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RESEARCH ARTICLE

THE EFFECT OF AIR POLLUTION ON CARDIOVASCULAR DISEASES IN THE EASTERN MEDITERRANEAN REGION: A SYSTEMATIC LITERATURE REVIEW

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ABSTRACT

Objectives: To assess the risk of cardiovascular diseases associated with air pollution in Eastern Mediterranean Region (EMR) by summarizing the existing knowledge from previous studies in the region and to identify knowledge and research gaps to support further research efforts.
Methods: Literature search between January 2000 and June 2016 using the combinations of keywords and hand search resulted in 366 articles published in the EMR. Of those, 13 studies met the inclusion/exclusion criteria.
Results: Thirteen studies from few countries in EMR have examined the effect of air pollution on cardiovascular disease and met the inclusion criteria. Most of studies were conducted in Iran. The most common study designs were ecological time series and cross-sectional studies. The reviewed articles showed that air pollution has a significant association with cardiovascular morbidity, especially in high risk groups, but not with mortality. For the majority of reviewed studies, limitations do exist in all studies even well conducted ones. The limitations and shortcomings that arise from inappropriate study designs, poor assessment of exposure and outcomes, questionable sources of data, lack of standardized methods, poor adjustment of confounders, limited geographical area studies, small sample sizes, poor statistical modeling, and not testing for possible interactions between exposures.
Conclusion: Air pollution has a significant association with cardiovascular morbidity, especially in high risk groups, but not with mortality in the reviewed studies. However, the limited number of studies in few EMR countries makes it difficult to construct evidence on the effect of air pollution on cardiovascular diseases in the region. The reviewed studies did not sufficiently represent the different geographic locations and compositions of the countries.

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INTRODUCTION

Exposure to outdoor particulate matter (PM) has been associated with a range of adverse health outcomes (Atkinson *et al*., 2014; Lim *et al*., 2010). A recent Global Burden of Disease Study showed that PM exposure is responsible for 3.2 million deaths per year and 76 million years of healthy life lost (Lim *et al*., 2010). PM exposure is a major health problem in the developing countries as the fine PM levels in some developing countries are reported to be 10 times higher than that in the developed countries (Lee *et al*., 2014). The majority of mortality following fine PM exposure has been related to cardiovascular diseases (Lim *et al*., 2010). There is mounting evidence that both acute and chronic exposure to PM can lead to a variety of specific cardiovascular effects including exacerbation of ischemic heart disease, heart failure, cerebrovascular disease, deep venous thrombosis, hypertension and cardiac arrhythmias, with varying degrees of evidence supporting these associations (Atkinson *et al*., 2014; Lim *et al*., 2010; Lee *et al*., 2014; Gardner *et al*., 2014; Shah *et al*., 2013; Stafoggia *et al*., 2014; Baccarelli *et al*., 2008; Bellavia *et al*., 2013; Urch *et al*., 2005; Bartell *et al*., 2013). The $PM_{2.5}$ exposure has been reported to produce a variety of deleterious effects on cardiovascular system including vascular dysfunction, reduced heart rate variability and prothrombotic

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and coagulant changes, systemic inflammatory and oxidative stress responses, autonomic imbalance and arrhythmias (Brook *et al*., 2010; Brook *et al*., 2009. Some recent evidence also implicates other size fractions, such as ultrafine particles (UFPs) < 0.1 µm, gaseous pollutants (e.g., ozone (O_3) and nitric dioxides (NO_2)), and specific sources of pollution (e.g, traffic). Policy changes addressing the need for more stringent air pollution standards at the local and global levels are projected to lower costs and improve health outcomes.

This study was conducted to provide a comprehensive assessment of the risk of cardiovascular diseases associated with air pollution in Eastern Mediterranean Region (EMR) by summarizing the existing knowledge from previous studies in the region and to identify knowledge and research gaps to support further research efforts.

MATERIALS AND METHODS

Literature search

The following databases were searched for relevant papers and reports: MEDLINE, CINAHL, Embase, PsychINFO, Cochrane Collection, Google scholar, Pubmed, and ISI Web of Knowledge. Key references from extracted papers were also hand-searched. These searches focused upon papers published between January 2000 and June 2016.

Search terms

Combinations of search terms from three categories ("country" keywords AND 'air pollution" keywords AND "Health outcomes" keywords were used to search for the relevant literature.

"Country" keywords

Jordan [Title/Abstract] OR Lebanon OR Libya OR Kuwait OR Bahrain OR Qatar OR Sudan OR Djibouti OR Iran OR Iraq OR Palestine OR Yemen OR Syria OR Emirates OR Somalia OR Tunisia OR Saudi Arabia OR Morocco OR Oman OR Pakistan OR Afghanistan OR Egypt OR Arabian Gulf OR Persian Gulf OR Eastern Mediterranean OR Middle East.

"Air pollution" keywords

Nitrogen dioxide OR smoke OR Sulphur dioxide OR ozone OR particles OR carbon monoxide (CO) OR particulate matter OR reactive nitrogen OR PM_{10} OR $PM_{2.5}$ OR SO_2 OR NO_2 OR gaseous pollutants OR volatile organic compounds OR persistent organic pollutants OR particulate matter OR respirable particles OR chemical emissions OR mold spores OR animal allergens OR combustion gases OR tobacco OR air quality OR aeroallergens OR dust OR air pollution OR outdoor air pollution OR indoor air pollution OR atmospheric pollution

"Health outcomes" keywords

Cardiovascular disease OR cardiovascular mortality OR cardiovascular and respiratory mortality OR acute coronary syndrome OR angina pectoris OR cerebral stroke OR admissions for cardiovascular diseases OR ischaemic heart disease OR blood pressure OR cardio-metabolic risk OR fasting blood glucose OR myocardial infarction

Filtering and study selection

Literature search using the combinations of keywords and hand search resulted in 366 articles (Figure 1). Two researchers assessed the eligibility of all citations by reviewing the abstract. Where citations could not be excluded based on title or abstract or when there were discrepancies, the full-text paper was retrieved and assessed. Full papers of potentially eligible citations were identified following screening of all titles and abstracts by two study authors. These were further reviewed for eligibility and inclusion in the review by a single author (YK).

Inclusion criteria and exclusion criteria

Literature search was limited to papers and reports published since 2000. Papers and reports that met inclusion criteria were included in this review and were summarized in review tables and discussed in the text. Papers which examined the link between air pollution and human health without explicitly quantifying or qualifying the impact or the link were included in supporting text but not in the tables. Data from unpublished reports and websites were not systematically extracted into review tables, but sources including World Health Organization and Center for Disease Control and Prevention were discussed in the accompanying text. Similarly, papers not fulfilling inclusion criteria were sometimes used to give a better contextual outline and are discussed in the relevant sections.

Inclusion criteria

- Papers presented original data from cohort, case-control, or cross-sectional studies, ecologic studies, case-crossover or time-series studies.
- Studies examining the relations between gaseous air pollutants (carbon monoxide, sulphur dioxide, nitrogen dioxide, ozone) or particulate ($PM_{2.5}$ or PM_{10}) or second-hand smoking and clearly defined cardiovascular diseases.
- Conducted in a human population
- Papers published in any country of the region between January 2000 and June 2016
- Papers published in English

Exclusion criteria

- Editorials and letters
- News articles
- Non English language papers
- Papers published before 2000

Data collection and analysis

Data from scientific papers that met inclusion criteria were extracted systematically using a specially designed data extraction form and categorized according to health outcomes into summary tables. Column headings of summary tables included the followings: Study outcome, authors, year of publication, country, study design, population, study years, exposure, and main results. Because of the heterogeneity in study designs, exposure, and outcomes, meaningful quantitative summary statistics were not possible. Moreover, quality assessment of the included papers was not undertaken.

RESULTS

Descriptive Summary of Studies

Thirteen studies (Fatmi *et al*., 2014; Qorbani *et al*., 2012; Hosseinpoor *et al*., 2005; Nabavi *et al*., 2012; Nakhlé *et al*., 2015; Bener *et al*., 2009; Dehghani *et al*., 2014; Khanjani and Bahrampour, 2013; Goudarzi *et al*., 2015; Lelieveld *et al*., 2015; Poursafa *et al*., 2014; Sughis *et al*., 2012; Trasande *et al*., 2015) from few countries in EMR have examined the effect of air pollution on cardiovascular disease and met the inclusion criteria. Characteristics of individual studies and their findings are summarized in Table 1. Most of studies were conducted in Iran (Qorbani *et al*., 2012; Hosseinpoor *et al*., 2005; Nabavi *et al*., 2012; Dehghani *et al*., 2014; Khanjani and Bahrampour, 2013; Goudarzi *et al*., 2015; Poursafa *et al*., 2014). Other studies were conducted in Pakistan (Fatmi *et al*., 2014; Sughis *et al*., 2012), Lebanon (Nakhlé *et al*., 2015), Qatar (Bener *et al*., 2009), selected EMR countries (Lelieveld *et al*., 2015), and Saudi Arabia (Trasande *et al*., 2015). The most common study designs were ecological time series and cross-sectional studies. Most studies on ambient air pollution assigned exposure based on central site monitoring data. Studies on the effect of ambient air pollution employed either continuous measures or ordinal measures, such as Air Quality Index (AQI) and Pollutant Standard Index (PSI). Potential confounders that were most commonly controlled for were body size (Body Mass Index (BMI), height, weight, and/or waist circumference), age, gender, diet, underlying diseases, socioeconomic status and ambient temperature. Adjustment was less common for physical activity, blood salts (sodium and potassium), ethnicity, second hand smoking (SHS), other pollutants, and relative humidity.

Air pollution and acute coronary syndrome

Six studies (Fatmi *et al*., 2014; Qorbani *et al*., 2012; Hosseinpoor *et al*., 2005; Nabavi *et al*., 2012; Nakhlé *et al*., 2015; Bener *et al*., 2009) of different designs investigated the association between air pollution and cardiovascular diseases outcomes. The six studies were conducted in 4 countries of EMR (Pakistan, Iran, Lebanon, and Qatar). Most studies were time-series in design. In a matched case-control study, Fatmi *et al*. (2014) investigated the relationship between indoor solid fuel use and gas fuel use and acute coronary syndromes in a sample of 73 matched pairs of Pakistani women. Significant association was found between current use of solid fuel and acute coronary syndromes (OR: 4.8; 95% CI: 1.5, 14.8), after adjustment for covariates (*i.e.*, ethnicity, BMI, family history of chronic diseases, diet, SHS, socio-economics). The relationship between daily average concentrations of CO and PM_{10} and the risk for hospital admission for acute coronary syndromes was investigated in a case-crossover study conducted in Tehran on 250 patients (Qorbani *et al*., 2012). A statistically significant association was seen only between CO and elevated risks of acute coronary syndromes (Odds ratio (OR): 1.18; 95% confidence interval (CI): 1.03, 1.35), after controlling for temperature, humidity and holiday status. PM_{10} showed a weak positive association, but did not reach statistical significance (OR: 1.02; 95% CI: 0.99, 1.00). Moreover, exposure to CO was found to make women 1.68 times more likely to be admitted for acute coronary syndromes than men (OR: 1.68; 95% CI: 1.25, 2.26). Stratification by gender did not change the relationship between PM_{10} and acute coronary syndromes. In a 5-years ecological time-series study in Tehran, Hosseinpoor *et al.* (2005) investigated the relationship between daily average levels of main air pollutants and hospitalization due to angina pectoris. The study found that CO was the only pollutant that was significantly associated with angina hospital admissions after a 1 day lag after controlling for confounding variables including long-term trend, seasonality, temperature, humidity, and weekly fluctuations in admissions. Relative risk was reported to be 1.009 (95% CI: 1.003, 1.015) for 1 mg/m^3 increase in the average daily concentration of CO. Nabavi *et al.* (2012) also investigated the relationship between AQI for main air pollutants and cerebral stroke admissions in Tehran in a cross-sectional study at the ecological level. The authors controlled for potential confounding variables including age, sex, and underlying diseases and found significant association between 48-hours prior exposure to NO_X, CO, and SO_2 and stroke admissions in different population groups.

In Lebanon, a retrospective co-epidemiological time-series study showed that the total cardiovascular admissions were not significantly associated with the levels of PM_{10} and $PM_{2.5}$ (Nakhlé *et al*., 2015). Cardiovascular disease admissions trend in relation with daily average concentration of main air pollutants in Qatar was described in a retrospective ecological time-series study in a period of 4 years (Bener *et al*., 2009). The study reported that as there was a slight increase in the concentration of air pollutants, the daily admissions from ischemic heart disease and cardiovascular disease also increased. However, the author did not test their observation statistically and failed to adjust for any potential confounders such as population inflation and change in the population structure.

Cardiovascular disease mortality

Four studies (Dehghani *et al*., 2014; Khanjani and Bahrampour, 2013; Goudarzi *et al*., 2015; Lelieveld *et al*., 2015) reported on mortality from cardiovascular disease. Dehghani *et al*. (2014) conducted a cross-sectional in Shiraz to investigate the correlation between the PSI of major air pollutants (CO, SO_2, NO_2, and PM_{10}) and the cardiovascular disease mortality from records of local health department, in a period of 10 months. The authors did not adjust for any potential confounders and found no significant correlation between ambient air pollution and cardiovascular disease mortality. This result was consistent with Khanjani and Bahrampour (2015) finding in a 4-years ecological time-series study conducted in Kerman to investigate the relation between daily average concentration of the same pollutants, in addition to O_3, and cardiovascular disease mortality, after adjusting to ambient temperature. In Ahvaz, Iran, Goudarzi *et al*. (2015) reported that 43 cumulative cases of cardiovascular deaths were attributed to ground-level ozone. In another study in EMR, Lelieveld (2015) reported that premature mortality caused by ischaemic heart disease related to $PM_{2.5}$ will increase from 19.224×10^{-3}% (n = 114,000) to 24.227×10^{-3}% (n = 188,000) in 2025 and 31.440×10^{-3}% (n = 321,000) in 2050.

Blood Pressure

In an Iranian nation-wide cross-sectional study on 1,413 schoolchildren, Poursafa *et al.* (2014) reported significant association between AQI and elevated systolic blood pressure

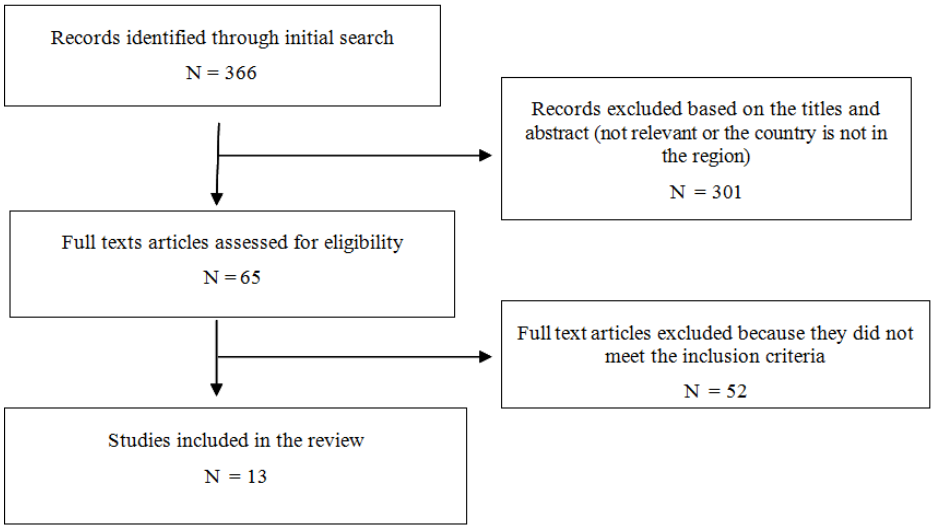

Figure 1. Flowchart of search strategy and selection of studies for inclusion in the systematic review

Table 1. The characteristics and main findings of 13 studies in the EMR that have examined the impact of air pollution on cardiovascular diseases

Study Outcome	Authors	Year	Country /Region	Study Design	Population	Study Year	Exposure
Acute coronary syndrome	Fatmi et al.	2014	Mirpurkha, Pakistan	A matched case-control	Women	Aug 2010-Feb 2012	Solid fuel used for cooking
Current use of solid fuel was strongly associated with acute coronary syndrome (OR: 4.8; 95% CI: 1.5, 14.8). The population attributable fraction for acute coronary syndromes in relation to current use of solid fuel was 49.0% (95% CI: 41.3%, 57.4%).							
Acute coronary syndrome	Qorbani et al.	2012	Tehran, Iran	Case–crossover study on 250 acute coronary syndrome patients	Patients with a first episode of acute coronary syndrome	Apr-Sep 2007	Mean daily concentration of CO and PM10
The risk of acute coronary syndrome was significantly associated with elevated concentrations of CO the day before the event (OR: 1.18, 95% CI: 1.03, 1.35) but not significantly with PM10. Women were more susceptible than men to CO levels.							
Angina pectoris	Hosseinpoor et al.	2005	Tehran, Iran	Retrospective time-series study	All hospital admissions from angina pectoris	Mar 1996-Mar 2001	Mean daily concentration of SO2, NO2, CO, O3, and PM10
CO was the only air pollutant that had a significant association with 1 day lag angina hospital admissions. A rise in CO level of 1 mg/m^3 was associated with an increment of 0.9% in the expected number of hospital admissions due to angina pectoris (RR for 1 mg/m^3: 1.00934; 95% CI: 1.00359, 1.01512).							
Cerebral stroke	Nabavi et al.	2012	Tehran, Iran	Ecological time-series study for a period of 1 year in 8 hospitals	All hospital admissions from cerebral stroke	2004	Air Quality Index (AQI) for SO2, CO, PM10, and NOX
Air pollution had a direct association with the incidence of stroke and this association differed among different subgroups of patients.							
Emergency hospital admissions for cardiovascular diseases	Nakhlé et al.	2015	Beirut, Lebanon	Retrospective time-series study	Patients visiting the emergency department of six hospitals	Jan 2012-Dec 2012	Daily levels of PM10 and PM2.5
Total cardiovascular admissions were not significantly associated with the levels of PM10 (Relative risk [RR]:1.01; 95 % CI: 0.998–1.018) and PM2.5 (RR: 1.02; 95 % CI: 0.999–1.036) per 10 µg.m-3 rise in daily mean pollutant concentration on the same day.							
Cardiovascular disease	Bener et al.	2009	Qatar	Retrospective time-series study	All hospital ischemic heart disease and cardiovascular illness data	2002-2006	Mean daily concentration of SO2, NO, NO2, CO, O3, and PM10
Increasing air pollutant levels and patients admitted for cardiovascular diseases followed the same trend.							
Cardiopulmonary mortality	Dehghani et al.	2014	Shiraz, Iran	Cross-sectional study	Deaths from cardiovascular disease registered in a local health department	Mar 2011-Jan 2012	Pollutant Standard Index (PSI) for SO2, CO, PM10, and NO2
There was no significant correlation between deaths due to cardiovascular diseases and SO2, CO, PM10, and NO2 emissions.							
Cardiovascular mortality	Khanjani and Bahrampour	2013	Kerman, Iran	Ecological time-series study for a period of 4 years	Deaths from cardiovascular disease registered in a local health department	2004 –2008	Mean daily concentration of SO2, NO, NO2, NOX, CO, O3, and PM10

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No significant correlation was found between cardiovascular disease and the air pollutants.							
Cardiovascular and respiratory mortality	Goudarzi et al.	2015	Ahvaz, Iran	Data of ground-level ozone (GLO) in four monitoring stations were processed to a health effect model.		2012	Ground-level ozone
Cumulative cases of cardiovascular deaths which attributed to GLO were 43 persons, respectively. Corresponding RR for these two events were 1.008.							
Premature mortality caused by ischaemic heart disease	Lelieveld et al.	2015	EMR	Health impact modelling study	Global	2015	$PM_{2.5}$
Premature mortality caused by ischaemic heart disease related to PM2.5 will increase from 19.224 × 10-3% (n = 114,000) to 24.227× 10-3% (n = 188,000) in 2025 and 31.440 × 10-3% (n = 321,000) in 2050.							
Blood pressure and cardio-metabolic risk factors	Poursafa et al.	2014	Iran	National cross-sectional survey	Students aged 10-18 years, from 27 provinces	2009-2010	Air Quality Index (AQI)
Exposure to air pollutants in the pediatric age has an adverse cardiometabolic risk. There is a significant positive correlation between AQI and cardiometabolic risk factors including systolic blood pressure, fasting blood glucose, total cholesterol, LDL-cholesterol, and triglycerides, as well as significant negative correlations with HDL-cholesterol.							
Blood pressure	Sughis et al.	2012	Lahore, Pakistan	Cross-sectional study on children living in high polluted area and low polluted area	Children between 8 and 12 years.	Jan - Apr 2009	Mean daily concentration of PM (PM1, PM2.5 and PM10)
The adjusted means systolic and diastolic blood pressures among students living in a more PM polluted area (115.9 mmHg and 70.9 mmHg respectively) are significantly higher than students living in a less polluted area (108.3 mmHg and 66.4 mmHg respectively). Higher prevalence of blood pressure in the pre-hypertensive range was found among students living in the more polluted area (34%) than students living in the less polluted area (19%).							
Blood pressure and brachial artery distensibility	Trasande et al.	2015	Jeddah, Saudi Arabia				
Systolic (0.47 SD units, p = 0.006) and diastolic (0.53 SD units, p = 0.001) blood pressure Z-scores were highest at the school near the refinery, with a 4.36-fold increase in prehypertension (p = 0.001). No differences in pulse pressure, brachial artery distensibility and heart rate were noted in relationship to school location.							

(OR: 1.926; $P < 0.05$), after adjustment for confounding factors including age and sex. In Pakistan, Sughis *et al.* (2012) also investigated the cross-sectional relation between the average concentration of PM (PM_1, $PM_{2.5}$ and PM_{10}) and blood pressure in 166 schoolchildren. They found significantly higher adjusted mean systolic and diastolic blood pressures and higher prevalence of blood pressure in the pre-hypertensive range (34% vs. 19%) among students living in a more PM polluted area than students living in a less polluted. In Saudi Arabia, Trasande *et al*. (2015) reported that ssystolic and diastolic blood pressure Z-scores were highest at the school near the refinery, with a 4.36-fold increase in prehypertension ($p = 0.001$).

DISCUSSION

Only 13 studies (Fatmi *et al*., 2014; Qorbani *et al*., 2012; Hosseinpoor *et al*., 2005; Nabavi *et al*., 2012; Nakhlé *et al*., 2015; Bener *et al*., 2009; Dehghani *et al*., 2014; Khanjani and Bahrampour, 2013; Goudarzi *et al*., 2015; Lelieveld *et al*., 2015; Poursafa *et al*., 2014; Sughis *et al*., 2012; Trasande *et al*., 2015) from only 5 countries (Pakistan, Iran, Lebanon, Qatar, and Saudi Arabia) in EMR have examined the effect of air pollution on cardiovascular disease and met the inclusion criteria. More than have of studies were conducted in Iran. This finding indicates that the effect of air pollution on cardiovascular disease is poorly studied in the EMR. Most of research in the EMR focused on the effect of ambient air pollution. Other pollutants such as SHS and indoor biomass fuel smoke and their effect on cardiovascular disease were not well studied. Such exposures are major issue of concern in the developing countries. The reviewed articles showed that air pollution has a significant association with cardiovascular morbidity, especially in high risk groups, but not with mortality. Exposure to poor ambient air quality and particulate matter may increase blood pressure in schoolchildren. CO and indoor biomass fuel combustion increase the incidence of acute coronary syndrome among exposed women. CO has also been shown to increase hospital admissions for angina pectoris. Exposure to air pollutants including NO_X, CO, and SO_2 increases the risk of cerebral stroke in high-risk groups. The dose-response relationship between different air pollutants and their mixture and cardiovascular disease was not studied as a function of susceptibility (e.g., age, preexisting disease). These studies ignored the interaction between preexisting traditional cardiovascular risk factors (*e.g.*, diabetes, hypertension) and air pollution. Moreover, the extent to which treatment of traditional cardiovascular risk factors, especially among patients with known cardiovascular disease, may modify the risk associated with air pollution exposure is not investigated in the region. In addition, the effects of mixtures of ambient pollutants (i.e., potential synergism between PM and gaseous or vapor-phase pollutants such as ozone) is not well understood

Although air pollution is recognized as an emerging public health problem in the EMR countries, it is difficult to construct evidence on the effect of air pollution on cardiovascular diseases in the EMR countries for different reasons:

- The impact of air pollution on health is not recognized as a priority area by health researchers, health professionals, and policy makers in the EMR countries. The main reason may be that air pollution co-exists with other important public health problems, such as communicable diseases, vector-borne diseases, malnutrition and poor sanitation, which are given higher priority in circumstances where economic resources are limited.
- Although that the burden of diseases from air pollution is expected to be high in the EMR, a limited number of studies in a limited number of areas in the EMR countries have assessed the association between various air pollution exposures and health outcomes. These studies did not sufficiently represent the different geographic locations and compositions of the countries.

In addition, it is difficult to compare and contrast the results of different studies in the region due to differences in study designs and the potential covariates that were controlled for.

- For the majority of reviewed studies, limitations do exist in all studies even well conducted ones. The limitations and shortcomings that arise from inappropriate study designs, poor assessment of exposure and outcomes, questionable sources of data, lack of standardized methods, poor adjustment of confounders, limited geographical area studies, small sample sizes, poor statistical modeling, and not testing for possible interactions between exposures.
- Knowledge in the area of air pollution and heath is based on limited information and remains limited primarily due to weak technical capacity particularly in the area of modeling air pollutants and the lack of adequate availability of relevant data.
- There is a lack of international research collaborations and partnerships and lack of multidisciplinary research to addresses public health challenges and risks associated with air pollution.

In conclusion, air pollution has a significant association with cardiovascular morbidity, especially in high risk groups, but not with mortality in the reviewed studies. However, the reviewed studies did not sufficiently represent the different geographic locations and compositions of the countries. There is a need to better define susceptible individuals or vulnerable populations, and document the time course and specific cardiovascular health benefits induced by reductions in air pollution exposure. Another need is to enhance research on the complex synergistic effect of temperature, weather variability, long-term climate change, and environmental exposures such as criteria air pollutants on the incidence of various cardiovascular disease outcomes. Several precautionary recommendations can be made for healthcare providers who interact with individuals who are at risk for cardiovascular disease. All patients with cardiovascular disease should be educated about the cardiovascular risks posed by air pollution. Consideration should also be given to educating patients without cardiovascular disease but who are at high risk.

Ethics Approval and Consent to Participate: Not applicable

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Authors' contributions: All authors contributed to: search for literature, review the literature, abstraction of the data from the literature, summarizing the data in tables, and helping to draft the manuscript. All authors read and approved the final manuscript.

Competing interests: None of the authors have any competing interests in the manuscript

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