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Scientometric analysis of health impact assessment of outdoor air pollution by WHO-AirQ tool (2005-2019)

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ABSTRACT

Introduction: This study provides a scientometric analysis of the health impact assessment within AirQ between 2005 and 2019, which are listed in the web science databases. Studies have been conducted in various indexed journals, researchers in World Health Organization (WHO) regional areas on product articles, international collaboration, and citation and keyword analysis.
Materials and methods: Bibliographic records of research publications and articles were found and after screening process were input to study plan. The authors compared the growth of article that was published in this period time, conducted a citation and co-authorship analysis, and keywords co-occurrences relationship by publication using the scientometric visualization, VOSviewer.
Results: The AirQ applying tool in research literature has seen most increase in 2017 production over the study period. Contributions by authors affiliated with WHO-Eastern Mediterranean Regional Office (EMRO) account for the most research literature. Most of studies focus on particles Particulate Matter with diameter ≤10 µm (PM_{10}) and Particulate Matter with diameter ≤2.5µm ($PM_{2.5}$) and according to total mortality and in hospital admission, Respiratory Disease (RD) and Cardio Vascular Disease (CVD) are most commonly.
Conclusion: All potential of AirQ has not been used in studies. Despite all function its scope is limited to several countries in the WHO regions. Implementation of "Driving Force, Pressure, State, Exposure, Effect, and Action" (DPSEEA) conceptual model need some evidence that AirQ can achieve and estimate Health Impact Assessment (HIA) but we didn't find any articles that work on intervention by it on policy makers and management programs.

Introduction

Air pollution is one of the most important components of the environment, and estimation their attributable Environmental Burden of Disease (EBD) factors as a key role in policy making and macro management of air pollutants control. The program of World Health Organization-Air Pollution and Health European Information System (WHO-APHEIS) in 26 cities and 12 European countries finding has shown capacity of WHO-European Center for Environment and Health (ECEH) AirQ tool to calculate Years of Life Lost (YLL) and Years of Life lost due to

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Disability (YLD) [1]. "Since 2005 WHO-AirQ tool has introduced to expert communities' to estimate health impact assessment of outdoor Air Pollution (AP) in polluted cities. One of the other capabilities of this tool is to estimate the short- and long-term effects of AP exposure in different age groups for each pollutant.

According to WHO report, more than 175 countries have above 10 µg/m³ annual mean concentration of Particulate Matter with diameter <2.5 µm ($PM_{2.5}$). However, it should also be noted that particulate matter is just one of the classic pollutants in urban air atmosphere. Other classical pollutants such as Nitrogen Oxide (NO_2),Sulfur Dioxide (SO_2), and Ozone (O_3) are also found in cities with excessive levels of WHO-Air Quality Guide line (AQG) that have adverse effects on health [2]. Also in 2013, WHO released a statement expressly that AP is in "A1 group" of International Agency for Research on Cancer (IARC) classification. In this announcement particulate matter refer to major component of outdoor AP with carcinogenic effects [3].

Increasing urbanization, energy consumption and transportation development, climate change severe phenomenon under WHO regions such as forest fires, volcanoes, dust storms due to increase annual mean concentration of air pollutants especially particulate matter in inhaled by in habitants of cities. So WHO-AirQ application will be a good opportunity to predict and estimate Health Impact Assessment (HIA) of short and long term exposure to the air pollutants. Because of accessible to this tool and country's need to know how much of population affected by air pollutants in cities, it seems after fourteen years (2005-2019) and improve AirQ in 2016, we would have expected to develop in all over the countries. This study will focus on articles and research published in English that have used WHO-AirQ from years 2005 to 2019 to evaluate the effects of AP on health in cities. The purpose of this systematic review will be done on the scientometric network by VOSviewer application. Science databases, Science Direct, Emerald insight, ELSEVIER, PubMed, and Springer were used to find the history of studies.

Among the results of review article can be cited to brief review on AirQ model, prediction of health effects of air pollutants that can use for interventions by policy making, legal guidelines, local authorities [4].

This study intends to follow up the WHO-AirQ use in address Ambient Air Pollution (AAP) countries, to use this software in the six WHO regions, Number of report and interpret the results of studies on the acceptability of scientific journals indexed, cited from articles that use the WHO-AirQ tool from the perspective of researchers and reviewers of scientific journals and indexed in the world is very small value. If the WHO-AirQ tool doesn't' have scientific value in impact of AP on health assessment studies, so it won't be an appropriate tool for assessing human, social, and economic damages to assist governance and policy makers in their AAP control programs. Therefore, implementation of the Driving force, Pressure, State, Exposure, Effect, and Action (DPSEEA) conceptual model will have challenges.

Until this article was presented, their results weren't found in any search engines mentioned, that has been used by researchers and authors with this approach to AirQ application. Therefore, this study seems to bring with it the necessary innovations.

Health impact assessment

Most regard to HIA through governments to create policies, eliminate inequity, interventions and assess the economic damage done to human capital and evaluation to policy implementation. Health Development Agency–National Health Service United of Kingdom (NHS) introduce HIA as: "developing process that uses a range of methods and approaches to help identify and consider the potential – or actual – health and equity impacts of a proposal on a given population" [5]. In Health Impact Assessment Guidelines, introduce HIA in two part, one refer to WHO European regional office (1999) explanation: "a combination of procedures or methods by which a policy, program or project may be judged as to the effects it may have on the health of a population." and other in glossary as: "the process of estimating the potential impact of a chemical, biological, physical or social agent on a specified human population system under a specific set of conditions and for a certain timeframe." Another approach describes as: "assesses plans, project, program or policies before they are implemented, predicts the health impacts of proposals, recommends mitigation measures" [6].

Effects of exposure to classic air pollutants

Classic air pollutants are NO_2, O_3, Particulate Matter, SO_2 and other photochemical oxidants [7]. According to studies and WHO presents health effects of AP are mainly classified into short and long-term consequences of deaths or diseases (emergency room visiting or hospital admission). The study of premature death in US shows annual changes in $PM_{2.5}$ and O_3 concentration due to 200000 (90% CI:90000-362000) and 10000 (90% CI -1000 to 21000) deaths in 2005 [8]. The increasing impact of mixed air pollutants (O_3, NO_2, $PM_{2.5}$) on Cardio Vascular Disease (CVD) and hospital admission has been demonstrated in a study of 85 US counties [9]. Research in 43-time series, 13 cases cross-over, and 3 cohort studies (1999-2013) has been shown that increased Emergency Room (ER) for all impacts in Total mortality, CVD and Respiratory Disease (RD) mortality, hospital admission for CVD and RD are related to variation in PM_{10} and $PM_{2.5}$ concentrations [10]. A meta-analysis and systematic review of 26 studies on the short-term effects of exposure to air pollutants in the East Asian region up to December 2014 have shown that the effect of exposure to NO_2 and CO on children hospital admission for asthma is more than 15-64 age groups. Increased Chronic Obstructive Pulmonary Disease (COPD) and hospitalization have been observed for all age groups for SO_2 and O_3 short term exposure [11]. The results of 17-cohort European studies of AP impact in lung cancer incidence have shown changes of 10 $\mu g/m^3$ for PM_{10}, hazard ratio (HR) 1.22 (95% CI 1.03–1.45) and 5 $\mu g/m^3$ for $PM_{2.5}$ (HR) 1.18 (95% CI 1.03–1.45), the risk of lung adenocarcinoma their become (HR) 1.51 and 1.55 respectively [12].

AirQ

Review article study conducted on models to predict health outcomes resulting from exposure to AP (classic pollutants) in cities by model AirQ, showed AirQ2.2.3 (2004) and improved it to Air Q+ (2016) by WHO is an appropriate tool for epidemiological studies of the effects of AP. This tool will help policy makers and government managers design interventions to reduce health risks by assessing the impact of short-term and long-term exposure to air pollutants. The conceptual model of DPSEEA in this study illustrates the role of policies and actions towards human health in the context of social, environmental and economic structure of society [13, 14] .

Materials and methods

We performed a scientometric analysis using literature studies in English language reported from 2005 to 2019 in indexed journals.

Data sources

The scientific databases of Science Direct, Emerald insight, Elsevier, PubMed, Springer were used.

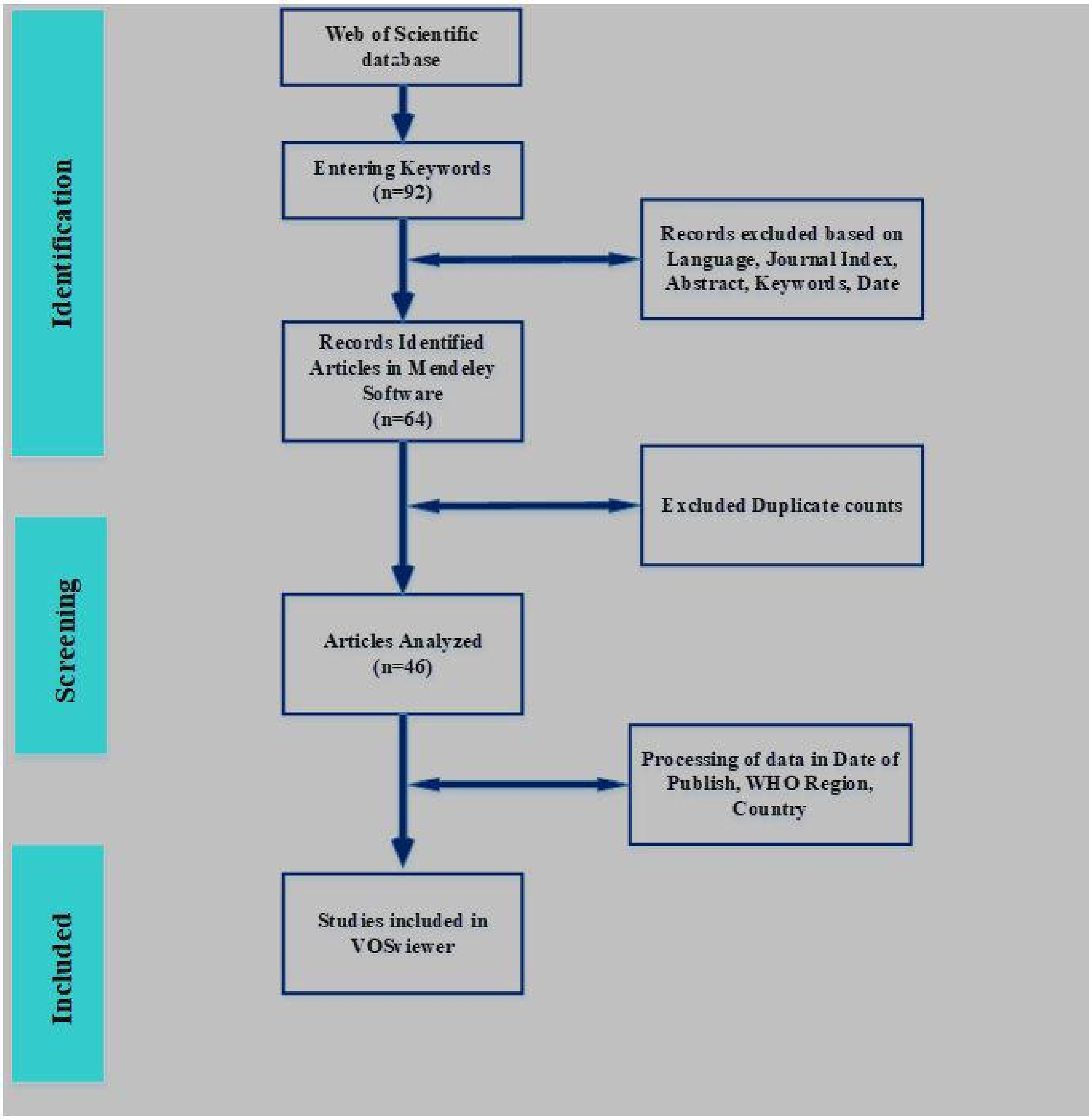


Fig. 1. Flowchart of scientometric search analysis

Search strategy

Our systematic review protocol began by searching the web of science databases. The search strategy included the keywords: "AirQ", "air pollution", "health impact assessment", "cardiovascular disease", "morbidity" and "mortality", using plural and singular variants, covering all the period of the Web databases. Fig. 1 schematically illustrates the steps of this study.

Data analyses

After articles gathering, were imported to Mendeley, exclude duplicate and screening, we found 46 articles that published from 2005-2019, and ready to analyses. RIS files from selected articles imported into VOSviewer 1.6.14 to visualization the situations.

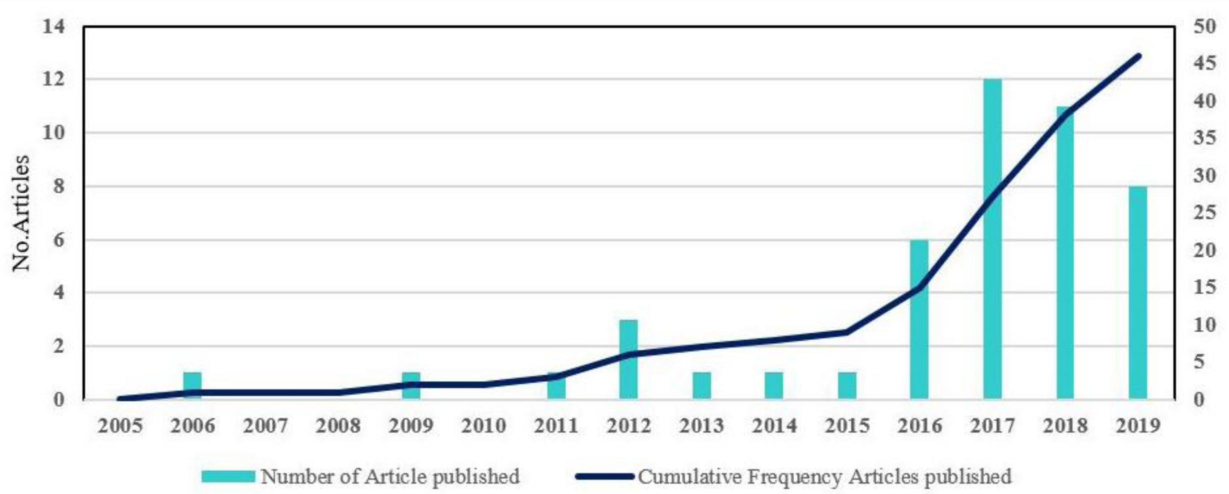


Fig. 2. Annual scientific documents published from 2005-2019

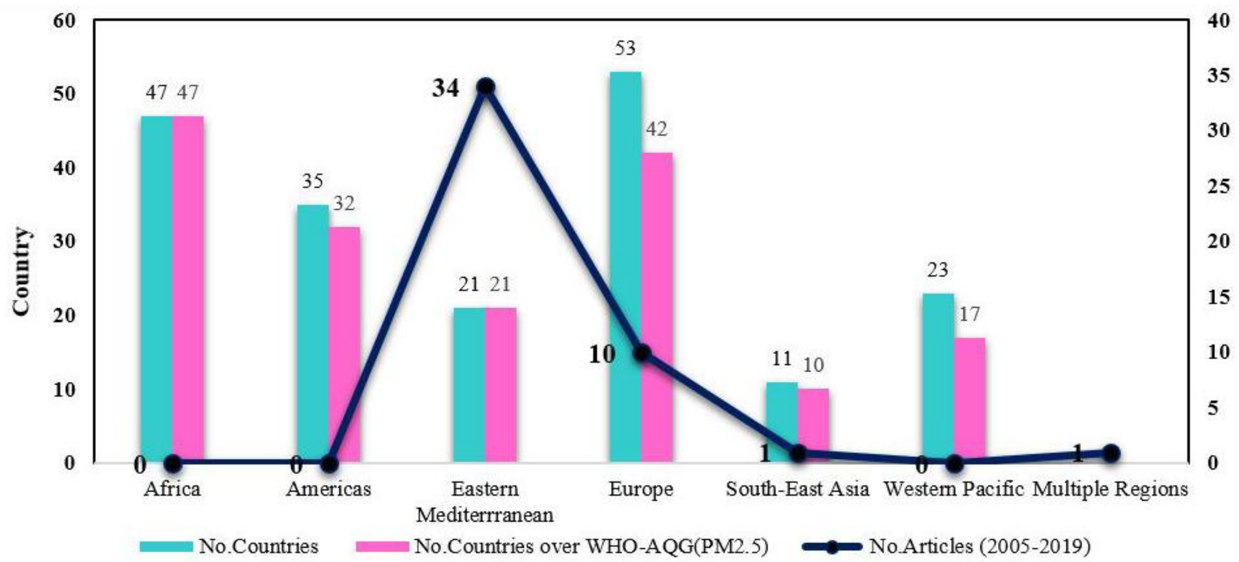


Fig. 3. Comparative number of articles by countries in WHO-regions from 2005-2019

Results and discussion

Literature growth and regional distribution

Fig. 2 summarizes the number of published range grouped by years. This figure shows the most articles published in 2017 after revising AirQ tools (AirQ2.2.3 to AirQ+). As WHO report, near 169 countries in six regions have AAP more than AQG for $PM_{2.5}$ [14]. South-East Asia region with 10 polluted countries has only one published article and Africa region with 47 polluted countries has no one too, Fig. 3. Presented most articles belongs to EMRO with 21 countries.

During the years 2005 to 2019, 46 articles have been published in 21 scientific journals, the largest number with 13 articles related to “Environmental Research Journal” and 2 articles by IF=7.943 belongs to “Environmental International Journal” have been published. (Table 1).

Table 1. Journals published articles, Impact factor (IF) and country area from 2005-2019

Journal	IF (2018)	No. Published	Country	References
Aeolian research	2.864	1	Iran	[15]
Annals of global health	NA	1	Iran	[16]
Atmospheric pollution Research	2.918	2	Iran	[17, 18]
Biomass and bioenergy	3.537	1	Estonia	[19]
Ecotoxicology and Environmental safety	4.527	2	Iran	[20, 21]
Environment international	7.943	2	Iran UK	[22, 23]
Environmental research	5.026	10	Iran Italy Kuwait Egypt	[24-32, 10]
Environmental science and pollution research	2.914	10	Iran Italy France	[33-42]
European journal of epidemiology	6.529	1	23 European cities	[43]
European journal of internal medicine	3.66	2	Iran Italy	[44, 45]
International journal occupational medicine environmental health	1.314	1	Poland	[46]
International journal of biometeorology	2.377	1	Iran	[47]
International journal of environmental health research	1.465	1	India	[48]
International journal of environmental research and public health	2.468	2	France Kuwait	[49, 50]
Iranian journal of environmental health science and engineering	2.337	1	Iran	[51]
Journal of arid environments	1.825	1	Iran	[52]
Journal of environmental health science and engineering	2.773	2	Iran	[53, 54]
Medicinia	1.467	1	Estonia	[55]
Process safety and environmental protection	4.384	2	Iran Oman	[56, 57]
Public health	1.696	1	Iran	[58]
Science of the total environment	5.589	1	Sweden	[59]

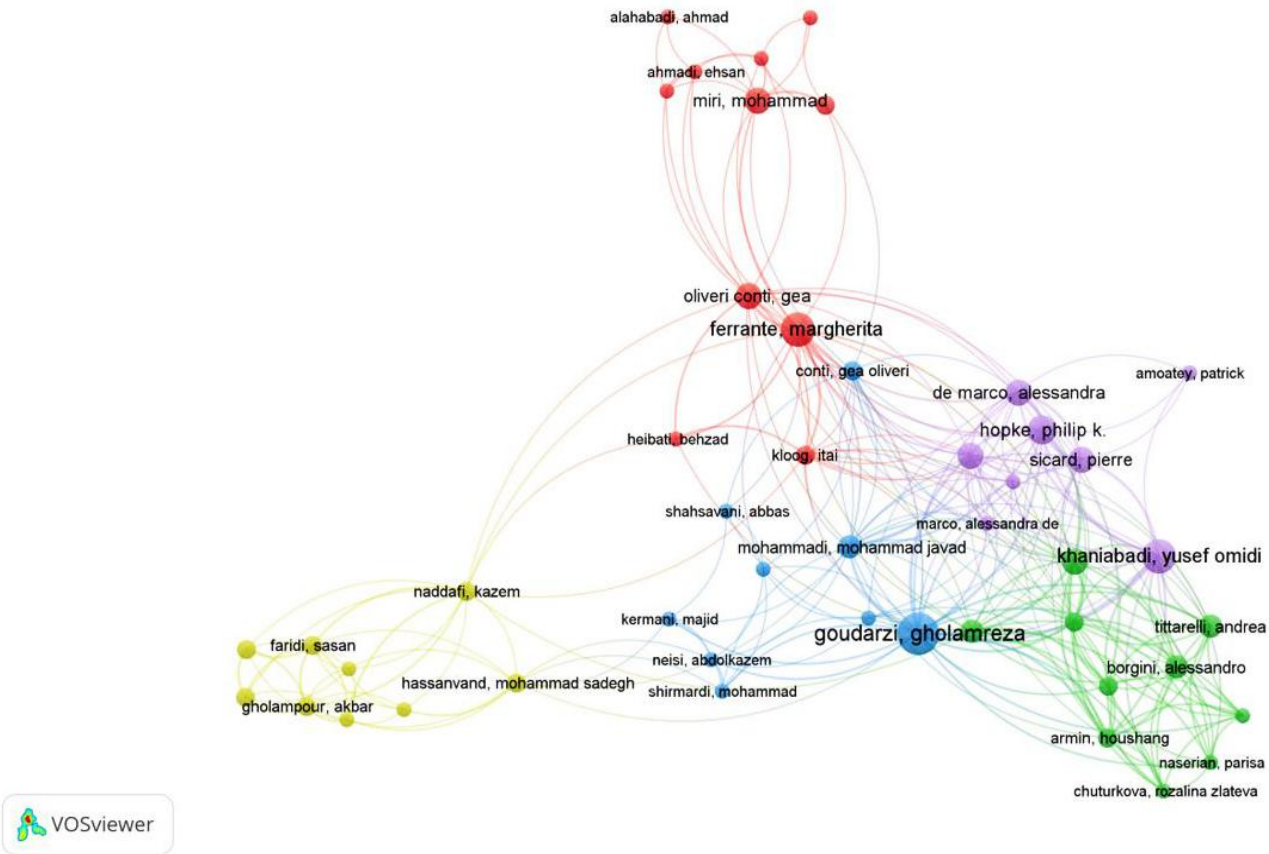


Fig. 4. International co-authorship 2005-2019

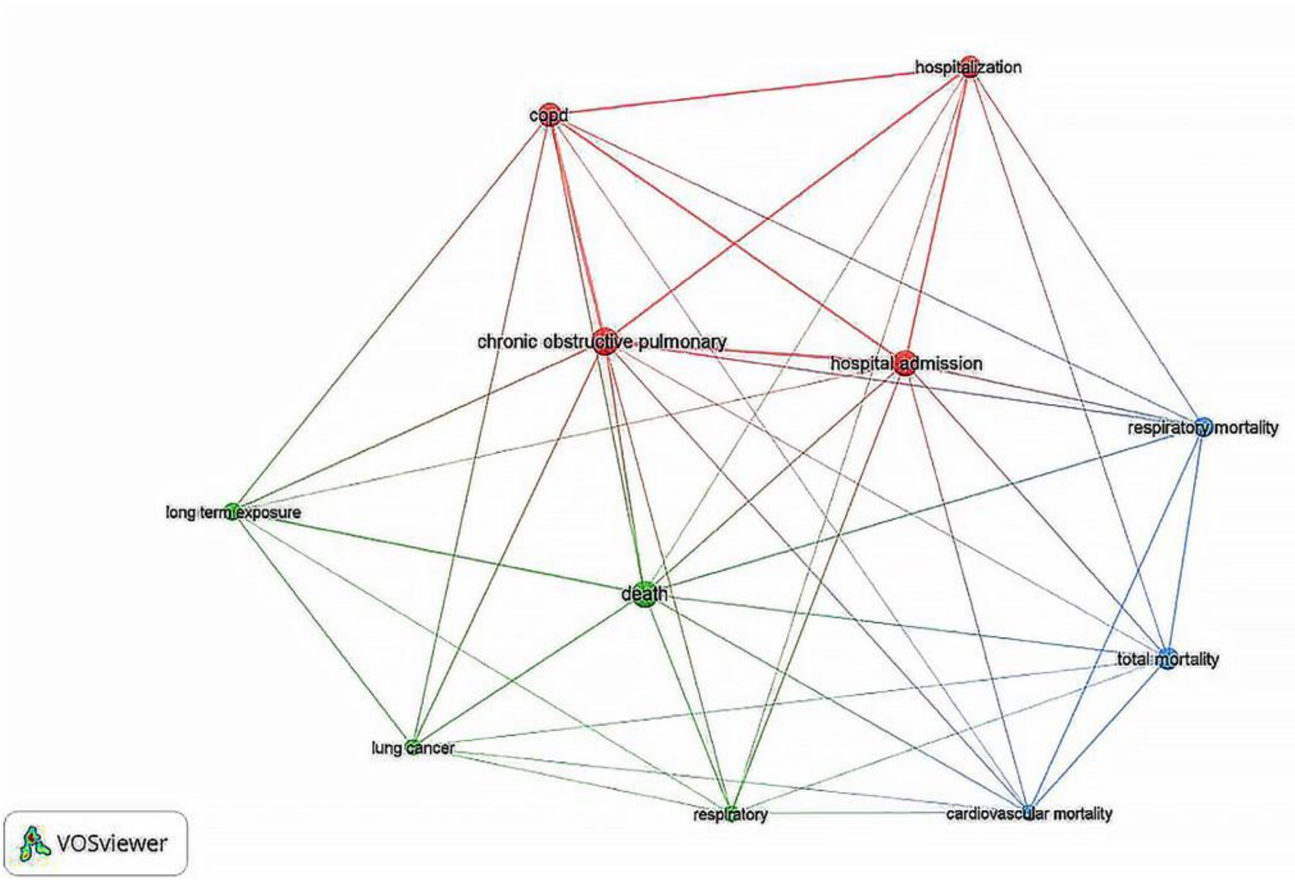


Fig. 5. Keywords co-occurrences relationship 2005-2019

Table 2. Operational status of WHO-AirQ tools (AirQ2.2.3 and AirQ+) used in studies 2005-2019

Area	Potential capacity	Utilization in studies	% Relative frequency
Air pollutant	TSP	-	0.0
	PM_{10}	✓	28.6
	$PM_{2.5}$	✓	27.6
	BS	-	0.0
	Pb	-	0.0
	NO_2	✓	18.4
	SO_2	✓	10.2
	O_3	✓	14.3
	CO	-	0.0
	BC	✓	1.0
	B[α]P	-	0.0
Mortality	Total mortality	✓	26.3
	Cardiovascular mortality	✓	18.6
	Respiratory mortality	✓	20.3
	ALRI mortality (children 0-4)	✓	5.1
	COPD mortality (adults 30+)	✓	8.5
	IHD mortality (adults 25+)	✓	6.8
	LC mortality (adults 30+)	✓	8.5
	Stroke mortality (adults 25+)	✓	5.1
	Post neonatal infant Mortality	✓	0.8
Morbidity	Bronchitis in children	-	0.0
	Bronchitis symptoms in asthmatic children (aged 5-14)	-	0.0
	Chronic bronchitis in adults	-	0.0
	CVD (including stroke)	✓	1.7
	CVD (without stroke)	✓	1.7
	Respiratory diseases	✓	36.7
	Acute Bronchitis	✓	1.7
	Congestive heart elderly	-	0.0
	COPD	✓	16.7
	Asthma attacks	✓	1.7
	Cardiovascular disease	✓	35.0
	Acute myocardial infraction	✓	5.0

Acronyms: Total Suspended Particulate matter (TSP), Particulate Matter less than 10 µm (PM_{10}), Particulate Matter less than 2.5 µm ($PM_{2.5}$), Black Soot (BS), Lead (Pb), Nitrogen dioxide (NO_2), Sulfur dioxide (SO_2), Ozone (O_3), Carbon monoxide (CO), Black Carbon (BC), Benzo [α] Pyrene (B[α]P), Acute Lower Respiratory Infections (ALRI), Chronic Obstructive Pulmonary Disease (COPD), Ischemic Heart Disease (IHD), Lung Cancer (LC), Cardiovascular Disease (CVD)

International co-authorship analysis

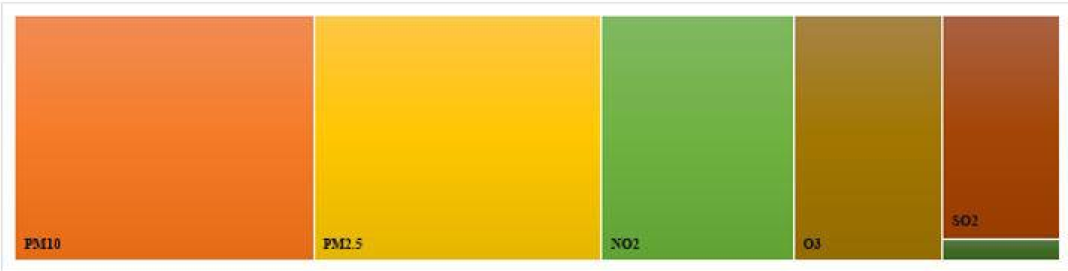
The VOSviewer visualization is shown for the co-authorship between authors for the periods 2005-2019. Map generated in 227 authors, which was limited by at least 2 number of documents for each authors. So for each of 53 selected authors, the total strength of the co-authorship links with other authors was calculated. The map includes 5 cluster of authors with strength links, violet cluster has the most citation between authors in WHO-Region countries and Goudarzi.G is the first author with 11 articles and total 68 link strength among all 227 authors (Fig. 4).

Author keyword co-occurrence analysis

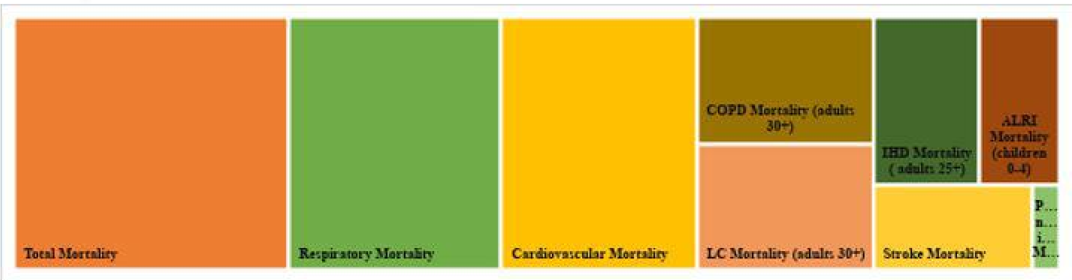
Author keywords provide an indication of the prevalence of topics addressed by research. Map generated for the 977 authors keywords in 46 articles, to keep the display interpretable, the resulting map was limited to their that occurred a minimum of 5 times. They are summarized in 3 clusters, Chronic Obstructive Pulmonary and COPD keywords have 28 occurrences (Fig. 5).

Air pollutants and health impacts

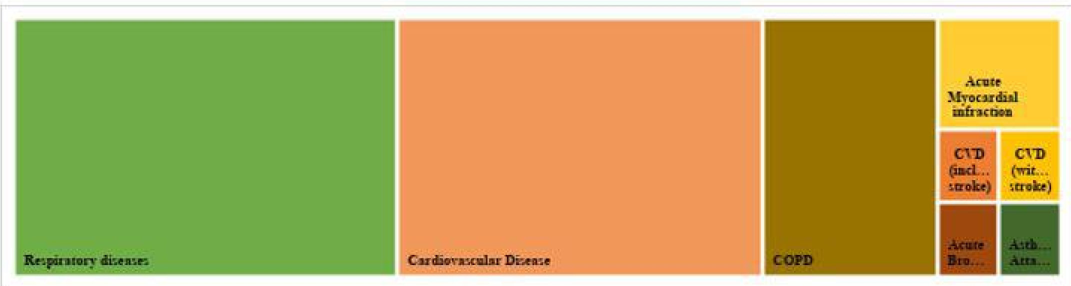
Operational status of 46 selective articles was shown some air pollutants like Benzo [α] Pyrene (B[α]P) and Lead (Pb), health impacts like Bronchitis in children and Bronchitis symptoms in asthmatic children (aged 5-14) have not been used in studies. Most of studies focus on particles (Relative Frequency Percent in PM_{10} and $PM_{2.5}$, 28.6 and 27.6), according to total mortality and hospital admission, RD and CVD are most commonly use in studies (Table 2) (Fig. 6).



a) Risk Factors



b) Mortality Impacts



c) Morbidity Impacts

Fig. 6. WHO-AirQ tool has been applied in HIA studies (in risk factor and their impacts a, b, c) 2005-2019

Disability Efforts of WHO-APHEIS program to produce and prepare the software that has been introduced by an international organization in 2005 to assess the health effects of air pollution, is admirable. AAP in both cities and rural areas was estimated to cause 4.2 million premature deaths worldwide in 2016. In this study, we expected total number of articles by using WHO-AirQ tool were higher than their extracted although 169 countries have AAP in the world. Our discussion reflects to:

• In the period from 2005 to 2019, not only cities and countries have been exposed to air pollutants emission from stationary and mobile sources, but also countries in six WHO regions have been exposed to natural phenomena that affect the air quality of cities and endanger people's health. Events such as the Icelandic island volcano in May 2010, the Chilean volcano in April 2015, droughts and dust storms affected by various parts of the world, especially in Africa and the eastern Mediterranean WHO-Regions, and widespread wildfires in Indonesia in July 2015, United States in 2015, was not considered the short-term and long term health effects of pollutants, including, TSP, PM_{10}, $PM_{2.5}$, BC, BS, NO_2, SO_2, B [α] P, by Air AirQ tool. Only eleven articles focus on dust storm in EMRO.

• According to the third report APHESIS, AirQ supported by studies and designed to influence policy makers, advisers political and researchers' states that use of scientific results based on calculations, strategy required to manage and air pollution control and maintain the health of their citizens [1]. In the 46 articles reviewed, evidence that policy interventions for urban air pollution were not observed with the help of AirQ software. Studies are limited to HIA and do not access to effects on local and regional policies of governments. These conditions can be subject to two aspects, one is that researchers did not use this software with the intention of interfering with local administrations and governments and did not use all its capacities, another is that the authors of the articles have not been able to publish the results of their studies and intervention on the policy and management of reduction air pollution in cities due to the evidence obtained from AirQ calculations.

• Children are the capital of a society and it is very important to pay attention to their health. Morbidity and mortality in this group are influence to Disability Adjusted Life Years (DALY) and EBD indicators in each country. Exposure to AAP and their aspects like Acute Lower Respiratory Infections (ALRI) Mortality (children 0-4), Bronchitis in children, and Bronchitis symptoms in asthmatic children (aged 5-14) could be estimated by AirQ, that in articles researchers didn't pay attention to them. While the output of AirQ estimation can alert policy makers and senior managers in order to show the perspective in Human and Social capital qualitative situation and these capacity in countries.

Conclusion

This study identifies and analyses 46 article published in English scientific journals between 2005-2019. As the first contribution, this research presents the classification and comparison of articles according to the operation of Air Q and the use of all its capacities.

According to the WHO report (2018) 169 countries in six regions in the face of AAP have over the AQG value. The introduction of free software by the WHO in 2005, which can estimate the human damage caused by exposure to AAP, is an effective step in determining health indicators affected by environmental factors. Accelerating to estimation effect of exposure to AP, mortality and morbidity in compare with field studies that need to longtime and expensive is very important. So, it was expected that its use in developing and less developed countries, which are facing difficulties in allocating appropriate financial resources and researches for studies, they were been used more for intervention plans and policies to reduce air pollution and improve public health. We have shown that AirQ use for estimation HIA in countries and mainly applied for particulate matter and revolves around total mortality and respiratory disease in adults. It seems that due to the small number of articles compared to the number of countries with air pollution:

1) There is no interest in using this tool.

2) The application and comprehensive training in the use of this tool by relevant organizations and institutions in the six regions of the WHO has not been comprehensive since 2005.

3) The basic information required to use the software is not accessible to users.

4) Reporting and interpreting the results of studies conducted is not as acceptable as validated scientific journals.

5) According to the little studies, it seems they have not been cited by researchers and scientific journals and reviewers.

During the study, however we had some limitations in this study to be solved in future work: expand the web of science databases, detect all articles in other languages. We are suggested that future studies focus on the reason of less applied this tool in WHO six regions especially in Training and education, technical expert knowledge's, and lack of infrastructure in AP monitoring and health care system that limits the use of this tool.

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This study did not receive any supporting funds from any financial resource.

Competing interests

The Authors declare that there is no conflict of interest.

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Ethical considerations

Ethical issues (including plagiarism, informed consent, misconduct, data fabrication and / falsification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors.

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