and lung cancer; and received a large number of citations suggestive

of great importance. The International Agency for Research on Cancer [60], which is part of the WHO, has classified outdoor air pollution, as a whole, as a cancer-causing agent (carcinogen) [60]. The International Agency for Research on Cancer (IARC) concluded that outdoor air pollution causes lung cancer and is associated with increased risk for bladder cancer. Urgent action to minimize level of outdoor air pollution and exposure of population to such carcinogenic pollutants is necessary, particularly in cities with high levels of outdoor air pollution [61, 62].

Analysis of Author Keyword Co-Occurrence

In bibliometric research, topic mapping is critical. Figure 1 illustrates all of the issue categories related to the keywords of scientific literacy in general. In the bibliometric analysis, VOSviewer may give six unique mapping visualisations. The thickness of the connecting line represented the strength of a pair of topic areas or keywords.

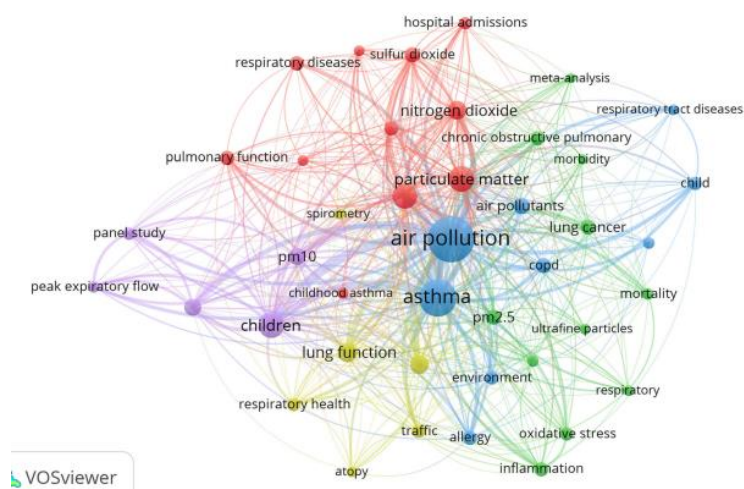


Fig. 1. The Network Visualization of Literacy Topic Area

In terms of country, co-authorship is as follows

Countries having an emphasis on scientific literacy research are depicted in Figure 2. The United States and India have the most scientific literacy research studies, followed by Canada, Australia, and Turkey, according to the data. Meanwhile, as the VOSviewer mapping results reveal, scientific literacy research in Indonesia is still in its infancy.

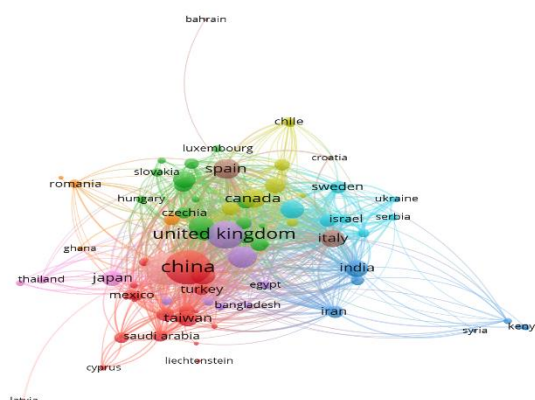


Fig. 2. The Visualization of Countries Related to Scientific Literacy Research

Co-authorship in terms of Authors

This analytical parameter is considered with 04 additional parameters. This parameter considers the word, authors, organisations, and countries. This research does not include documents with a large number of authors. This number is considered to be 13. For the author's minimum number of documents, the barrier is set at 4. It should be highlighted that 328 of the 1549 writers met the requirements from the scopus and web of science databases.

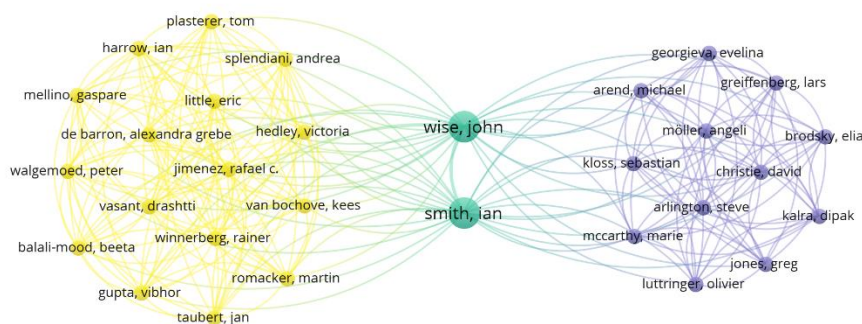


Fig. 3. Network Analysis of Co-authorship in terms of authors

CO-authorship in terms of Organizations

Co-authorship in the unit of organisations is calculated by disregarding the citation of at least two publications in organisations; 45 organisations meet the condition out of the total of 1426 displayed in the image. Stony Brook University (SBU), NY, United States has the highest link strength of 5 and the highest number of citations of 154. (with 2 documents).

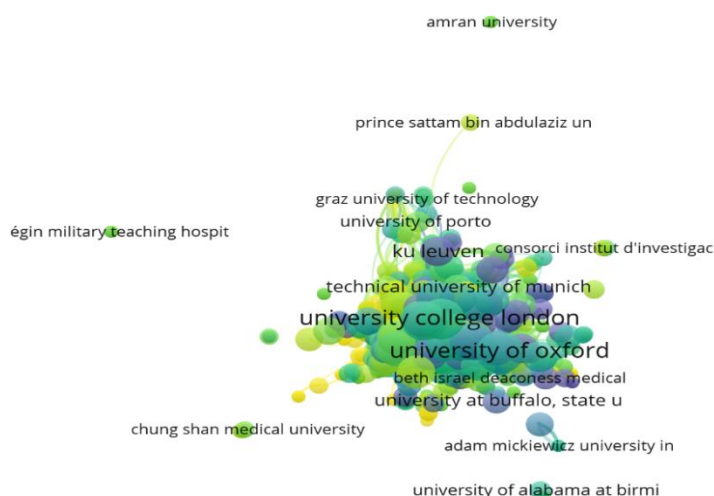


Fig. 4. Network Analysis of Co-authorship in terms of organizations

Conclusions

Growth of publications in outdoor air pollution – related respirator health is rapidly increasing. However, limited research output and international collaboration were seen in world regions such as the Middle East, Africa, and South-East Asia. International multidisciplinary research network, involving countries with high levels of air pollution and limited resources, are needed. Research in atmospheric pollution should also be directed toward prevention of air pollution problems by investing more in green technology. The results presented in this study are indicative of how research activity is interacting with the urgent acceleration of the air pollution crisis at the global level. Furthermore, the research activity is indicative of the response rate adopted by certain countries to face this global problem in a responsible way. Pressure groups can use the research activity to enforce certain environmental and industrial agendas on politicians and political campaigns. Countries with high levels of outdoor air pollution, and therefore, poor air quality, need to get engaged in research pertaining to this field to provide health policymakers with baseline data for future action. Establishing research center for monitoring national air quality and level of air pollution is a step forward that needs to be adopted by all countries.

Such centers could include scientists from different disciplines who can collaborate to convert research findings into national agendas and policies. At the national levels, different world countries need to adopt strict guidelines for air quality. Collaboration between industry and health authorities is needed to implement measures that could significantly reduce the levels of particulate matter. The outdoor air pollution is a global public health and therefore research networking between developed countries and developing countries with high levels of air pollution should be prioritized. The Chinese model in controlling air pollution and minimizing its health consequences could be of a global benefit. Finally, since the respiratory effects of air pollution are affecting children, there is a need to educate and increase the awareness of parents regarding this issue.

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