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Review Article

Dust Storm Effect and Climatological Factors on Cardiovascular and Cerebrovascular Respiratory Diseases: A Literature Review

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Abstract

Background & Aims: Dust storms, which are considered natural occurrences, have harmed the global population's health as a result of the broad increase in climate change. The most serious consequences of these alterations are cardiovascular, pulmonary, and cerebrovascular diseases. This review study focused on the effect of dust storms and climatic factors on mortality and morbidity in worldwide and assessed the prediction of these diseases based on changes in each of the meteorological factors and dust storms.

Materials and Methods: For data collection, English literature was searched using keywords "dust storm" and "respiratory disorders" or "cardiovascular disease" or "cerebrovascular disease" in PubMed, Web of Science, and Scopus as databases, along with Google Scholar as engine search. The first step was to use statistics on the number of instances of cardiovascular, cerebrovascular, and respiratory diseases. The association between the occurrence of these diseases and variations in climatic factors underwent assessment.

Results: Adverse repercussions could be noticed when dust storms were paired with changes in metrological parameters. More local information about the link of these diseases with dust storms and changes in metrological variables in the nation, as well as their capacity to anticipate them, is needed to prevent and reduce the health risk of these diseases.

Conclusion: In areas prone to dust storms, the population will be prone to its effects and consequences. Thus, preventive measures are beneficial at the community level.

Keywords: Climate change, Dust, Cyclonic storms, Risk factors, Environmental health, Disease

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1. Introduction

Climate change is one of the most serious public health concerns of the twenty-first century, posing a significant threat to human society [1]. Climate change's effects can take various forms, and these risks are not always obvious. Climate change is causing major political, economic, social, [2], and health [3] issues throughout the world, including dust storms and changes in meteorological parameters. Strong winds and hole storms remove significant volumes of sand and dirt off drylands, causing them to become movable and suspended in the air, resulting in haze [4]. Very small particles have a higher chance of causing major health problems [1]. Dust storms have become more common in recent years, both regionally and globally. The effects of these storms have been split into environmental and human categories [5,6]. The development of eastern waves, lower growth, and production of agricultural goods, as well as the escalation of insect and plant disease damage, are all examples of environmental consequences. Air pollution, the incidence of cardiovascular diseases such as coronary artery disease (CAD), business closures and drinking water pollution, increased road accidents due to reduced vision, an increase in per capita household treatment costs, closure of industrial, service, educational units, and financial losses [7,8], and psychological problems of humans [3] are among the most important human effects of dust storms [7,8]. High wind speeds, a lack of soil cover,

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soil moisture, rainfall, deforestation, drought, changes in land use, and various human activities are all elements that influence the frequency of dust storms in a given area [9-11]. Dust storms can be found on the beaches of North Africa, southern Europe, the Middle East, and East Asia, among other places [12]. Every year, millions of tons of minerals are transported to remote locations by the world's two largest dust storms. Dust storms in Asia, which primarily occur in the spring, originate in Mongolian and Chinese deserts and can strike eastern China, Korea, Japan, Taiwan, and even North America [13,14]. Strong winds blow in the arid regions of southwestern Saudi Arabia, which can transfer heat to other areas and, due to its proximity to water, can also carry moisture [15]. Early in the summer, this phenomenon, particularly its duration, intensifies, and powerful winds reach other surrounding regions, including Iran, during this time [16,17]. Even though Asian dust is a well-known natural phenomenon, new epidemiological research shows that it has negative health consequences [18]. As dust mixes with other contaminants in city air as it travels through the atmosphere, its effects become more hazardous [19,20]. This dust is also full of bacteria and biological chemicals that can induce or worsen respiratory illnesses [21]. It can potentially induce cardiovascular disease by inflaming the lungs or allowing highly small dust particles to enter the circulatory system [22-24]. Dust storms are becoming more common in the Middle East [25]. The dust has become a company of Iran in recent years as a result of human and environmental forces in bilateral interactions [26]. The financial and human problems and damages to people's lives caused by these storms are witnessed every year due to Iran's location in the semi-arid part of the world and its expansion of around 50% in the arid and desert region [27]. Wind erosion is one of the most visible examples and key characteristics of damaging desertification, and it is one of the most pressing issues confronting most countries in extraterrestrial, dry, and semi-arid bio-climates [28]. According to current evidence, not only has wind erosion harmed substantial lands in Iran, but the situation is also deteriorating at a considerably faster rate than the global average [29]. This review study focused on the effect of dust storms and climatic factors on mortality and morbidity in worldwide.

2. Materials and Methods

This study is a narrative review. In this type of study, researchers review the existing literature, and attempt to summarize what has been written on a specific area and is skewed toward the interpretation of prior knowledge [30]. For data collection, related literature was searched using keywords such as "dust storm" and "respiratory disorders" or "cardiovascular disease" or "cerebrovascular disease" in PubMed, Web of Science, and Scopus databases, and Google Scholar. Studies addressing the effects of dust storms and climatic conditions on cardiovascular and cerebrovascular disorders, as well as respiratory diseases in worldwide, were considered for inclusion. Only 56 related research were found from the 163 obtained articles. As a result, articles published between 1982 and 2022 were assessed, and the inclusion criteria were studies on the effects of dust storms and climatic factors on the cardiovascular and cerebrovascular diseases of respiratory diseases related to human health.

3. Results

A total of 163 articles related to the effects of dust and climatic changes on complications and mortality from cardiovascular and cerebrovascular respiratory diseases were found, of which, 37 and 70 articles were removed because of duplication and the lack of relevance to our study, respectively. Of these, 67 articles dealt with the various effects of dust on health, except cardiovascular, and cerebrovascular respiratory diseases effects. Among them, 56 articles focused on the health effects of dust on the incidence and mortality of cardiovascular and cerebrovascular respiratory diseases. The extracted articles are categorized in Table 1 by the author's name, type of study, year of publication, and the intended outcome used for the research.

4. Discussion

4.1. Dust storm trends and impacts

Dust storms have been a natural event every year for the past 50 years according to weather data. There have been four key changes in the pattern of dust storms in the country since a decade ago, including increased dust storm frequency, increased dust storm concentration, increased shelf life, and increased transmission distance from the source location. According to a review of the records for days with dust storms, the frequency of dust storms has always fluctuated over the decades with no consistent incremental trend. Dust concentration is one of the indications that have risen considerably in the last decade. The duration of dust and stability in Khuzestan province has increased by almost four times in recent years, and the amount of pollution has reached up to 10 000 micrograms per cubic meter according to a comparison of dust storm features in different years. Other statistics research has represented that recent dust storms in Asia had a substantial impact on the workload in the health care systems of the nations involved, causing the health care system, particularly the nursing system, to be overburdened in caring for elderly patients afflicted by the storm [29].

Dust storms were first observed in the southern regions of Iran and Iraq between 1984 and 1988 according to an examination of dust history. Until 2001, this phenomenon was only temporary, but over the next few years, it progressively extended throughout the country's southern

Table 1. Some studies included in this research

Author	Type of Study	Year	Findings
Ansari and Ehrampoush [31]	Correlational	2018	It was found that an increase of one microgram per cubic meter of PM2.5 will result in an additional 27 instances of fatalities due to air pollution in Tehran.
Sherbakov et al [32]	Descriptive	2018	Heatwaves and temperature exposure can have independent effects on a variety of ailments, including kidney, cardiovascular, brain, pulmonary, and gastrointestinal diseases according to research.
Lai [33]	Correlational	2018	It has been shown that when the Laoshan wind blows in conjunction with cold weather and strong local winds, the incidence of respiratory disorders increases, which is also related to winter and topographic factors.
Goggins and Chan [34]	Descriptive-analytical	2017	It was discovered that minimizing cold exposure among people at risk of heart failure could potentially minimize heart failure-related hospitalization and fatalities.
Ryti et al [35]	Systematic review and meta-Analysis	2016	The cold wave was linked to an increase in mortality and other detrimental health effects in the local population according to research.
Zheng et al [36]	Correlational	2016	The incidence of primary ICH related to high blood pressure increases as the temperature changes (a quick drop in hot weather or an increase in cold weather).
Vencloviene et al [37]	Correlational	2015	The number of emergency calls and the likelihood of acute coronary syndrome were linked to variations in daily air temperature, daily air pressure, and wind speed according to the study.
Son et al [38]	Correlational	2014	It was revealed that in Korea, both high and low ambient temperatures are linked to the incidence of hospitalization, particularly among women and young people.
Ebrahimi et al [39]	Cross-sectional	2014	It was indicated that despite the statistically insignificant link between respiratory disorders and dust storms, the number of cardiovascular diseases is significantly correlated to it.
Kang et al [40]	Descriptive-Analytical	2013	According to the study, myocardial infarction was significantly higher one and two days after the dust storm in Taiwan than on the other days without dust.
Brook et al [41]	Review	2010	These storms could have a considerable impact on the incidence of cardiovascular disease. Climate change, for example, is causing a health problem among migrants. However, epidemiologists claim that there is no meaningful effect on the link between cardiovascular diseases.
Staskiewicz et al [42]	Descriptive-analytical	2010	There was a new relationship between weather and the incidence of pulmonary embolism in men.

Note. ICH: *Intracerebral hemorrhage*.

and western cities, eventually covering all 18 provinces by 2008. According to research on dust storm statistics in Khuzestan province, the chemical composition of these dust storms contains heavy metals in quantities extremely exceeding the permissible limit, which are highly detrimental to human health [29]. The drying out of many areas of the wind path wetlands that act as air filters, notably the Great Hurricane, and the decrease in the water of the Tigris and Euphrates Rivers and their diversion, which has led to changes in the environment over time, are two of the reasons of dust in Khuzestan province [43]. The Gap Project is one of the primary (and possibly indirect) sources of dust in Iran's southern cities. Turkey has begun large dam-building projects that are expected to increase the country's economy, tourism, and jobs, but it is experiencing drought and dust storms downstream in Iraq and Iran. Another significant effect of the Turkish Gap Project will be a significant reduction in the downstream inflows of the Tigris and Euphrates rivers, as well as a lack of environmental water rights to downstream water areas and the worsening of dust storms [29]. Furthermore, control of the waters of the Karun, Dez, Karkheh, Zohreh, and Jarahi rivers by several dam chains, as well as the increased use of water from these rivers, has resulted in a reduction in downstream ecosystem environmental water rights, such as wetlands, and the formation of dust storm hotspots [29].

4.2. Effects of dust storm on human health

The propensity of dust to convey numerous allergenic and infectious particles was addressed in a study on the condition of dust storms. The skin, eyes, ears, and throat are the first organs to be affected by these toxins [44]. Considering the extent of the impact of dust on Iran, which is caused by the impact of climate change and drought in Iran, it is not implausible to expect consequences such as health problems in a wide range of provinces in the country, and paying attention to these health areas in short- and long-term plans should be taken into consideration. Choi et al studied the Asian dust storm particles including a broad toxicological transcriptional program in human epidermal keratinocytes. The most common fungal infections were *Aspergillus* and *Cryptococcus* according to reports [45]. Considering that the most source of dust storms in Iran is from neighboring countries, many fungal- and bacterial-related diseases may be transferred to Iran through dust storms. Dockery et al examined air pollution and mortality in six US cities [46]. Different places in Iraq were evaluated in terms of dust status in a study focusing on investigating dust storms in Iraq using a geographical information system. Particle samples were prepared and examined as well. Perez et al identified and quantified plant particles, microorganisms, and industrial particles, and discovered fungus spores, plant pollen, and agriculture seeds as

common allergens linked with dust storms [47]. In 2010, a study was undertaken in Korea to evaluate the impacts of dust storm particles on gene expression in human skin keratinocytes [48]. The researchers discovered that gene stimulation caused particulate matter to increase or create inflammatory cytokines or immune system regulators. PM2.5 to PM10 dust particles are commonly found in the atmosphere. In recent years, numerous studies have demonstrated their impact on health and death. People who are exposed to dust, even a short-time exposure, were found to have a higher likelihood of hospitalization and mortality [49]. Many studies have been conducted on the impact of dust on human health and mortality rates with mixed results. The findings of many studies suggest a link between dust and respiratory diseases. The impact of dust on cardiovascular disease has been highlighted in investigations by Peters et al [50]. According to different researchers, rising dust and air pollution concentrations increase mortality and hospitalization, further increasing the incidence of cardiovascular and acute respiratory disorders in these types of disasters. These situations are also more common in those who have a poor socioeconomic position and are illiterate [41,51-56].

5. Conclusion

According to studies, the trend of the incidence of dust storms around the world is increasing. In the field of health, the effects of these storms on various diseases, especially the incremental trend of the hospitalization process on days with the occurrence of dust events, are emphasized in many articles. The causes of these hospitalizations are mostly respiratory, cardiovascular, and cerebrovascular diseases, and as a result, the mortality associated with these diseases in the studies is clear. However, some studies failed to find statistical significance in the mentioned cases. The type and size of particles in the dust have been investigated in some studies, along with the effect of these parameters on the incidence of disease or prolongation of diseases, which often indicates contradictory results in this field. However, most studies have been conducted in capitals, metropolises, and industrial cities full of various man-made pollutants. Given that the synergistic effect of man-made pollutants and particles in dust storms has been considered in some studies, the results of studies are in a haze of ambiguity. The effect of meteorological elements on some diseases has also been evaluated, and the harmful effects of these factors on some diseases, including cardiovascular, respiratory, and cerebrovascular diseases, have been proven, although some studies did not confirm these results. On the other hand, there is no comprehensive study on the combined effects of dust storms and meteorological elements on health in the world; therefore, according to all aspects and studies, it seems that there is still a need for further studies in this field to clarify the many hidden angles that exist in this area. With the help of the results of this research to predict the occurrence of dust and the synchronization of meteorological elements in the future, it will be helpful to plan properly to reduce the effects, and prepare and respond to this risk, leading to beneficial outcomes.

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Authors' Contribution

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Competing Interests

The authors declare that they have no conflict of interests.

Ethical Approval

This article is a literature review with no human or animal sample. However, this article is the background of a research study with ethical considerations (IR.ZBMU.REC.1398.151).

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