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Global Public Health Implications of Traffic Related Air Pollution: Systematic Review

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ABSTRACT

BACKGROUND: Traffic-related air pollution (TRAP) has significant public health implications and a wide range of adverse health effects, including cardiovascular, respiratory, pulmonary, and other health problems. This study aimed to determine the public health impacts of traffic-related air pollution across the world that can be used as an input for protecting human health.

METHODS: This study considered studies conducted across the world and full-text articles written in English. The articles were searched using a combination of Boolean logic operators (AND, OR, and NOT), MeSH, and keywords from the included electronic databases (SCOPUS, PubMed, EMBASE, Web of Science, CINAHL, and Google Scholars). The quality assessment of the articles was done using JBI tools to determine the relevance of each included article to the study.

RESULTS: In this study, 1 282 032 participants ranging from 19 to 452 735 were included in 30 articles published from 2010 to 2022. About 4 (13.3%), 9 (30.0%), 12 (40.0%), 8 (26.7%), 2 (6.7%), 15 (50.0%), 3 (10.0%), 3 (10.0%) 1 (3.3%), and 3 (10.0%) of articles reported the association between human health and exposure to CO, PM10, PM2.5, NO_x, NO, NO_2, black carbon, O_3, PAH, and SO_2, respectively. Respiratory diseases, cancer, cognitive function problems, preterm birth, blood pressure and hypertension, diabetes, allergies and sensitization, coronary heart disease, dementia incidence, and hemorrhagic stroke were associated with exposure to TRAP.

CONCLUSIONS: Exposure to nitrogen dioxide, nitrogen oxide, sulfur dioxide, and fine particulate matter was associated with various health effects. This revealed that there is a need for the concerned organizations to respond appropriately.

KEYWORDS: Traffic related air pollution, health impact, air pollution, public health, air pollutants

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Introduction

Urban areas are hot spots for human exposure to air pollution, mainly originating from road traffic. Understanding efforts to curb traffic related air pollution (TRAP) in urban areas is particularly critical, as the world is currently witnessing its largest urban growth in human history. According to the United Nations and the Department of Economic and Social Affairs Population Division, about two-thirds of the world's population is estimated to reside in urban areas by 2050[1] meaning more people will be at risk of exposure to TRAPS.

Traffic-related air pollution is a complex mixture of particulate matter (PM2.5 and PM10) derived from combustion and non-combustion sources such as road dust, tire wear, and brake wear, as well as primary gaseous emissions, including nitrogen oxides. These primary emissions lead to the generation of secondary pollutants such as ozone, nitrates, and organic aerosols that can cause various health problems, including asthma and other health conditions.[2]

The prominence of traffic emissions and TRAPS has great implications for human exposure and its wide range of adverse health effects. Traffic emissions disperse into the ambient air that humans are exposed to and cause health impacts that result from direct exhaust emissions or non-exhaust emissions.[3,4] Exposure to air pollution increases health risks, including adverse cardiovascular, respiratory, pulmonary, and other health-related outcomes. Particularly, low-income countries suffer the highest burden of disease and premature death attributable to environmental pollution.[5]

According to some findings, the health impacts associated with TRAPS have proven costly, including the cost of death from ambient air pollution (over $496 000 000 in the United States, $201 000 000 in Japan, $148 000 000 in Germany, $102 000 000 in Italy, and $85 000 000 in the United Kingdom). Despite the growing awareness of the links between traffic, air pollution exposure, and associated adverse health impacts, many cities across the globe struggle to meet the air quality guidelines set to protect public health.[6]

Various review articles are conducted on the impacts of traffic-related air pollution on specific health conditions, such as lung function and other respiratory illnesses.[7,8] In addition, the previous studies addressed some air pollutants such as NO_2, elemental carbon, and PM2.5[7,9] and were conducted on a specific group of the population, particularly among students[7] and children.[8] However, the current study addressed the health impacts of various traffic-related air pollutants in addition to those addressed by previous studies, such as CO, NO_x, NO, O_3, PAH, and SO_2, and multiple health conditions, including respiratory diseases, cancer, cognitive function problems, preterm birth, coronary heart disease, allergic diseases, dementia, and hemorrhagic stroke.

Materials and Methods

The Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guideline was used to perform this systematic review.[10]

Eligibility criteria

Articles that met the following predetermined inclusion criteria were included in the systematic review.

- *i.* ***Location***: This study included traffic-related air pollutants across the world, regardless of their location and their health impacts.
- *ii.* ***Study design***: There was no restriction based on the study design used in the study.
- *iii.* ***Types of pollutants***: carbon monoxide (CO), nitrogen monoxide (NO), nitrogen dioxide (NO_2), nitrogen oxide (NOx), sulfur dioxide (SO_2), ozone (O_3), and particulate matter (PM2.5 and PM10) were included in the current study.
- *iv.* ***Outcome***: Studies reported quantitative outcomes (magnitude, frequency, rate, or prevalence).
- **v.** **Language**: Studies written in English

Sources of information and Search Strategies

The searches of the literature were performed by the authors using keywords from search strategies such as the databases SCOPUS, PubMed, Embase, Web of Science, CINAHL, and Google Scholars from June 1, 2023, to December 30, 2023. Articles were searched using a combination of Boolean logic operators ("AND, OR, and NOT"), medical subject headings (MeSH), and keywords. The authors used the following main keywords to search articles from the included electronic databases: public health OR health impacts, OR health consequences, OR asthma (related terms), OR respiratory disease, OR respiratory illness OR cancer, AND traffic-related air pollution AND air pollution AND particulate matter AND gases AND pollutants AND mobile sources of air pollution, etc.

For example, the following are the search strategies used by all authors in the initial search of PubMed: "health" OR "public health" OR "population" OR "community" OR "rrespiratory disease" OR "asthma" OR "pulmonary" OR "disease OR illness" OR etc. AND "Impact" OR "implication" OR "risk" OR "hazards" AND "Air pollutants" OR "air pollution" OR "traffic related" OR "transport related" OR "ambient air pollution" OR "urban air pollution" AND "Developing countries" OR "worldwide" OR "global" OR "low in countries" OR "developed countries" OR "high income countries" OR "low and middle income countries" etc.

The combination of the above terms was used based on the search protocols used for each database. Additionally, manual searching of the articles was done to cover those articles that were difficult to locate and missed from the included electronic databases. Finally, references within eligible articles were further screened for additional articles.

Study selection

The study selection process was performed using the PRISMA flow chart, showing the number of articles included in the current study as well as those excluded from the study and the reasons for their exclusion. Following the search for articles, duplicate articles were removed using the Endnote software version X5 (Thomson Reuters, USA). After duplicated articles were removed, the authors independently screened the articles based on their titles and abstracts to determine their eligibility for this study by applying the inclusion criteria. Any disagreements made with respect to the inclusion of studies were resolved by consensus. Finally, articles that met the inclusion criteria were included in this study.

Data extraction

The data were extracted using Microsoft Excel 2016 form, which was developed by authors under the following headings: author(s), year of publication, sample size, study region or country, and primary outcomes: carbon monoxide (CO), nitrogen monoxide (NO), nitrogen dioxide (NO_2), nitrogen oxide (NO_x), sulfur dioxide (SO_2), ozone (O_3), and particulate matter (PM2.5 and PM10).

Quality assessment

Then the selected articles were subjected to quality assessment using the Joanna Briggs Institute (JBI) Critical Evaluation,[11] to determine the quality and relevance of the articles for the current study. The evaluation tools have 9 evaluation criteria: appropriate sampling frame, proper sampling technique, adequate sample size, description of the study subject and setting description, sufficient data analysis, use of valid methods for identifying conditions, valid measurement for all participants, use of appropriate statistical analysis, and adequate response rate. Then, failure to satisfy each parameter was scored as 0, and if it met the criteria, it was scored as 1. The score was then

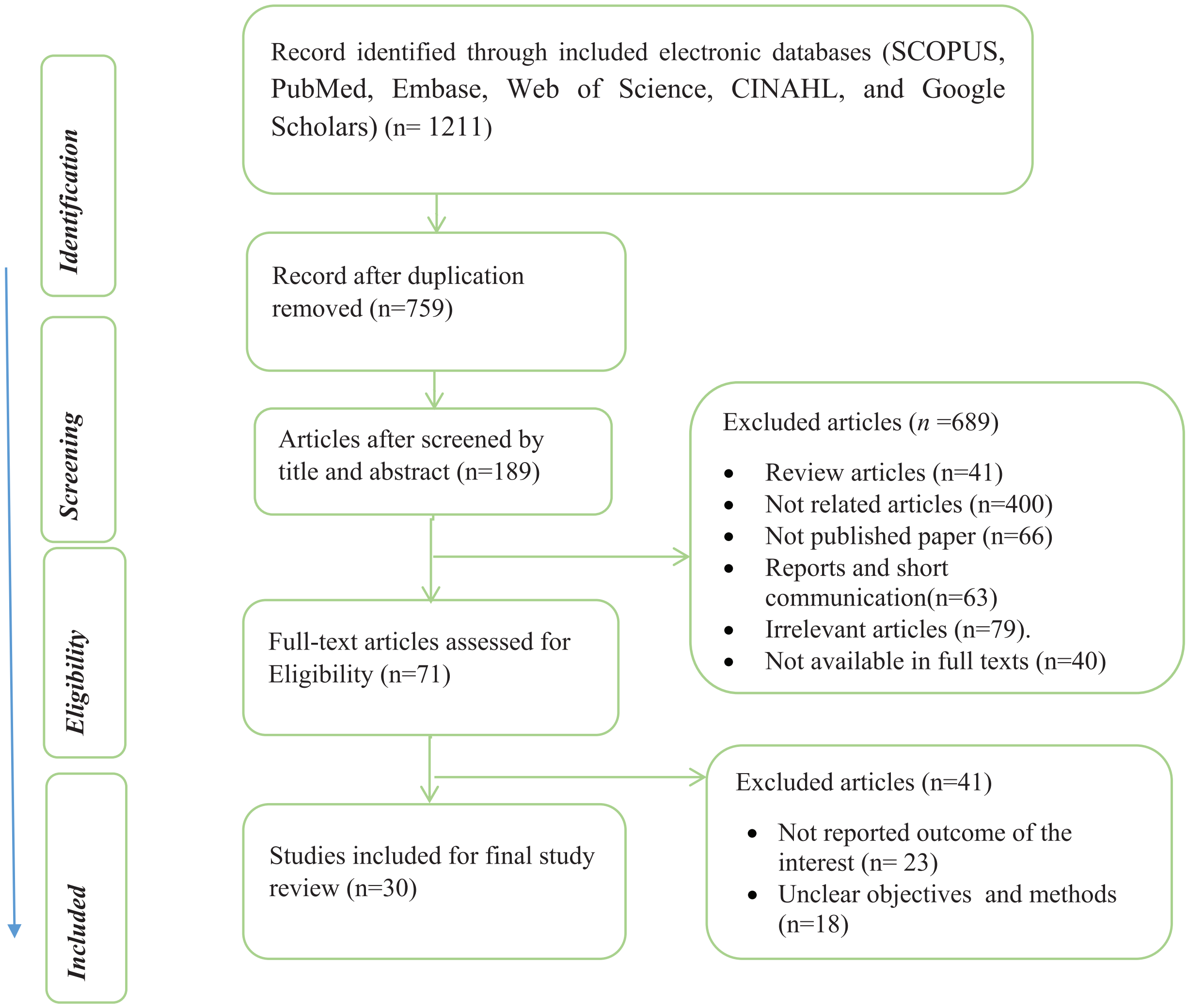

Figure 1. Study selection process of included articles in the current systematic review, 2023.

given for each study and graded as high (7/9 and above), moderate (5/9%-6/9% score), or low (if it scored less than 5/9) quality. The disagreement over what was to be extracted was solved by discussion after repeating the same procedures.

Results

A total of 1211 articles were searched through the selected electronic databases, such as Scopus, PubMed, EMBASE, Web of Science, Google Scholar, and Science Direct. After searching for articles, 452 duplicate articles were excluded from the study. About 750 articles were excluded after initial screening, and 41 articles were excluded after full-text articles were assessed for eligibility. Finally, 29 articles were included in the systematic review (Figure 1).

Characteristics of included articles

In the current study, 1 282 032 participants, ranging from 19 to 452 735, were included in 30 articles published from 2010 to 2022. Regarding the countries where the studies were conducted, 4 articles were conducted in the USA, 4 in China, 2 each in Spain, Germany, England, and the Netherlands, and 1 article from Taiwan, Japan, Sweden, France, Australia, Korea, Malaysia, Columbia, Brazil, India, Denmark, and Nigeria.

Among the included articles, about 4 (13.3%), 9 (30.0%), 12 (40.0%), 8 (26.7%), 2 (6.7%), 15 (50.0%), 3 (10.0%), 3 (10.0%) 1 (3.3%), and 3 (10.0%) reported the association between human health and exposure to CO, PM10, PM2.5, NO_x, NO, NO_2, black carbon, O_3, PAH, and SO_2, respectively. However, in 2 articles, the types of traffic-related pollutants were not reported.

Furthermore, regarding the health outcome of exposure to traffic-related air pollution, various health problems or impacts associated with exposure to traffic-related air pollution, such as respiratory diseases, cancer, cognitive function problems, preterm birth, blood pressure and hypertension, diabetes, allergies and sensitization, coronary heart disease, pediatric allergic diseases, dementia incidence, hemorrhagic stroke, and lung cancer, were identified in the current study (Table 1).

Table 1. Characteristics of the included articles used to determine the public health impacts of traffic-related air pollution, 2023.

AUTHORS	SAMPLE SIZE	TYPES OF POLLUTANTS	OUTCOME	TARGET POPULATION	OUTCOME (HEALTH IMPACTS AND ASSOCIATED FACTORS)	COUNTRY OR REGION	QUALITY
Mustapha et al[12]	1518	CO	Respiratory illness	Children	• TRAP such as fine particles was associated with an increase in phlegm [OR = 1.38: 95%CI: 1.09-1.75].	Nigeria	Medium
Hennig et al[13]	8204	PM2.5 and PM10	High-sensitive C reactive protein	All age	• High-sensitivity C reactive protein was associated with 1 μg/m³ increases in traffic-related PM2.5 and PM10. [OR = 17.89: 95% CI: 7.66-29.1]	German	Medium
Raaschou-Nielsen et al[14]	1216	NO_x	Cancer incidence	All age	• NO_x was significantly associated with the risks of cervical cancer (IRR = 2.45, 95%CI: 1.01; 5.93) and brain cancer (IRR = 2.28, 95%CI: 1.25; 4.19).	Denmark	High
Dong et al[15]	9941	PM10 and NO_2	Respiratory disease	All age	• There was an association between respiratory disease and respiratory mortality per 10 g/m³. (RR = 1.67, 95%CI: 1.60-1.74 for PM 10 and 2.97, 95%CI: 2.69-3.27 for NO_2).	China	High
Lepeule et al[16]	858	Black carbon	Lung function	Elderly people	• A 0.5 mg/m³ increase in long-term exposure to black carbon was associated with an additional rate of decline in forced vital capacity (FVC) and forced expiratory volume in 1 s (FEV1), between 0.5% and 0.9% per year, respectively.	United States	High
Gupta et al[17]	100	Vehicular pollution	Respiratory effects	Traffic police man	• 68% of the participants reported a frequent coughing, 22% reported having shortness of breath, and 36% suffered from respiratory tract irritation.	India	High
Urman et al[18]	1811	NO_2, NO, NO_x, O_3, PM10, and PM2.5	Lung function	Children	• An increase in near-roadway NOx of 17.9 ppb was associated with deficits of 1.6% in FVC and 1.1% in FEV1. • Lung function deficits of 2%-3% were associated with regional PM10 and PM2.5 (FVC and FEV1) and with O_3 (FEV1).	United States	High
Tonne et al[19]	2867	PM10 and PM2.5	Cognitive function	Adult	• Increased PM2.5 (1.1 μg/m³ (lag4)) is associated with decline standardized memory score (5-year decline) [OR = 0.03 (95%CI: 0.06-0.002).	England	Medium
Sérgio Chiarelli et al[20]	19	PM10 and O_3	Diastolic blood pressure	Traffic police man	• Interquartile increases in PM10 (33 mg/m³) and O_3 (49 mg/m³) levels were associated with increases in arterial pressure parameters, ranging from 1.06 to 2.53 mmHg.	Brazil	High

(Continued)

Table 1. (Continued)

AUTHORS	SAMPLE SIZE	TYPES OF POLLUTANTS	OUTCOME	TARGET POPULATION	OUTCOME (HEALTH IMPACTS AND ASSOCIATED FACTORS)	COUNTRY OR REGION	QUALITY
Heck et al[21]	590	PM2.5	Childhood cancer	Children	• A per-interquartile range increase in exposure to traffic-related pollution was associated with acute lymphoblastic leukemia [OR = 1.05 (95%CI: 1.01, 1.10)], and germ cell tumors [OR = 1.16 (95%CI: 1.04, 1.29).	USA	Medium
Wilhelm et al[22]	241 415	PAHs, PM2.5, NO, NO_2, and NO_x	Preterm birth	Children	• There were strongly negative correlation between first trimester and last pregnancy month exposures, and pollutants (NO, NO_x and PAHs) ($r = -.7$). • There were strongly positively correlation between second trimester and entire pregnancy averages and all pollutants ($r = .7$-0.9).	USA	High
Foraster et al[23]	3700	NO_2	Blood pressure and hypertension	Adult	• A 10 $\mu g/m^3$ increase in NO_2 level is associated with higher systolic blood pressure (1.34 mmHg) (95%CI: 0.14, 2.55).	Spain	High
Nielsen et al[24]	679	NO_x	Lung cancer cases	All age	• The incidence rates for lung cancer were 1.30 [95%CI: 1.07-1.57] and 1.45 (95%CI: 1.12-1.88] for NO_x concentrations of 30-72 and >72 $\mu g/m^3$, respectively, compared to <30 $\mu g/m^3$.	Denmark	High
Dijkema et al[25]	8018	NO_2	Diabetes	All age	• Smoothed plots of exposure vs type 2 diabetes supported some association with traffic in a 250 m buffer.	Netherlands	Medium
Fuertes et al[26]	6604	PM2.5 and O_3	Asthma, allergies and sensitization	Children	• There was an association between O_3 and allergic rhinitis [AOR = 1.30 (95%CI: 1.02, 1.64)] and eyes and nose symptom prevalence (1.35 [1.16, 1.59]). • There was an association between allergic rhinitis and PM2.5 absorbance [AOR = 0.83; (95%CI: 0.72, 0.96)].	*German*	*High*
Gan et al[27]	452 735	Black carbon, PM2.5, and NO_2	Coronary heart disease	All age	• An interquartile range elevation in the average concentration of black carbon was associated with a 3% increase in CHD (95%CI: 1%-5%) and a 6% increase in CHD mortality (3%-9%).	Columbia	High

(Continued)

Table 1. (Continued)

AUTHORS	SAMPLE SIZE	TYPES OF POLLUTANTS	OUTCOME	TARGET POPULATION	OUTCOME (HEALTH IMPACTS AND ASSOCIATED FACTORS)	COUNTRY OR REGION	QUALITY
Jung et al[28]	5443	Not specified	Allergic disease, asthma	Children	• Positive relationships were found between the length of the main road within the 200 m home area and wheeze (PR = 1.24; 95%CI: 1.04-1.47) and asthma (PR = 1.42; 95%CI: 1.08-1.86). • Living less than 75 m from the main road was significantly associated with allergic rhinitis.	Korea	High
Suhaimi et al[29]	152	PM10, PM2.5, NO_2, SO_2, and CO	Lung & respiratory symptoms	Children	• Children in high traffic areas were 3 times more likely to experience chest tightness when compared to children in low traffic areas.	Malaysia	Medium
Bai et al[30]	274 880	NO_2, PM2.5, and CO	Bronchitis	Children	• The increase in concentrations of NO_2, 5, and CO significantly increased the daily hospital visits in childhood. • Acute bronchitis with 4-day cumulative effect estimates of NO_2, PM2.5, and CO was with RR: q1.03, 95%CI: 1.01-1.05, 1.09, 95%CI: 1.07-1.11, and 1.07, 95%CI: 1.05-1.09, respectively.	China	High
Bilenko et al[31]	1400	NO_2, PM2.5 and PM10	Diastolic blood pressure	Children	• Long-term exposure to NO_2 and PM2.5 were associated with increased diastolic blood pressure in children who lived at the same address since birth (adjusted mean difference (0.83, 95%CI: 0.06-1.61) and 0.75 (0.08-1.58), respectively).	Netherlands	High
Min et al[32]	14 614	NO_2, PM10, and PM2.5	Pediatric allergic diseases	Children	• Symptoms and diagnoses of atopic eczema symptoms were associated with NO_2 (OR = 1.07, 95%CI: 1.02-1.13; 1.08, 1.03-1.14) and PM10 (OR = 1.06, 95%CI: 1.01-1.12). • PM2.5 exposure was not significantly associated with allergic diseases (OR = 1.01, 95%CI: 0.95-1.07).	Korea	Medium
Bowatte et al[33]	689	NO_2	Asthma and low lung function	All age	• Being never having asthma by 45 and living in a distance of <200 m from a major road was associated with increased odds of asthma (AOR = 5.20; 95%CI: 1.07, 25.4). • Asthmatic participants at 45 had an increased risk of persistent asthma up to 53 years if they were living within <200 m of a major road (AOR = 5.21; 95%CI: 1.54, 17.6).	Australia	High

(Continued)

Table 1. (Continued)

AUTHORS	SAMPLE SIZE	TYPES OF POLLUTANTS	OUTCOME	TARGET POPULATION	OUTCOME (HEALTH IMPACTS AND ASSOCIATED FACTORS)	COUNTRY OR REGION	QUALITY
Rancière et al[34]	2015	NO_x	Respiratory Symptoms	Children	• An interquartile range (26 µg/m^3) increase in NO_x levels was associated with increased persistent wheezing at 4 years (AOR = 1.27; 95%CI: 1.09, 1.47). • TRAP exposure was positively associated with persistent wheeze, dry cough, and rhinitis symptoms.	France	High
Oudin et al[35]	1806	NO_x	Dementia Incidence (Alzheimer's disease or vascular dementia)	All age	• Participants in the group with the highest exposure were more likely than those in the group with the lowest exposure to be diagnosed with dementia (Alzheimer's disease or vascular dementia), with a hazard ratio (HR) of 1.43 (95%CI: 0.998-2.05 for the highest vs the lowest quartile).	Sweden	High
Lu et al[36]	2598	NO_2, SO_2 and PM10	Eczema	Children	• Childhood eczema was associated with traffic-related air pollutant NO_2 during 3 months before pregnancy and throughout pregnancy, with an AOR = 1.19 (95%CI: 1.04-1.37) and 1.21 (95%CI: 1.03-1.42), respectively. • The highest risk of eczema was observed for the first trimester exposure to NO_2 [OR = 1.26 (95%CI: 1.09-1.46)].	China	High
Sunyer et al[37]	2715	Elemental carbon and NO_2	Cognitive development	Children	• Children from highly polluted schools had a smaller growth in cognitive development than children from paired lowly polluted schools [AOR = 11.5 [95%CI: 8.9-12.5]. • Children attending schools with higher levels of EC, NO_2, and UFP both indoors and outdoors experienced substantially smaller growth in all the cognitive measurements.	Spain	High
Yorifuji et al[38]	14 001	NO_2	Hemorrhagic stroke and lung cancer	All age	• We found positive associations of NO_2 levels with cardiopulmonary disease (HR = 1.22, 95%CI: 1.15-1.30) and LC mortality (HR = 1.20, 95%CI: 1.03-1.40).	Japan	High
Lee et al[39]	11 117	NO_x and CO	Risk of Parkinson's disease	All age	• In multi-pollutant models, for NO_x and CO above the 75th percentile exposure compared with the lowest percentile, the ORs of PD were 1.37 (95%CI: 1.23-1.52) and 1.17 (95%CI: 1.07-1.27), respectively.	Taiwan	Medium

(Continued)

Table 1. (Continued)

AUTHORS	SAMPLE SIZE	TYPES OF POLLUTANTS	OUTCOME	TARGET POPULATION	OUTCOME (HEALTH IMPACTS AND ASSOCIATED FACTORS)	COUNTRY OR REGION	QUALITY
Carey et al[40]	211016	NO_x and PM2.5	Cardiorespiratory outcomes	Adult	• There were associations between traffic-related air pollution (20 µg/m^3 change in NO_x) and heart failure (HR = 1.10, 95%CI: 1.01-1.21).	England	High
Deng et al[41]	2598	NO_2, SO_2, and PM10	allergic rhinitis	Children	• There was an association between life-time prevalence of allergic rhinitis in preschool children (7.3%) and pre- and post-natal exposure to traffic-related air pollution. • There were a significant association between exposure to a 15 µg/m^3 increase in NO_2 and third trimester of pregnancy (AOR = 1.40 (95%CI: 1.08, 1.82). • There were a significant association between exposure to 11 and 12 µg/m^3 increase in NO_2 and PM_{10} and the first-year of life accounted for AOR = 1.36 (95%CI: 1.03-1.78) and 1.54 (95%CI: 1.07-2.21), respectively.	China	High

Abbreviations: CO, carbon monoxide; EC, elemental carbon; HR, hazard ratio; NO_2, nitrogen dioxide; NO_x, nitrogen compounds; O_3, Ozone; PM2.5, fine particulate matter; SBP, systolic blood pressure; SO_2, sulfur dioxide; TRAP, traffic related air pollution.

Discussion

The current study aimed to determine the public health impacts of traffic-related air pollution. This study identified various health impacts related to different types of traffic-related air pollutants across the world. The results of this systematic review indicate that exposure to higher levels of traffic-related air pollutants such as nitrogen dioxide, nitrous oxide, carbon monoxide, particulate matter, and sulfur dioxide can increase the risk of various health conditions.

According to the current finding, traffic-related air pollutants could cause respiratory disease, particularly among children[12,18,21,22,26,28-30,32,34,36,37] and elderly people.[16,24,25,27,35,38-40] For example, according to the study conducted in Nigeria,[12] respiratory illness (phlegm and wheeze) among children with ages ranging from 7 to 14 years was about 1.38 times higher among those exposed to CO than those not exposed. It was in line with the findings of another study that reported the same outcome.[42]

Similarly, another study conducted in the US reported that an increase in near-roadway NO_x of 17.9 ppb was associated with deficits of 1.6% in forced vital capacity among children aged 5 to 7 years old.[18] A study conducted in the USA reported that an increase in exposure to traffic-related pollution was associated with acute lymphoblastic leukemia [OR: 1.05; 95%CI: 1.01, 1.10] and germ cell tumors [OR: 1.16; 95%CI: 1.04, 1.29].[21]

Most studies reported a significant association between traffic air pollutants such as PM10, NO_2, PM2.5, and O_3 and respiratory disease, illness, or function, including lung function and bronchitis.[12,15-18,24,29,34] The current finding was in line with the findings of another systematic review and meta-analysis, which reported a positive association between asthma and exposure to vehicle air pollution such as nitrogen dioxide, nitrous oxide, and carbon monoxide, which were associated with a higher prevalence of childhood asthma.[42]

According to the current finding, exposure to traffic-related air pollutants such as PM10, NO_2, PM2.5, and O_3 can increase diastolic blood pressure,[20,23,31] and pediatric allergic diseases.[32] Another health problem reported in the included articles is cancer, including cervical cancer,[14] and lung cancer.[38] This study was in line with the findings of another study that reported a statistically significant association between traffic-related air pollutants such as nitrogen oxide, sulfur dioxide, fine particulate matter, and lung cancer, that was supported by the current evidence.[43]

Cognitive development[37] and cognitive function problems[19] is another health consequences related to traffic air pollution exposure. The study reported that children from highly polluted environments had a smaller growth in cognitive development than children from the paired lowly polluted[37] and particle metrics (PM10 and PM2.5) were associated with lower scores in reasoning and memory. For example, higher PM2.5 was associated with a 5-year decline in standardized memory score.[19] Furthermore, Exposure to a high concentration of traffic-related air pollutants, higher than the maximum recommended level, can be toxic to different organs. Some experimental evidence showed a toxic effect of traffic-related air pollutants, including inflammation and changes in lung tissue.[44] Furthermore, TRAP, such as Particulate matters may cause neurotoxicity, such as neurodevelopmental and neurodegenerative disorders.[45]

In general, the current study found that there was a statistically significant association between various traffic-related air pollution caused by different air pollutants, including CO, NO_x, NO_2, PM2.5, and PM10, and human health. Despite current progress in different countries adopting vehicle emission standards, transportation emissions remain a major contributor to ambient air pollution and are associated with major health impacts.[46] This indicates a need to implement control strategies to reduce traffic-related air pollution and its public health burden by having a TRAP management plan[46] and policy.[47] Furthermore, using alternative transportation methods or technology, and strict regulations by the concerned organizations across the world can play a major role in reducing TRAP.[47-49] International cooperation on pollution, including research, development, developing policy, monitoring, and politics, is vital for effective air pollution control.[47]

Furthermore, the authors recommend future researchers to focus on identifying an effective traffic related air pollution control interventions and role of national and international entities, particularly in controlling health burden of traffic related air pollution.

Conclusion

In general, the current study found that exposure to nitrogen dioxide; nitrogen oxide, sulfur dioxide, and fine particulate matter was associated with various health conditions such as respiratory diseases, cancer, cognitive function problems, preterm birth, blood pressure and hypertension, diabetes, allergies and sensitization, coronary heart disease, pediatric allergic diseases, dementia incidence, hemorrhagic stroke, and lung cancer. This revealed that there is a need to take appropriate action, including using alternative transportation methods or technology, reducing exposure to air pollutants, and enforcing regulations.[48,49]

Limitations

Exposure was assessed differently using different methods. The publication is not evenly distributed across various countries. Even though there is a limited number of articles conducted on the public health, impacts of traffic-related air pollutants or pollution, particularly in developing countries as a result of poor databases for recording pollutants, various health outcomes have been reported in this study based on the previous findings.

Abbreviations

BC: Black Carbon; CO: Carbon Monoxide; EC: Elemental Carbon; HR: Hazard Ratio; NOx: Nitrogen compounds; PAH: Poly-Aromatic Hydrocarbon; PM: Particulate Maters; PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-Analysis; SBP: Systolic Blood Pressure; TRAP: Traffic Related Air Pollution; WHO: World Health Organization.

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Author Contributions

DD conceived the idea and had a major role in the review, extraction, and analysis of data, as well as the as well as the writing, drafting, and editing of the manuscript. DD, BM, DAM, WD, and AA have contributed to data extraction. DD, BM, DAM, WD, and AA contributed to the quality assessment, drafting, and editing of the manuscript. Finally, all authors read and approved the final version of the manuscript to be published and agreed on all aspects of this work.

Ethics Approval and Consent to Participate

Not applicable.

Consent for Publication

Not applicable.

Data Availability

Almost all data are included in this study. However, additional data can be available from the corresponding authors on the reasonable request.

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