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Original Research

Health risk assessment of exposure to the Middle-Eastern Dust storms in the Iranian megacity of Kermanshah

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ABSTRACT

Objective: This study assessed the effects of particulate matter (PM), equal or less than 10 μm in aerodynamic diameter (PM_{10}), from the Middle-Eastern Dust events on public health in the megacity of Kermanshah (Iran).
Study design: This study used epidemiological modeling and monitored ambient air quality data to estimate the potential PM_{10} impacts on public health.
Methods: The AirQ2.2.3 model was used to calculate mortality and morbidity attributed to PM_{10} as representative of dust events. Using Visual Basic for Applications, the programming language of Excel software, hourly PM_{10} concentrations obtained from the local agency were processed to prepare input files for the AirQ2.2.3 model.
Results: Using baseline incidence, defined by the World Health Organization, the number of estimated excess cases for respiratory mortality, hospital admissions for chronic

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PM_{10}
Morbidity

obstructive pulmonary disease, for respiratory diseases, and for cardiovascular diseases were 37, 39, 476, and 184 persons, respectively, from 21st March, 2014 to 20th March, 2015. Furthermore, 92% of mortality and morbidity cases occurred in days with PM_{10} concentrations lower than 150 $\mu g/m^3$. The highest percentage of person-days occurred for daily concentrations range of 100–109 $\mu g/m^3$, causing the maximum health end-points among the citizens of Kermanshah.

Conclusions: Calculating the number of cumulative excess cases for mortality or morbidity attributed to PM_{10} provides a good tool for decision and policy-makers in the field of health care to compensate their shortcomings particularly at hospital and healthcare centers for combating dust storms. To diminish these effects, several immediate actions should be managed in the governmental scale to control dust such as spreading mulch and planting new species that are compatible to arid area.

Introduction

Air pollution due to urbanization, industrialization, and population growth is an environmental concern in the current century.[1–4] Exposure to ambient air pollution has been associated with increased mortality and morbidity cases in the world.[5–8] The World Health Organization (WHO) reported that annually more than 800,000 deaths were attributed to air pollution. Approximately 150,000 cases of these deaths happened in southern Asia.[2,9,10] Among different air pollutants, particulate matter (PM) is a pollutant with the most harmful impacts on human health.[11,12] Epidemiological studies have proven that there is a strong correlation between PM levels and morbidity due to the acute and chronic cardiovascular and respiratory diseases.[2,13] PM with an aerodynamic diameter equal or less than 10 μm (PM_{10}) has the most adverse effects on human health.[14] The major anthropogenic sources of PM are e.g. road traffic, combustion, power plant activities, and industrial processes.[15] Some PM occurs naturally, originating from volcanoes, dust storms, forest and grassland fires, living vegetation, and sea spray.

Exposure to ambient PM_{10}, even below a daily mean of 100 $\mu g/m^3$, can cause several health outcomes such as immune system reactions, lung irritation, bronchitis, asthma exacerbation, hospitalization due to respiratory and cardiovascular diseases, chronic bronchitis, cancer, and death.[4,16] Particles can also increase a person's susceptibility to respiratory infections. Epidemiological studies have showed that more than 500,000 Americans passed away per year due to cardiovascular diseases attributed to PM_{10}.[4] Jeong (2013) highlighted an association between ambient PM_{10} levels and total mortality, cardiovascular mortality, respiratory mortality (RM), hospital admissions for respiratory diseases (HA-RD) and cardiovascular diseases (HA-CVD).[16] Since 2004, the city of Kermanshah (Iran) has experienced major desert dust storms originating from Western Asia especially Iraq, Kuwait, Syria, and Saudi Arabia.[21] These dust events lead to thousands of hospitalizations each year due to cardiovascular and respiratory diseases.[2,17] The studies of Kwon et al., Meng et al., Shahsavani et al., and Omidi et al. showed that there is a significant correlation between dust storms and mortality and morbidity for cardiovascular and respiratory diseases.[17–20]

The main objective of this study was to assess, through an ecological study, the impact of the Middle-Eastern Dust (MED) events on the excess number of RM, hospital admissions for chronic obstructive pulmonary diseases (HA-COPD), HA-RD, and HA-CVD over the one-year period (2014–2015) in the Kermanshah city (Iran) known to be frequently exposed to desert dusts.

Methods

Study area

Kermanshah (34°19′N, 47°30′E), with a population higher than 870,000 people, is the capital city of Kermanshah Province (Fig. 1). It is located in Western Iran, adjacent to Iraq borders. The city has been exposed to large amounts of PM_{10} as a result of the MED storms. During some days, the visibility can be reduced to 200 m or even lower.[24] Kermanshah has an elevation of 1350 m above sea level with a semi-arid climate and an annual mean temperature of 14.3 °C.[21] The presence of several huge industrial factories, such as the petrochemical refinery and Kermanshah Oil Refining Company, the high road traffic, and the proximity of Iraqi deserts which are a source of MED results in Kermanshah being one of the largest contaminated cities in the world.[22]

PM_{10} sampling

An air pollution monitoring site was established and the Kermanshah's Environmental Protection Agency (KEPA) is responsible for maintenance and operation. PM_{10} concentrations were measured using a beta attenuation monitoring, a widely used air monitoring technique employing the absorption of beta radiation by solid particles extracted from air flow. This technique allows for the detection of PM_{10} and $PM_{2.5}$. One-year data of PM_{10} concentrations were obtained from KEPA from 21st March 2014 to 20th March 2015. Hourly PM_{10} concentration data were processed by using Excel to prepare the input files for the AirQ software.