(REVIEW ARTICLE)

A bibliometrics of air pollution studies in Bangladesh from 1995-2020

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Abstract

This study aims to analyze the air pollution studies published online from 1995-2020 in Bangladesh. The data of research publications on "air pollution" from the online database were collected with the following search strategy: publications with terms "air pollution," "air pollutants," "concentration of particulate matter/aerosol," or "effects on human health," "sources of air pollutants" gaseous air pollutants," and "heavy metals in the air" in their titles for the period of 1995-2020 were collected. The study summarized the characteristics of published documents, the contents and number of citations, and most profiles of authors. This study is based on research on air pollution exposure from relevant sources, such as peer-reviewed articles, proceedings, and national and international reports. In this study, a total of 143 scientific documents were found online. The first publication on air pollution in Bangladesh was revealed in 1995, while the highest number of publications was published in 2019. The years 2018, 2019, and 20 showed a rapid increase in the number of articles published; 15, 19, 16, and 638, respectively. The articles published in the year 2004 received a more significant number of citations (294). In this study, the offline publication has not been counted, and the study covers only the online publication.

Keywords: Air Pollution; Bangladesh; Bibliometric analysis; Particulate matter; Review

1. Introduction

Air pollution is a crucial environmental issue due to its detrimental effects on human health [2, 45]. Air pollution has risen to such a level which was never experienced before. Bangladesh has gotten the 1st position in terms of $PM_{2.5}$ concentration in (2021) report. It is estimated that globally, 92% of the world's population breathes toxic air [30, 60]. The level of air pollution in developing countries is higher than in developed countries [37]. Air pollution is defined as an atmospheric condition in which substances (air pollutants) are present at concentrations higher than their normal ambient (clean atmosphere) levels to produce measurable adverse effects on humans, animals, vegetation, or materials [54]. Rapid urbanization, vehicle emission, industrialization, brick kilns, biomass burning, transboundary air pollution, etc., are responsible sources of indoor and ambient air pollution [14, 22, 39, 51]. On account of combustion of Sulphur containing fuels, such as coal and crude oils, is a key anthropogenic source of SO_2 emissions; CO, $PM_{2.5}$ directly emitted during incomplete combustion processes with high-temperature conditions from power stations, biomass burning, vehicular and agricultural activity; coarse particles ($PM_{2.5-10}$) coming from wind-blown, grindings, re-suspended road; leaded gasoline used to be main sources of lead emission; airborne viruses, bacteria, protozoa, pollen grains, different propagules and vegetative cells of algae, fungi, lichens, bryophytes, and pteridophytes are consistent in the air [1, 25, 46, 51, 57, 58]. Sources of Particulate matter ($PM_{2.5-10}$) include brick kilns, soil dust, road dust, motor vehicle, metal smelter, fugitive Pb, Zn sources, and sea salt sources [26]. The study found that, among the sources, more than 62% of the $PM_{2.5-10}$ was soil and road dust in Rajshahi, Chattogram and Khulna sites but in Dhaka, the dust contribution was about 38%, and for fine particles ($PM_{2.5}$), the identified sources are similar to those for the coarse particle samples, but their contributions are different. Various studies found that more than 63% of the fine particle mass comes from

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anthropogenic sources such as brick kilns, wood-burning, biomass burning, and motor vehicles, and the contribution of mass, as well as black carbon and delta-C from the motor vehicles, is much less than from brick kilns or biomass burning sources. Some study shows that $PM_{2.5}$ concentrations are increasing in the number of brick kilns [39, 46]. Nayeem et. al. [39] found that in 2006, 2010, and 2018, the number of brick kilns was 307, 497, and 551, respectively, in three Upazila of Dhaka City. Air Pollution has tremendous and various effects on the human body, climate change materials, plants, and animals [2, 26, 31, 57]. Some study found an association between air pollution and diseases such as premature deaths, stroke, heart disease, coughing, eye irritation, headaches, and kidney damage [2, 6, 59]. Developing countries like Bangladesh suffer $PM_{2.5}$ exposures that are four to five times more than developed countries, and worldwide, air pollution is the fourth risk factor for mortality [28, 57]. Aktar and Shimada [5] estimated that a 0.65% (95% confidence interval of 0.62 to 0.68%) change in all cause's mortality is associated with a 10 mg/m^3 change in PM_{10}. Air pollution can cause high respiratory disease [35]. Respiratory problems were found more in households with an increased concentration of pollutants in the indoor air [40]. It reduces the Forced Vital Capacity (FVC), Forced Expiratory Volume in one second (FEV 1), FEV 1/FVC%, and Peak Expiratory Flow Rate (PEFR) of people, especially children [4]. Vehicle emission causes Chronic Obstructive Pulmonary Disease (COPD) (which is a type of obstructive lung disease characterized by long-term breathing problems and poor airflow) in traffic police officers as they are exposed for a long time [2]. Due to air pollution, respiratory problems among school children in Dhaka cities have been found [59]. One of the most difficult problems is irritation of the eyes, coughing, sneezing, high fever, asthma, and headache [6, 57]. Heavy metals cause severe diseases such as lung cancer, asthma, bronchitis, tuberculosis, kidney damage, high blood pressure, birth defects, etc., because of long persistence in nature and bioaccumulation in the food chain [16, 43]. On the other hand, Particulate matter affects the cognitive function of children by changing the brain structure, Blood Lead levels due to heavy metals reduce child brain development [59]. Maternal exposure to exceeding levels of particulate matter in the air can cause a low birth weight of the child and raises the chances of preterm birth and often stillbirths. Moreover, a positive correlation was found between particulate matter pollution and peak flow decrements in children with asthma symptoms, particularly those who are asthmatic that those with non-symptomatic children [19]. Conversely, brick kilns workers are more vulnerable due to heavy metals and PM pollution [16, 36]. Trace metals such as Fe, Ca, K, Ti, Zn, Pb, Sr, Rb, Cu, As, Cr, Ni, etc., are also carcinogenic and seriously impact children's nervous systems [33, 59]. To envisage a brighter tomorrow, we must solve the issue of air pollution. To reduce the severity of air pollution, which is increasing beyond acceptable levels, numerous efforts have been made globally on a personal, industrial, and governmental basis [12, 19]. The study has collected several research papers and reports on air pollution and the biosphere's effects from 1995-2020. Analyzing scientific research from online publications yields the knowledge structure on air pollution. Collection and formulation of subject category analysis, keyword analysis, the top ten cited papers, the most cited authors, the top ten most cited articles' citations, and the top publications from 1995 to 2020 [32]. Researchers and decision-makers may find it useful to evaluate the knowledge structure of air pollution research to gain insight into the field's most recent trends and state to make more informed choices and develop fresh research ideas.

2. Methodology

This study is based on a bibliometric analysis of air pollution exposure from pertinent sources such as peer-reviewed articles, university reports, etc. The data of research publications on "air pollution" search by following the search strategy: publications with terms "concentration of particulate matter/aerosol in Bangladesh," "air pollution and human health in Bangladesh", "concentration of gaseous pollutants in Bangladesh," "pollute the air in Dhaka city" ,"pollutants of air", "trace metal in the air of Bangladesh", "heavy metal in the air in Dhaka", "air pollution and respiratory disease", "air pollutant effects on plants", "air pollutants effects on children health", "indoor air pollution and women health", "air pollutant and economy" and "air pollution effects on the environment" for the period of 1995-2020 were collected. Studies were collected from worldwide accepted sources, including Science Direct, Publons, ISI, Elsevier, Web of Science, Springer Link, and other national libraries such as Bangla JOL, Department of Environment, Bangladesh Bureau of Statistics, Ministry of Health, International Center for Diarrheal Disease Research, Bangladesh (ICDDRB), Bangladesh Atomic Energy and Commission (BAEC), Dhaka Transport Coordination Authority (DTCA) and international libraries such as Asian Development Bank, Global Air, Clean Air Asia, Norwegian Institute for Air Research, School of Environmental Science Murdoch University, Australia, Stockholm Environment Institute (SEI), Sweden, World Health Organization (WHO), World Bank, IQAir, and Heath Effects institute. All of the studies were screened via abstracts to determine whether the study was relevant to air pollution. Considered studies included a good description of sources of ambient and indoor air pollution, impacts on humans and other living organisms of air pollution, the economic impact of air pollution, the environmental impact of air pollution, and the controlling methods of air pollution. After sorting out the related abstracts, full-text articles, reports, and thesis were assessed to identify studies fully or partially related to the study's objectives. Selected papers after abstracts were screened and excluded for not being appropriate with the objectives. The retrieved article considers those related to the source, monitor, impact, and control of air pollution. A total of 143 articles were selected for the review, and the data were used to create a database in SPSS and Microsoft

Excel for analysis purposes. Results are shown by graph chart and table. A review of the publications was made during 1995–2020, which are only available online.

3. Results and discussion

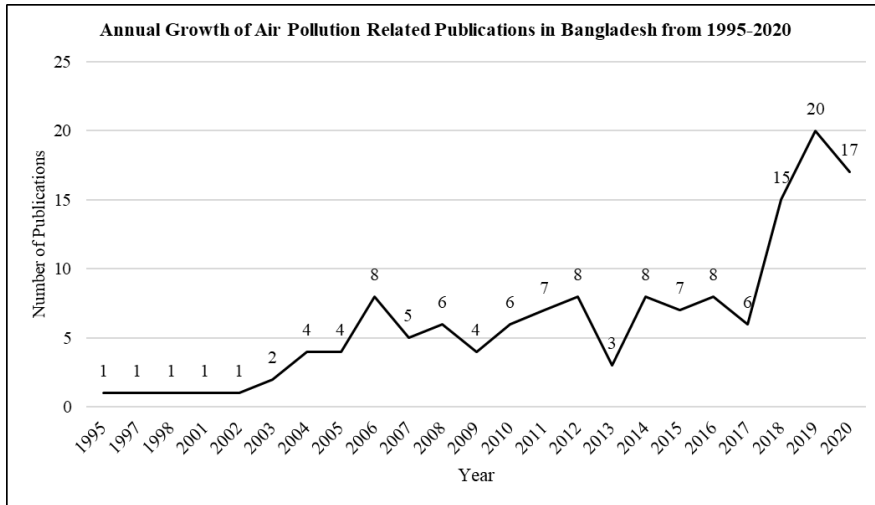### 3.1. Annual Growth of Publications

Figure 1 Annual Growth of Air Pollution Related Publications in Bangladesh from 1995-2020 and 2014. However, the highest number of publications has been revealed in 2019

Figure 1 shows Bangladesh's annual growth of air pollution-related publications from 1995-2020. The total number of published articles is 143, whereas the first publication on air pollution was revealed in 1995. The highest publication takes place in the year 2019, with 20 publications. Therefore, from 2003, publications on air pollution fluctuated a lot, dropped in 2013 and increased in 2018. It has also been noticed that a similar number of publications was revealed in the years 2006, 2012, 2014, and 2016 which is 8.

3.2. Data Type

Figure 2 explained the data type of retrieved publications from 1995-2020. Among total amount of retrieved publications, 73 publications (51%) are based on primary data, 55 publications (38.5%) are based on secondary data, 8 publications (5.6%) are based on review data and 7 publications (4.9%) study on both primary and secondary data. It means most of the retrieved publications use preliminary data in their studies. Researchers have used instruments or questionnaires to collect their data.
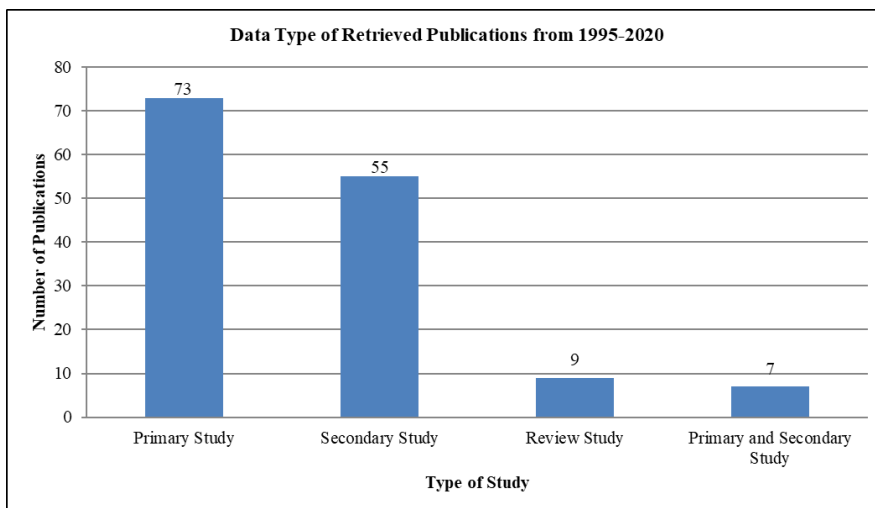

Figure 2 Data Type of Retrieved Publications from 1995-2020

3.3. Sector Wise Study

Figure-3 illustrate that 78% (111 no) publications retrieved publications on ambient air pollution. On the other hand, only 8% (11) retrieved publications based on indoor air pollution. Last one, 9%, (13) publications retrieved publications covered the health impact of air pollution on human health.
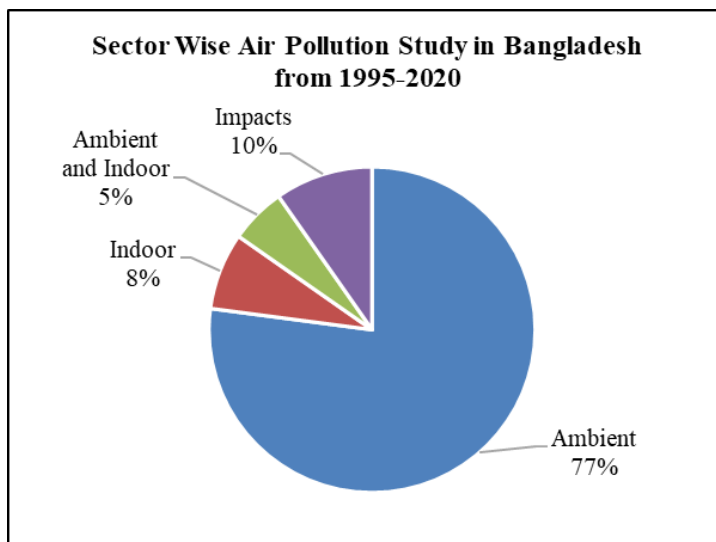
Figure 3 Sector Wise Air Pollution Study in Bangladesh from 1995-2020

3.4. Medium of Publication

The provided figure 4 demonstrate the medium of publication study found in last 25 years span. This study has considered three types of publications; Journals, reports, and proceedings. Here, most retrieved publications were published in the journal, 73% (104 publications) of the full publication. 6% (9 publications) articles are published as proceedings while 21% (30 reports) are report which different organizations publish.
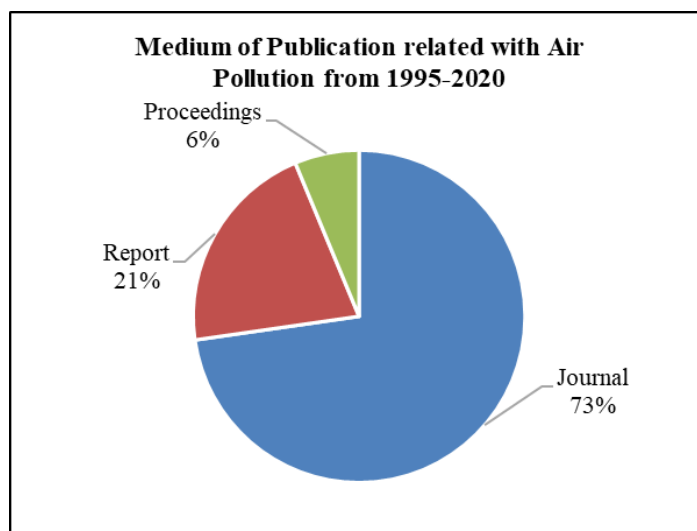
Figure 4 Medium of Publication related with Air Pollution from 1995-2020

3.5. Keywords of Publications

Some common keywords found are particulate matter/aerosol, which affects human health, particulate matter and gaseous, management and policy, heavy metals, gaseous, trace elements, microbial, and effects on plants. Analysis of keywords in publications showed that the most frequently encountered keywords were: particulate matter/aerosol 54 times, effects on human health 25 times, and Particulate matter and Gaseous 29 times (Table-1). In terms of its severe health impacts, it is considered a major pollutant, while many epidemic types of research have interlinked airborne

particles with a variety of health disorders [4, 52]. It has been found significant association between inhalable particles and mortality and morbidity rates [21]. PM$_{2.5}$ has effects on respiratory, cardiovascular, nervous and renal system that cause persistent cough, asthma, nasal blockage, respiratory infections, hypertension, eye irritation, drowsiness, headaches, and renal damage [2, 53, 57], and eventually, in increasing number of premature deaths [52]. Air pollution is also responsible for some fatal diseases such as cancer and heart attack [46]. Jargis et. al. [31] also showed that PM has effects on leaf also. Particulates may generate from a diversity of sources, such as industrial processes, brick kilns, power plants, transports, biomass, fossil fuel burning, wind-blown dust, and sea spray, and also, they are formed in the atmosphere by the transformation of gaseous emissions [39].

Table 1 Keywords Based Publications of Air Pollution in Bangladesh from 1995-2020

Keywords	Frequency	Percent
Particulate Matter/Aerosol	54	37.8
PM and Heavy metals	6	4.2
Gaseous	7	4.9
Trace Elements	3	2.1
Heavy Metals	5	3.5
Microbial	2	1.4
Effects on Human Health	25	17.5
Effects on Plants	1	.7
Management/Policy	11	7.7
PM and Gaseous	29	20.3
Total	143	100%

These particles' chemical and physical compositions depend on the emission sources' characteristics, time of year, area, and superintendent weather conditions. Particulate Size fraction ranges, PM$_{10}$ fraction ranges from 0 to 10 μm, and PM$_{2.5}$ size fraction ranges from 0 to 2.5 μm [25]. Burning of diesel and compressed natural gas emit particulate matter consisting of fine particle (PM$_{2.5}$) with a high number of ultrafine particles. These inhalable particles with large surface areas can cause acute eye or throat irritation [6].

3.5.1. Study Area of Publications

Table 2 Geographical Location of Published Research on Air Pollution in Bangladesh from 1995-2020

Area	Frequency	Percent
Overall Bangladesh	41	28.7
Barisal	1	0.7
Bhola	1	0.7
Chittagong	8	5.6
Dhaka	89	62.2
Kushtia	1	0.7
Munshiganj	1	0.7
Pabna	1	0.7
Total	143	100.0

Table 2 and Fig-5 shows the geographical distribution of published article on air pollution in Bangladesh from 1995-2020. Retrieved publications that we have collected; among them, 63% of research has been done on Dhaka district,

where 28.7% of research has been conducted on Bangladesh overall; fewer types of research are on another section which is only 9.1%.
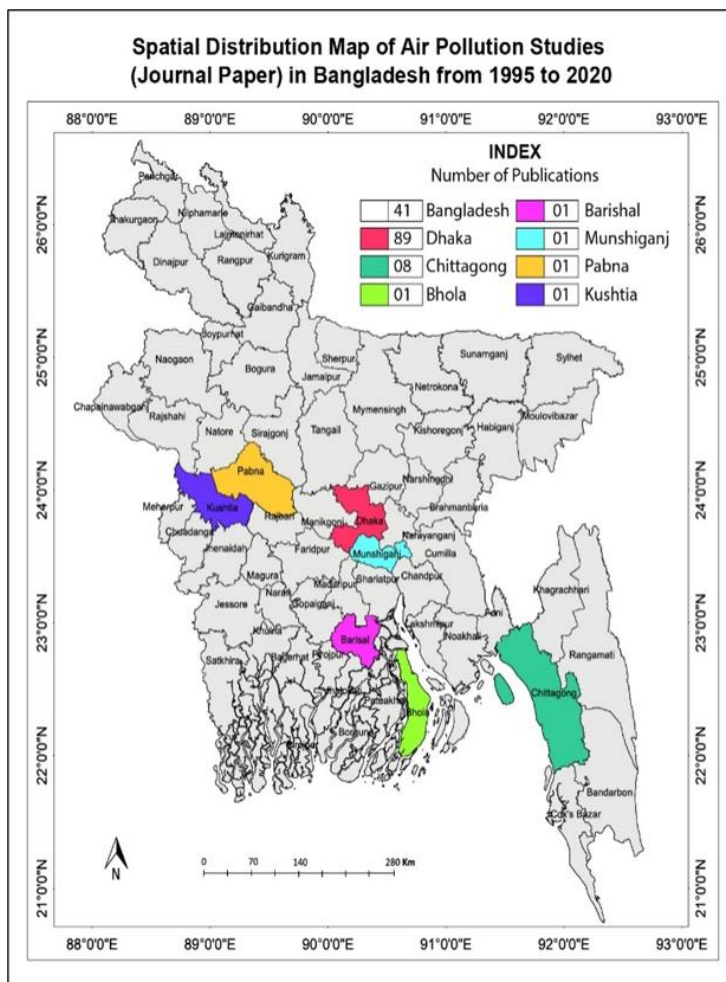

Figure 5 Spatial Distribution of Air Pollution Studies (Journal Paper) in Bangladesh from 1995-2020

3.6. Highly Cited Documents

Table 3 Top 10 Cited Papers on Air Pollution in Bangladesh from 1995-2020

Rank	Title	Frequency of Citation	References
1	Investigation of sources of atmospheric aerosol at urban and semi-urban areas in Bangladesh.	295	Begum *et al.*, 2004
2	Indoor Air Quality for Poor Families: New Evidence from Bangladesh.	228	Dasgupta *et al.*, 2006
3	Aerosol chemical characteristics of a mega-city in Southeast Asia (Dhaka–Bangladesh).	196	Salam *et al.*, 2003
4	Blood Lead Levels of Primary School Children in Dhaka, Bangladesh.	120	Kaiser *et a*l., 2001
5	Who suffers from indoor air pollution? Evidence from Bangladesh.	103	Dasgupta *et al.*, 2006
6	Identification of Sources of Fine and Coarse Particulate Matter in Dhaka, Bangladesh.	95	Begum *et al.*, 2010

7	Investigation of Sources of Atmospheric Aerosol at a Hot Spot Area in Dhaka, Bangladesh.	91	Begum *et al.*, 2005
8	Key issues in controlling air pollutants in Dhaka, Bangladesh.	90	Begum *et al.*, 2011
9	Impact of Unleaded Gasoline Introduction on the Concentration of Lead in the Air of Dhaka, Bangladesh.	87	Biswas *et al.*, 2003
10	Temporal variations and spatial distribution of ambient $PM_{2.2}$ and PM_{10} concentrations in Dhaka, Bangladesh.	74	Begum *et al.*, 2006

Ten top-cited articles from 1995-2020 are presented in Table 3. The top cited documents in the field was about the sources of ambient air pollution, lead pollution and its health impact on children's health, indoor air pollution and its effects, sources of fine and coarse Particulate Matter in Dhaka City, and ambient $PM_{2.2}$ and PM_{10} concentrations in Dhaka. A total of 1499 citations were received by the top ten articles, out of which, five received more than 100 citations. The article that received the highest number of citations (295) was published in 2004 in Journal of Atmospheric Environment; the research identifies the sources of atmospheric aerosol (fine and coarse particulate matter) in semi-residential (AECD) area of Dhaka and an urban area of Rajshahi.

3.7. Authorship Analysis

This study reviewed 104 articles written by 290 authors. Among them, Table-4 shows the top 5 authors' names, the most prioritized authors in the air pollution field of Bangladesh. Dr. Bilkis Ara Begum has the highest number of articles (27). Swapan K. Biswas and Prof. Dr. Philip K. Hopke have the 2nd and 3rd highest publications, respectively. Mention that these three toppers are co-author of each other for publishing articles.

Table 4 Top 5 Authors Who Are the Contributors of Documents on Air Pollution in Bangladesh from 1995-2020

S.N.	Author Name	Designation and Institute	Number of Article
1	Dr. Bilkis Ara Begum	Director & CSO, Bangladesh Atomic Energy Center	27
2	Swapan K. Biswas	Chief Scientific Officer (Retired), Bangladesh Atomic Energy Center	20
3	Dr. Philip K. Hopke	Professor Emeritus, Clarkson University, New York.	16
4	Dr. Abdus Salam	Professor, University of Dhaka	15
5	Dr. Ahmad Kamruzzaman Majumder	Director, Center for Atmospheric Pollution Studies & Professor, Stamford University Bangladesh	10

Prof. Dr. Abdus Salam has 15 articles in this field followed by Prof. Dr. Ahmad Kamruzzaman Majumder who has 10 articles. Bilkis Ara Begum, Swapan K. Biswas and Prof. Dr. Philip K. Hopke have been doing more research using primary data, and have also used secondary data at times; some of their work is also about the health risks due to air pollution. Dr. Abdus Salam have done most of research using primary data, he has measured the concentration of particulate matter, trace metal, heavy metals, organic and inorganic ions. He also did research on Air pollution tolerance index (APTI) of mango trees which was also based on primary data. Prof. Dr. Ahmad Kamruzzaman Majumder has done his research works mostly based on primary data, and he also used secondary and review data in his research purpose. He identifies the sources of air pollution, brick kilns status in Dhaka city, microbial presence in air pollutant, impact on human health etc.

4. Major Findings from Reviewed Air Pollution Studies

4.1. Sources and Concentration of Air Pollution in Bangladesh

Air pollution has some primary sources (brickfields, cement industry, rock crushers, motor vehicles, and open burning) and secondary sources (road dust, airborne soil from agricultural fields, trans-boundary) [3, 23]. Brick kilns and motor vehicles are the most responsible sources for air pollution in different cities, produced CO, SO_2, NO_X, O_3, HC, PM, fluoride compounds [39, 47]. Emissions from the brick kiln are the major contributors to air pollution in Dhaka especially in the dry seasons, while the contribution from emissions from metal smelters increases during rainy seasons [12, 22]. In Dhaka, both local (mostly from vehicular emissions) and some regional emission sources are responsible for high $PM_{2.2}$

and BC. According to DoE, 2019 fine particles ($PM_{2.5}$) in dry season usually dominate in the contributions to PM concentrations all the time of the day except in the evening, when the coarse particles (PM_{10} and $PM_{2.5}$) are found to be equal to or sometimes greater than the fine particles. $PM_{2.2}$, $PM_{2.2-10}$, and Black Carbon (BC) concentration levels depend on meteorological characteristics like-precipitation, wind direction, and wind speed. It has a strong relationship with meteorological characteristics [20, 48]. Transport related emissions are a major source of BC and biomass burning could be another substantial source of BC on the other side long-range transportation from fossil fuel-related sources are also a responsible source of BC. $PM_{2.5}$ concentrations in mixed and motorized areas were on average higher than the non-motorized and vehicle-free areas [23]. Except for the rainy season, the value of Particulate Matter in the air is higher than that of the Threshold Limit Value (TLV) recommended by the World Health Organization (WHO), Environmental Protection Agency (EPA), USA and Air Quality Standards (AQS), Bangladesh [22, 42]. Most of the time, $PM_{2.5}$ is approximately twice that of WHO and USEPA [22, 27]. Average pollution concentrations of the Metropolitan area in Dhaka exceed National Ambient Air Quality Standards (NAAQS) except in monsoon; the average concentrations of particulate matter ($PM_{2.5}$ and PM_{10}) in the three monitoring sites exceeded the relatively lax Bangladesh National Ambient Air Quality Standards (150 µg/m³ for PM_{10} and 65 µg/m³ for $PM_{2.5}$) in all seasons [42]. Similarly, heavy metal concentration also exceeds the standard value in different cities of Bangladesh [24]. Some studies identify that anthropogenic sources, especially industrial activity, vehicular emission, and household cooking, are the main sources of trace elements in the ambient and indoor air. Khan et al., [33] found trace metals such as Fe, Ca, K, Ti, Zn, Pb, Sr, Rb, Cu, Cr, Ni, etc., in indoor and ambient air of industrial areas. We found that the overall trace metal concentrations in Dhaka are higher than those in Europe (e.g., Spain, Norway) and East Asian (e.g., Taiwan) locations [51]. The concentration of PM in Dhaka city is very high; the mean $PM_{2.5}$ from 2002 to 2010 ranges from 62.75 to 89.5 µg/m³ and the mean PM_{10} ranged from 110.66 to 147.34 µg/m³ from 2002 to 2010 [38]. There is a relationship between the number of increasing brick kilns with $PM_{2.5}$ concentrations; the number of brick kilns in Dhamrai, Savar, and Keraniganj increased to 307, 497, and 551 in 2006, 2010, and 2018, respectively. Besides, the annual average of $PM_{2.5}$ concentrations in Dhamrai sub-district was 58.6, 58.9, and 64.8 µg/m³, while 58.6, 58.2, and 64.5 µg/m³ in Savar and 57.7, 56.7 and 63.1 µg/m³ in Keraniganj in 2006, 2010 and 2016, respectively. $PM_{2.5}$ concentration was almost three to four times higher than the Bangladesh National Ambient Air Quality Standard (BNAAQS) and World Health Organization (WHO) standards. In Pabna, Particulate matter such as 0.3µm, 0.5µm, 1µm, 3µm, and 5µm measured in some areas where Library Bazar, Gachpara Crossing, Traffic Mor, Ononto Mor, Main Bus Terminal $PM_{0.3}$ were found 107669, 580343, 501856, 255411 and 748091 Count/m³. On the other hand, Library Bazar, Gachpara Crossing, Traffic Mor, Ononto Mor, Main Bus Terminal PM_3 were found 290, 191, 159, 106, 686 Count/m³. It means that the quality of Pabna Air is also not good. In Dhaka, the average concentration of NOx, O_3, and SOx with eight hours of sampling was measured at 82.8, 22.5, and 25.5 µg/m³, respectively, higher than the WHO guideline values [41].

4.2. Impacts of Air Pollution in Bangladesh

There is a positive correlation between air pollution and health effects [5, 55]. According to HEI (2018), indoor and ambient air pollution led to 1.23 lakh deaths in Bangladesh in 2017. Air pollution can cause high respiratory diseases [35]. Respiratory problems were found more in households with an increased concentration of pollutants in the indoor air [40]. It reduces the FVC, FEV 1, FEV 1 / FVC%, and PEFR of people, especially children [4]. Vehicle emission causes Chronic Obstructive Pulmonary Disease (COPD) (which is a type of obstructive lung disease characterized by long-term breathing problems and poor airflow) in traffic policemen as they are exposed for a long time [2]. Due to air pollution, respiratory problems among school children in Dhaka city have been found [59]. The major problems caused are irritation of the eyes, coughing, sneezing, high fever, asthma, and headache [6, 57]. Heavy metals result in severe diseases like lung cancer, asthma, bronchitis, tuberculosis, kidney damage, high blood pressure, birth defects, etc., due to long persistence in nature and bioaccumulation in the food chain [16, 44, 56]. On the contrary, particulate matter affects children's cognitive function by changing the brain structure; blood lead levels due to heavy metals reduce child brain development [59]. Maternal exposure to exceeding levels of particulate matter in the air can cause a low birth weight of the child and raises the chances of preterm birth and often stillbirths. A stronger association was found between particle pollution and peak flow decrements in children with asthma symptoms, particularly asthmatic children, than non-symptomatic children [19]. On the other hand, brick Kilns workers are more vulnerable due to heavy metals and PM pollution [8, 36]. Trace metals such as Fe, Ca, K, Ti, Zn, Pb, Sr, Rb, Cu, As, Cr, Ni, etc., are also carcinogenic [33]. Some microflora presented in the polluted air, such as- *Aspergillus spp., Penicillium spp. Alternaria spp.*, *Curvularia spp.*, *Fusarium spp.*, *Rhizopus spp.*, and *Trichoderma* are pathogenic to plants and/or humans and strongly allergenic to human being [58]. Increasing air pollution has stress on plants, the plants become sensitive if the APTI value is smaller than or equal to 12 (APTI ≤ 12). Plants had the highest sensitivity towards pollutants during winter; average APTI values also varied depending on the locations and plant species. From the observation from the study, we can say that plants are highly sensitive towards pollution [49].

4.3. Law and Policy Control

Bangladesh Govt. makes some laws and regulations for preventing Air pollution, by often taking some historical steps to control air pollution. In Bangladesh, Bangladesh Environment Conservation Act 1995, makes laws against the vehicle, sub-section (1) of section 6 has restrictions on vehicles emitting smoke which is injurious to environment, another one is (1) A vehicle emitting smoke or gas injurious to health or environment shall not be operated, nor shall such vehicles be switched on except for the purpose of test operation for stopping the emission of such smoke or gas [60]. After that, two stock engine vehicles named baby Taxi were banned and government banned leaded fuel at the end of 2002 to control air pollution. These steps have proven to be very effective for controlling air pollution in Dhaka city [61]. As Brick kilns are another major source of air pollution, the government formulate Brick Manufacturing and Kiln Establishment (Control) Act, 2013 in 2013. That makes a restriction on placing Brick kilns, in the provisions of Section 4, if the brickfield produces brick in brick kilns without obtaining a license from the district administrator. He is not imprisoned for more than one year (one year) or more than one (one) shall be punished with a fine extending to one thousand takas or both [62]. BNAAQ set annual and hourly standards for air pollutants where it considered Carbon monoxide (CO), Lead (Pb), Sulfur dioxide (SO_2), Nitrogen dioxides (NO_2), Ozone (O_3), $PM_{2.5,}$ and $PM_{10.}$ Then the Ministry of Environment, Forestry, and Climate Change, with the assistance of the World Bank have taken the Clean Air and Sustainable Environment (CASE) project to address the issue of urban air pollution and manage air pollution in Bangladesh [20]. It is not possible to reduce or prevent air pollution without the involvement or awareness of people. It is really important that people are known and aware of reducing air pollution.

5. Conclusion

The annual growth of publications in Bangladesh significantly rose in the span of 25 years. If we divide these 25 years, we can see that the first 12 years of publications stood at only 28 out of the total 143 publications; hence, 115 revealed publications occurred during the last 13 years. Most of the publications were based on primary data which is 51% of the retrieved article. The number of journal articles, proceedings, and reports was 72.2% (104), 21.0% (30), and 6.3% (9) of the total publication, respectively. The most frequently encountered keywords were particulate matter/aerosol 54 times, followed by effects on human health 25 times. The present study also revealed that among 143 articles, 62.2% are based in Dhaka city. Most of the study is based on urban areas. Hence, conducting more air pollution studies in semi-urban and rural areas is necessary. The study found that more than 1200 citations came from research published between 2001 and 2006. Even though there has been a rise in publications in recent years, it is still not enough, as pollution in Bangladesh is still rising more than ever. Nevertheless, the primary publication is still required more because of the constant deterioration of the air quality in recent years. However, more research should be done on the impacts of air pollution on human health. Additionally, indoor air pollution research should be prioritized because the rise of urban areas and buildings affects the natural environment and reduces trees. Therefore, there is always a high probability of air pollution from construction areas, roadside, etc., entering homes, offices, or shopping malls. From the geographical point of view, research on other parts of Bangladesh besides Dhaka is required, mostly in Chittagong, as it is the 2nd most polluted city in Bangladesh. This study did not address all aspects of air pollution. Research needs to be further improved in the future, and institutions that have done researches on air pollution. According to their type, such as national organizations, international organizations, educational institutions, etc., it is possible to do extensive research. It is also possible to analyze according to the journal impact factor, type, and number of publications in the same journal.

Compliance with ethical standards

Disclosure of conflict of interest

The authors involved in this article have unanimously agreed and declared that no conflict of interest with anybody or group.

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