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The correlation between middle schoolchildren allergic symptoms and airborne particle season

A cross-sectional study

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Abstract

Limited studies correlate allergic symptoms and associated outdoor biological particle exposure among schoolchildren globally.

This study aimed to investigate the relationship between the seasonality of symptoms of allergic diseases among middle schoolchildren and the annual variation of airborne pollen and fungal spore in a hot and humid geographical region (Qatar).

During November 2017 to January 2018, a self-reported study of middle schoolchildren living in the Doha capital city of Qatar was conducted, and data gathered were evaluated in relation to the collected monthly pollen and fungal spores. Participants' data were collected by conducting a survey based on a modified questionnaire adopted from the International Study of Asthma and Allergy in Childhood (ISAAC). The airborne pollen and fungal spore in Doha's atmosphere were extracted from the Doha aerobiology project (2017–2020).

Among the 1000 distributed questionnaires, 100 were excluded due to significant missing data and 644 middle schoolchildren living in Doha city responded and were included in the final analysis. The symptoms of allergic rhinitis (AR) pattern among the responders with positive symptoms were strongly linked with the higher airborne fungal spore incidence during the month of November. Out of 331 students with positive symptoms, the prevalence of AR, lifetime wheeze, and eczema was 62.8%, 28.1%, and 26.6%, respectively. Asthma was significantly higher in Qatari (39.8%) compared to non-Qatari (26.7%) middle schoolchildren ($P=.02$).

Outdoor aeroallergen may be a contributing factor in addition to other environmental and genetic predisposing factors for childhood atopic diseases in the prevalence rate of allergic symptoms among middle schoolchildren in the peninsula of Qatar.

Abbreviations: AR = allergic rhinitis, ISAAC = The International Study of Asthma and Allergies in Children.

Keywords: airborne aeroallergens, allergic rhinitis, asthma, eczema, middle schoolchildren

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Consent for publication: We confirm that the manuscript has been read and approved by all named authors and that there are no other persons who satisfied the criteria for authorship but are not listed. We further confirm that the order of the authors listed in the manuscript has been approved by all of the authors. We confirm that we have given due consideration to the protection of intellectual property associated with this work and that there are no impediments to publication, including the timing of publication, with respect to intellectual property. In doing so, we confirm that we have followed the regulations of our institutions concerning intellectual property. We further confirm that any aspect of the work covered in this manuscript that has involved either experimental animals or human patients has been conducted with the ethical approval of all relevant bodies and that such approvals are acknowledged within the manuscript. We understand that the corresponding author is the sole contact for the editorial process (including the editorial manager and direct communications with the office). She is responsible for communicating with the other authors about the progress, submission of revisions, and the final approval of proofs. We confirm that we have provided a current, correct email address which is accessible by the corresponding author.

Availability of data and materials: The datasets used and/or analyzed during the present study are available from the corresponding author on reasonable request.

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1. Introduction

Asthma, rhinitis, and eczema in childhood have become the three important public health problems worldwide.[1] Asthma is a major cause of morbidity and mortality among all age groups, with an estimated 300 million affected people and an annual 250.000 deaths worldwide.[2]

The International Study of Asthma and Allergies in Children (ISAAC) has been developed to measure the prevalence and severity of asthma and other atopic diseases in children. Standardized research instruments, such as the ISAAC questionnaire, have been introduced to gain better insight into the world prevalence of asthma and other allergic diseases among children.[3,4]

By the time children reach middle school (10–13 years of age), asthma is strongly associated with positive skin tests to common inhalant allergens.[5] Besides, allergic rhinitis (AR) is a common allergic disease, and multiple comorbidities are associated with AR, and considerable costs arise due to school or work absenteeism, loss of productivity, and use of healthcare resources.[6] The prevalence of asthma and AR is high and increasing in western countries.[7] However, longitudinal data to estimate the trend over time about the prevalence rate of allergic disorders in schoolchildren in the Middle East and Arab Gulf countries using the ISAAC protocol are limited.[8]

In Omani schoolchildren, the occurrence rate of reported asthma, AR, and eczema was significantly higher in older children aged 13 to 14 years (20.7%–19.8%) than in younger 6 to 7 years old (10.5%–10.6%).[9] Behbehani et al (2000) indicated that the prevalence rate for asthma symptoms, AR, and eczema are 25.9%, 43.9%, and 17.5% of the 13 to 14 years old children in Kuwait. These authors indicated that Kuwait's studied children have a moderate prevalence of asthma, AR, and eczema compared with other countries where international studies of asthma and allergies in childhood have been done.[10]

The prevalence of asthma and allergic diseases among schoolchildren has been investigated in Qatar using the ISAAC questionnaire. A total of 3280 children aged 6 to 14 years received a cross-sectional survey in Doha from February 2003 to February 2004. The overall prevalence rate of diagnosed allergic diseases was asthma (19.8%), AR (30.5%), and eczema (22.5%). Genetic factors related to the high rate of consanguinity may play an important role in the observed high prevalence noted in the Qatari population.[11]

There is a gap in the knowledge of the implication of the naturally occurring environmental factors and their effect on the prevalence of respiratory symptoms among schoolchildren and particularly in Qatar. The current report is part of a national research project initiated in 2017 to evaluate the distribution of airborne particles, prevalence and incidence of asthma and AR among adults and children, and correlate their symptoms with airborne pollen and fungal spore monitoring in the peninsula of Qatar. The first part of the project was conducted among adult patients attending Allergy clinics in Hamad Medical Corporation—Doha, Qatar using ISAAC questionnaires to identify the association between airborne particles and allergic diseases. It was found that among 940 surveyed patients, 204 were sensitized to pollen (54% female) with 135 (66.2%) and 114 (55.8%) to Amaranthaceae and Poaceae, respectively. Also, there was a statistically significant correlation between Amaranthaceae and asthma and AR.[12] For further evaluation, we conducted a second survey using the same methodology to determine the relationship and correlation between the seasonal pattern of airborne particles and the pattern of asthma, AR, and eczema among middle schoolchildren in the state of Qatar.

2. Materials and methods

Approval for the study was obtained from the Medical Ethics Committee of the Hamad Medical Corporation (MRC#16150/16). The questionnaire with a letter of explanation was distributed to the parent of these children. The survey was anonymous, so no written consent was obtained from the students or parents of each child. A clear instruction was given to students that the survey is voluntary, and an explanation of the study was done to students and any parent who had any concerns.

2.1. Questionnaires

The ISAAC questionnaire was adopted with modifications to determine the incidence of airborne allergens with focusing on asthma, AR, and eczema among middle schoolchildren. The standardized ISAAC questionnaire, originally written in English, was translated into Arabic, and physicians revised the adequacy of the translated questionnaire with a few modifications from the original questionnaire. In addition to the original ISAAC core questions on asthma and eczema symptoms, the following questions were added to our modified ISAAC questionnaire: *Was your disease confirmed by a specialist physician? Which month of the year do you have wheeze in the last 12 months? Which month of the year do you observe exacerbation of Allergic rhinitis and/or eczema in the last 12 months?*

After getting approval from the Ministry of Education's authorities in Qatar, the questionnaire was applied to schoolchildren between 12 and 15 years old between November 2017 and January 2018. The sample comprises Qatari and expatriate male and female students from four schools (governmental and private schools) located near the pollen sampling station, Hamad Bin Khalifa Medical City, Doha capital.

The collected information about middle schoolchildren's symptoms was correlated with the average pattern of airborne pollen and fungal spore seasonality in Doha's atmosphere during 2017 to 2018 to assess the questionnaire's validity.

2.2. Aerobiological monitoring

The airborne biological particles (pollen and fungal spore) that are considered environmental allergens were collected weekly with a volumetric 7-day recording spore trap placed about 15 m above ground level on the rooftop of Hamad Bin Khalifa, Medical City in Doha, Qatar, as previously described.[12] The sampling was started on May 7, 2017. An experienced aerobiologist investigated the pollen grains and fungal spore identification and counting according to the standard methods of the Spanish aerobiological network[13] and the minimum requirements from the European Society of Aerobiology.[14] The sampling period May 2017 to May 2018 was taken into consideration to provide the association between the symptoms and overall monthly exposure to pollen and fungal spore.

2.3. Statistical analysis

The collected data were entered into a database in the Allergy and Immunology Unit, Hamad Medical Corporation. The data were analyzed using the Statistical Package for Social Sciences software (SPSS, Chicago, IL) for Windows, Version 21.0. We calculated the prevalence of each symptom and investigated the correlation of these symptoms to the aerobiological particles of each month of the year (May 2017–May, 2018). Additional comparison between symptoms and middle schoolchildren citizenship (Qatari and non-Qatari) was investigated to ascertain the association between the symptoms and nationality. $P < .05$ was considered statistically significant.

3. Results

Among 1000 middle schoolchildren enrolled for the survey, 100 were excluded due to significant missing data. A total of 644 out 900 responded to the modified ISAAC questionnaire representing an overall participation response of 71.5%. Among the responders, 313 questionnaires were excluded due to the non-presence of allergic symptoms. The final analyzed sample size was 331 surveys of children with at least one symptom.

Figure 1 compares the three respiratory symptoms' monthly dynamics, and the airborne pollen and fungal spore count was presented. A time delay between the appearance of allergic symptoms and pollen in the air was observed. Several schoolchildren reported an increase in AR (10.3%) during November and asthma in December (6.9%) after an important peak of pollen recorded during September (29.8% of the total pollen). When we analyzed the airborne fungal spore effect on the allergic symptoms, the results confirmed a correlation between the AR pattern among middle schoolchildren and November (19.3% of total fungal spore), representing the highest levels of airborne fungal recorded in Doha, the Capital city of Qatar.

The lifetime prevalence of asthma, AR, and eczema are shown in Table 1. According to the written questionnaire, a total of 93 children (28.1%) had a lifetime (ever) wheeze, 208 (62.8%) sneezing and nasal congestion, and 88 had eczematous skin (26.6%). In assessing the severity of asthma, AR, and eczema symptoms, 53 (16%), 188 (56.8%), and 79 (23.9%) children experienced wheezing attacks, Sneezing, and eczematous skin rash, respectively, in the past 12 months. Regarding sleep disturbances, 17 (5.1%) and 21 (6.34%) were awake more than one night per week due to wheezing and itchy rash. About the middle schoolchildren's life quality, 68 (20.5%) children reported that AR affects their lives a little bit, and 52 (15.7%) of children's lives were moderately disturbed. A total of 64 (19.3%) had physician-diagnosed asthma, 54 (16.3%) AR, and 52 (15.7%) atopic eczema.

Table 2 shows a comparison between middle schoolchildren's citizenship and the prevalence of allergic symptoms. Asthma was a significantly higher parameter in Qatari middle schoolchildren than the expatriates ($P = .02$). The prevalence rate of AR was higher in Qatari children (67.7%) than in non-Qatari children (60.9%). The results did not show significant differences between the nationality parameter and the types of analyzed symptom. Eczema showed a similar pattern of higher prevalence rate among Qatari middle schoolchildren (37.6%) compared to other nationalities (22.2%).

4. Discussion

This study aimed to analyze the association between schoolchildren's symptoms of allergies in subjects aged 12 to 15 years and the exposure to outdoor allergens (pollen and fungal spore) in the atmosphere of Doha, the capital city of Qatar.

Daily pollen and fungal spore follow a distinct seasonal pattern in Doha City, with pollen typically present during the hot season (August to October) and fungal spore present during the cold season (November and March) (Fig. 1). Our data have a trend toward a correlation between the seasonal variation of the onset of AR symptoms and the peak of fungal spore concentrations during November. In the first air monitoring report, higher levels of fungal spore were recorded in Qatar's atmosphere. A high monthly distribution of *Cladosporium* spore was recorded in November and *Alternaria* spore in April.[15] These results emphasize the importance of measuring fungal allergen exposure and allergic respiratory diseases. As indicated by previous researchers' studies, the relationship between day-to-day respiratory diseases severity and combined exposure to airborne fungal spore remains not clearly defined.[16–18]

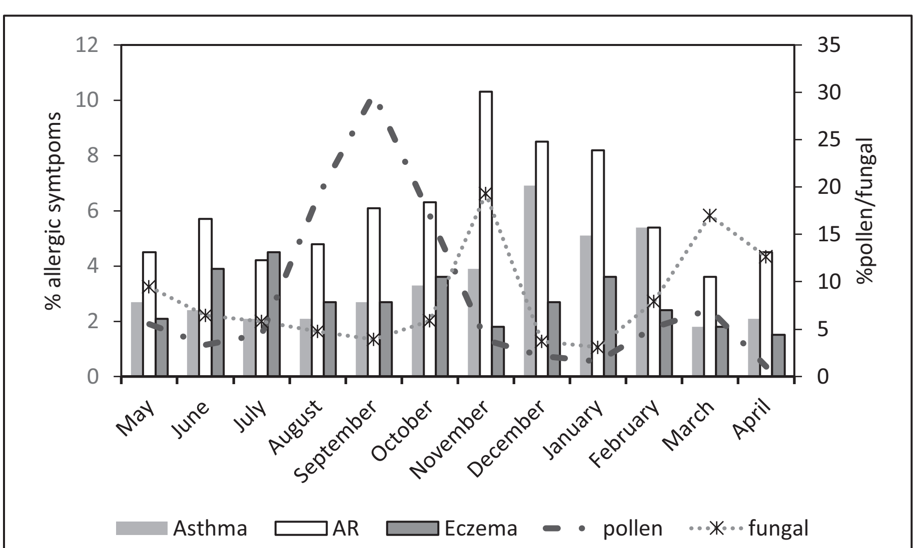

Figure 1. Association between allergic symptoms (n=331) and seasonal variation of airborne particles in Doha (2017–2018).

Table 1

Prevalence of asthma, allergic rhinitis, eczema, and associated symptoms in the study group (n=331).

Symptoms	N (%)
Allergic rhinitis	
1. Sneezing, rhinorrhea, and nasal congestion without flu, ever	208 (62.8)
2. Sneezing, rhinorrhea, and nasal congestion without flu in the last 12 mo	188 (56.8)
3. Any eye symptoms (itchy and watery) in the last 12 mo?	125 (37.8)
4. How much rhinitis affected your quality of life?	
Not at all	56 (16.9)
A little	68 (20.5)
A moderate amount	52 (15.7)
A lot	17 (5.1)
5. Any diagnosis by a specialist to have allergic rhinitis?	54 (16.3)
Asthma	
1. Wheeze ever in life	93 (28.1)
2. Wheeze in the last 12 mo	53 (16.0)
3. Frequency of wheeze attacks last 12 mo	
Never	12 (3.6)
1–3 times	45 (13.6)
12–4 times	13 (3.9)
More than 12 times	12 (3.6)
4. Frequency of wheeze attacks while sleeping last 12 months	
Never	38 (11.5)
Less than 1 night per week	26 (7.9)
More than 1 night per week	17 (5.1)
5. Unable to speak due to wheeze in the last 12 mo	36 (10.9)
6. Diagnosed with asthma?	64 (19.3)
7. Does exercise induce wheeze?	81 (24.5)
8. Dry cough in the night without flu last 12 mo	164 (49.5)
Eczema	
1. Any eczematous skin rash with the itchiness that goes and comes back in less than 6 mo	88 (26.6)
2. Any eczematous skin rash with itchiness in the last 12 mo	79 (23.9)
3. Has this itchy rash at any time affected any of the following places	
The folds of the elbows, behind the knees	35 (10.6)
In front of the ankles, under the buttocks	95 (28.7)
Or around the neck, ears, or eyes	49 (14.8)
4. Has this rash cleared completely at any time during the past 12 mo?	45 (13.6)
5. In the past 12 mo, how often, on average, have you been kept awake at night by this itchy rash?	
Never	53 (16.1)
Less than one night per week	22 (6.6)
One or more nights per week	21 (6.3)
6. Any diagnosis by a specialist to have atopic eczema	52 (15.7)

Table 2

The prevalence rate of asthma, allergic rhinitis, and eczema among Qatari and expatriate schoolchildren (n=331).

	Qatari		Non-Qatari		
Symptoms	n=93	%	n=238	%	*P*-value
Allergic rhinitis	63	67.7	145	60.9	.10
Asthma	39	41.9	54	22.7	.02*
Eczema	35	37.6	53	22.2	.08

* $P < .05$.

We have identified a significant time lag between the peak pollen counts and allergic symptoms. Pollen counts are generally considered a good indicator of allergenic individuals.[19–21] In general, investigators attempted to identify threshold pollen counts necessary to evoke allergic symptoms.[22–24] Our data have no trend toward a correlation between pollen aeroallergen and onset of symptoms in middle schoolchildren. A good aerobiology approach is to quantify the total allergenic load of a known pollen type for a given geographic area. In our previous report, a more detailed report about the first 2 years of pollen monitoring in Qatar was illustrated.[12] A general pattern of low airborne pollen concentrations was recorded in the Doha sampling station. We believed that a high pollen record was not expected in our sampling station due to the hot and arid climate characteristics and poor vegetation cover in Qatar's peninsula. For this reason, we thought that it might help to understand the real effect of pollen counts on allergic diseases. Our data in the report and the previous report should allow a preliminary suggestion of the role of fungal spore and pollen in the pathogenesis of allergic diseases and the seasonal variability that contribute to symptoms development and the health care visits in the population of Qatar.

Our finding of higher prevalence rates of asthma and AR among Qatari middle schoolchildren compared to the expatriate support the hypothesis reported previously[25] about the association between parents and children's respiratory allergies in Qatar. Therefore, a great likelihood of genetic component showing a significant relationship between parental history of asthma, AR and eczema, and asthma in Qatari children. In genetically predisposed individuals, several non-atopic factors seem to play a role in asthma pathogenesis, such as early-life environmental factors and the lung and gut microbiome composition. At the same time, among the factors implicated in asthma development are lifetime exposure to aeroallergens, multiple sensitizations as a child, and infections of the lower respiratory tract early in life, particularly those caused by rhinoviruses. Additionally, the synergistic effect of infections caused by respiratory viruses and atopy was proposed. One of the most essential suggested mechanisms of such effect is the inhibition of innate antiviral responses to rhinoviruses in IgE-mediated ways.[26]

A total of 64 (19.3%) have been physician-diagnosed asthma, 54 (16.3%) AR, and 52 (15.7%) atopic eczema. In other Gulf countries, the prevalence of childhood physician-diagnosed asthma was reported to be 16.8% in Kuwait,[10] 13% in the United Arab Emirates,[27] 10.6% in Oman,[28] and 19,6% in Saudi Arabia.[29]

Our study has inherited limitations due to the study design of a cross-sectional survey that is inefficient to make a causal inference and carries a potential of recall bias. Another limitation is the limited studies correlating the airborne particle levels in the peninsula of Qatar and allergic symptoms.[12]

5. Conclusion

The outdoor and airborne allergens, mainly fungal spores, should be investigated rigorously to identify airborne particles' fundamental role in the different allergic symptoms' pathogenesis in dry, hot climates and over a longer time. Moreover, many previously suggested factors such as the genetic background and other factors influencing the heritable phenotypic. Traits such as environmental conditions and dietary habits should be further investigated and elaborated in bigger projects on patients suffering from allergic symptoms.

The prevalence of asthma symptoms is high among adolescents in Qatar, and the symptoms are more common in Qatari than non-Qatari children. Asthma and AR rates among Qatar's middle schoolchildren are within the reported prevalence ranges from many other neighboring countries. However, longitudinal data over a longer period is mandated in the Middle-East and Arab countries, as well as countries with desert environments, to estimate and identify the real allergic diseases' trends and the role played by the environmental factors, particularly airborne particles such as pollens and fungal spores.

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