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A retrospective study examining climatic influence on the respiratory health of Qatar residents

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Abstract

There are obvious and well known links between air quality and acute respiratory illnesses that are common in Qatar and other Middle Eastern countries. For example, recent studies have documented a number of respiratory problems associated with inhalation of dust during dry, windy periods. In Qatar, exposure to dust and sand are anecdotally associated with a variety of respiratory issues including asthma and chronic obstructive pulmonary disease (COPD). These illnesses may be brought about by physical damage caused by the particles themselves, or by microorganisms that can be associated with these particles. In this study we examine the relationship between different climatic variables, daily airborne particulate matter, and hospital admissions for respiratory problems over a six month period to establish possible relationships. The results of the study will shed light on the importance of weather phenomena, particularly windy conditions, in impacting respiratory health in Qatar. These data are particularly important as respiratory problems are expected to increase as climate change results in hotter, drier conditions over the next few decades.

Keywords: Health; respiratory problem; air quality; weather; Doha; Qatar; Middle East.

1. Introduction

Acute respiratory problems, such as chronic obstructive pulmonary disorders (including bronchitis and emphysema), asthma, and respiratory infections are important causes of hospital admissions in Qatar and other Middle Eastern countries. A variety of climatic factors are known to influence respiratory health, usually through their impact on air quality. In dry, hot areas, one of the main climatic factors influencing air quality is wind.

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Windy conditions increase the risk of exposure to a variety of physical, chemical and biological agents, all of which may negatively impact health. More recently, investigators have begun to examine the relationship between dust/sand storms and respiratory health. In general, chronic exposure to airborne particulate matter can result in an increase in lower respiratory symptoms, COPD, reduction in lung function and reduction in life expectancy (Weese & Abraham 2009). Short-term exposure (less than 3 days) may result in lung inflammation and other respiratory problems (Bell et al., 2004).

How important are weather conditions in causing or aggravating such problems? The region around Qatar is one of the driest on earth with maximum daily average temperatures in August reaching 45°C (Sadiq & Howari 2009). Wind, particularly during the winter months, can carry significant amounts of dust/sand. This results in a dust loading in Qatar and neighbouring countries (200 mg/m2) as being second highest in the world (after Saharan Africa) (De Longueville et al., 2010). While a relationship between weather patterns and respiratory problems are commonly noted in newspaper articles and websites (e.g., "Weather flux triggers respiratory diseases" -Qatar Tribune; "Residents advised to take health precautions during dust storms" -Qatar is Booming; "Air pollution causes allergy-induced ailments" -Gulf Times), detailed investigations concerning such links are lacking. Interestingly, Dr. Osama al Dulaimi reported that the number of asthma cases at the Qatar Medical Centre (QMC) increased by as much as 30% during and shortly after very windy conditions (Qatar Tribune, 27/03/11).

In this study, we propose to conduct a detailed correlational analysis between various climatic variables, the density of airborne particulate matter, and the incidence of hospital admissions related to respiratory problems.

2. Methods

We examined admissions at a local health clinic for which incoming patients used a nebulizer for respiratory problems. The clinic was chosen due to its proximity to the university (within walking distance), the frequency of admissions, and their interest in being involved in the project (one senior staff member is a collaborative mentor on this application). Information collected was limited to gender, age, occupation, and ethnicity of patients. These variables allowed us to identify groups most at risk as well as facilitate the correlation /regression analysis by controlling other variables likely to influence clinic admissions.

To obtain accurate local weather information, we employed a wireless weather data logging station located at the university. This device transmitted information concerning minimum and maximum temperature, relative humidity, precipitation, wind speed, wind direction, and gust averages. Daily averages for the period from 1 November 2013 to 31 March 2014 was used to examine the relationships between climatic variables and 1) airborne particulate concentration and 2) respiratory illnesses. Because wind data from this device were lower than normal (presumably due to the location of the weather station), wind speed and direction were taken form airport values.

We used two laser particle counters (Dylos Corporation, DC 1700) to gather daily information on particle concentration for two sizes of airborne particles: 0.5-2.5 microns and above 2.5 microns. These devices can store approximately 10,000 samples over a one week period, sampling every one minute. Samplers will be located on opposite sides of the university campus to account for potential variability due to wind direction, etc.

3. Results

A total of 774 people used the nebulizer between mid November and the end of March. Slightly more than half of these were female and most of these fell into the "adult" category of being 20-59 years of age. Slightly more than half were Qataris with the remainder coming from 28 different countries, most notably Egypt, Pakistan, India and Sudan (Fig. 1a-d). The temperature ranged from about 35 °C in November and April to a low of about 20 °C in January and February. Doha, being a peninsula, is quite humid had an average percentage of daily high humidity of 83.9 over the study period. The wind speed averaged just over 10 kph, after correcting for direction, and came primarily from two directions corresponding to southeast and northwest (Fig. 2a-d)). There was just over 3 mm of rain during the five months. The total number of particles averaged just over 720,000 per day (657,000 small and 65,000 small (Fig. 3a, b).

The number of particles to which people were exposed depended directly on various weather factors. For example, when the total number of particles was considered, particle number was positively related to humidity and negatively related to rainfall, high temperature and wind speed (multiple regression, n = 134, $r^2 = 0.275$, $p < 0.0001$). Weather was also weakly associated with respiratory admissions ($r^2 = 0.096$, $p = 0.014$); it was positively related to rainfall events and negatively related to wind speed. Air quality, to date, has shown no relationship with how many people used the nebulizer although this analysis has not yet been completed.

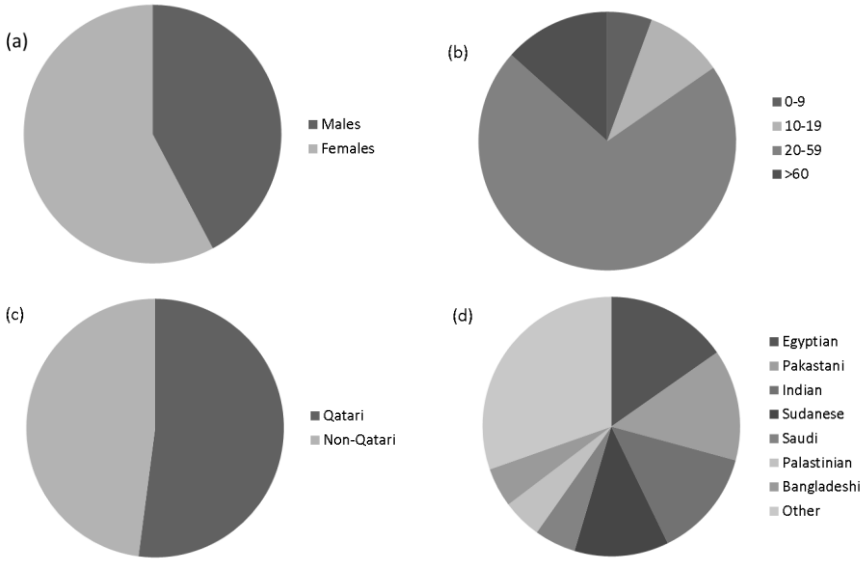

Fig. 1. The study population. (a) Sex ratio, (b) age distribution, (c) ethnicity, (d) non Qataris.

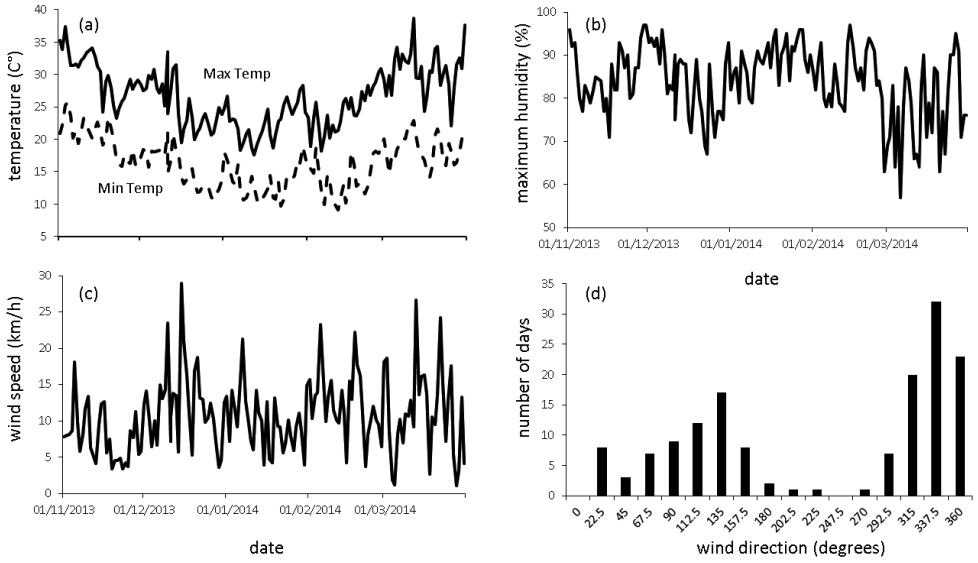

Fig. 2. Weather variables. (a) Temperature, (b) humidity, (c) wind speed, (d) wind direction.

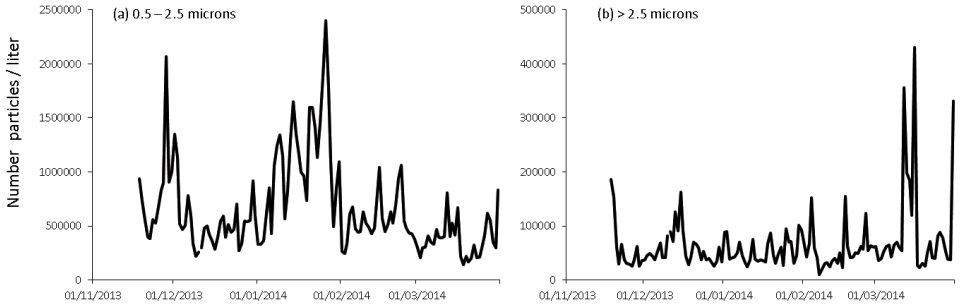

Fig. 3. Air quality. (a) Small particles, (b) large particles.

4. Discussion

Although we found evidence of certain weather variables affecting the amount of particulate matter, we found little to convince us that air quality is related to the number of people who visit the clinic and receive nebulizer treatment. High temperatures, for example, are often associated with an increase in ground levels of ozone, which in turn negatively impact respiratory function (Thurston & Ito, 1999; WHO, 2000). In New York City, high temperatures were correlated with increased hospital admissions for both chronic airway obstruction and asthma (as well as some cardiovascular problems) (Lin et al., 2009). Humidity levels are often positively correlated with allergenic spores (e.g., Hasnain et al., 2012) and other particulates (e.g., Kulshrestha et al., 2012) and thus can trigger asthmatic

attacks or other forms of respiratory distress. More recent reviews of the diversity of organisms that may occur in aerial dust along with their potential impact on human health are provided by Griffin (2007) and Al Saadi (2010).

Waness et al. (2011) cited evidence suggesting that exposure to dust-sand storms in the Middle East may contribute to pulmonary alveolar proteinosis and silicosis. Respiratory illness is an important reason for clinic visitation, hospital admission and drug use in Qatar. Janahi et al. (2006) reported high prevalence of diagnosed asthma (19.8%), allergic rhinitis (30.5%), and chest infection (11.9%) among 6-14 year old schoolchildren in Qatar, with the prevalence of each illness being similar in parents. Al Marri (2006) reported a hospital admission rate of 42 per 100,000, of which 35% were less than 15 years of age. In addition, Al Marri reported a seasonal pattern with December the peak month for hospitalization. While researchers to this point have focused largely on the incidence of asthma, other respiratory problems in Qatar also appear to be on the rise. According to Dr Hussain al Awadhi, a senior consultant at Hamad Medical Corporation (HMC), *"While statistics continue to show a steady decrease in reported cases of health conditions such as stroke, hypertension and even cancer, the reverse is the case for COPD diseases commonly referred to as chronic bronchitis and emphysema, as they continued to be on the increase."* (Qatar Tribune, 27/10/2010).

Given the results above, it is fair to ask why particulate matter does not appear to be related to respiratory stress in our study. First, it is possible that many of the people that visit the clinic are not subject to the poorest air quality. The fact that more than 50% of the patients were female, suggest we are not getting an unbiased representation of the population (that tends to be heavily biased towards males) and many of the patients may be staying inside during much of the day. Second, it is possible that the clinic we have chosen (due mainly to its proximity to the university) is, itself, not representative of the Doha population as a whole. Many of the records were incomplete and diagnoses were unavailable. Thus we limited our selection of patients not to all those experiencing respiratory problems but only those using the nebulizer. These factors combined to reduce the overall number of patients to less than 15 (normally) daily. Third, because this part of the project ended at the end of April, we have not yet had time to complete our analysis. Over the next few months, we will examine the relationship between air quality (particulate matter) and respiratory health (patients using the nebulizer) more closely. Also, pending funding, we also hope to compare our results with similar ones from June through October when temperatures are higher and dust storms are more frequent.

5. Acknowledgements

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