original article

Meteorological factors, aeroallergens and asthma-related visits in Kuwait: a 12-month retrospective study

Jafar A. Qasem,[a] Hassan Nasrallah,[b] Bader N. Al-Khalaf,[b] Faysal Al-Sharifi,[b] Ahmed Al-Sherafyee,[a] Samirah A. Almathkouri,[a] Hussein Al-Saraf[c]

From the Departments of [a]Applied Medical Sciences and [b]Environmental Health, College of Health Sciences, Al-Ahmadi, Kuwait and [c]Department of Meteorology, Kuwait International Airport, Kuwait

Correspondence and reprints: Jafar A. Qasem PhD · Applied Medical Sciences, College of Health Sciences · PO Box 9508 Al-Ahmadi City, Al-Ahmadi, Kuwait 61006 · T: +965-662-5554 F: +965-390-6099 · ja.qsem@paaet.edu.kw · Accepted for puclication September 2008

Ann Saudi Med 2008; 28(6): 435-441

BACKGROUND: The increasing prevalence of asthma in many countries has been related to weather factors and aeroallergen concentrations, but this has not been studied in Kuwait. We evaluated the effect of meteorological factors and the occurrence of aerobiologicals on the number of asthma cases in Kuwait.

METHODS: The number of daily asthma visits to the allergy center and emergency department at Al-Sabha Hospital for 1 year were examined on a monthly basis for correlation with major metereological factors (temperature, relative humidity, rain, wind speed and direction). Spore and pollen counts were collected hourly.

RESULTS: A total of 4353 patients received asthma treatment during the year. The highest pollen count was in the month of September with a maximum relative humidity of 47% and no precipitation, but with a high mean temperature of 39.7ºC. Pollen counts were higher in the late summer (September) and occurred with a high patient visit to the allergy center. Fungal spore counts were significantly higher in early winter (December). The high fungal spore count seemed related to with high relative humidity and high precipitation with a low mean average temperature of 19.7ºC. The increase number of patients with bronchial asthma visiting an emergency clinic during December was significantly associated with high aerial counts for fungal spores ($P<.03$), and the months of September and October were more significant for pollen.

CONCLUSION: This study indicates that meteorological factors, aeroallergen concentrations and asthma-related visits are interrelated. The results may prove useful in the generation of hypotheses and development of designs for more comprehensive, individual-based epidemiological studies.

Asthma is the most common chronic illness of people living in Kuwait.[1] An increase in the prevalence of asthma occurred in the Asian Pacific areas and Kuwait 14.9%.[2,3] There is evidence that the rate of emergency department visits for asthma has been increasing in Kuwait.[2-5] Epidemics of acute asthma have been described at the time of dramatic meteorological events such as thunderstorms.[6-9] The role of climatic factors (e.g. barometric pressure, temperature and humidity) in triggering and/or exacerbating respiratory allergic symptoms in predisposed subjects is still poorly understood,[10] and asthma attacks have been linked with both low and high atmospheric pressure.[11] Studies are required to clarify the role of the weather in morbidity and mortality for respiratory allergy.[6] The disease is exacerbated by climatic changes and variations in the level of airborne allergens that may be responsible for fluctuations in asthma symptoms.[1,2,10,11]

In the Arabian Gulf, *Salsola* pollen of the Chenopodiaceae and Amaranthaceae (weeds) families were reported as major aeroallegens related to plantation in Kuwait.[5,12,13] *Prosopis juliflora* pollen has been reported as a triggering agent of allergic asthma in Saudi Arabia and the United Arab Emirates.[14,15]

Some studies have linked increased pollen levels to asthma admissions and others have associated pollen exposure with increased bronchial responsiveness.[16-20] A variety of fungal spores including ascospores, basidiospores, and airborne spores of species of *Cladosporium* and *Alternaria* have been implicated as trigger factors in asthmatic subjects.[21,22] *Alternaria* were found to be the

strongest independent associate of the asthma group in Kuwait and Saudi Arabia.[23-25] *Cladosporium* spores were also found to be the prevalent major component in the outdoor environment in Qatar.[26]

With increased plantation and greenery in Kuwait and the adjoining countries, the prevalence of fungal spores and pollen is likely to increase. The aim of this study was to explore what weather factors contribute to the increase in the pollen and spore level in the air and if the increased aerial counts of pollen and fungal spores are associated with more frequent episodes of asthma in the Kuwaiti population.

METHODS

From January 2003 to December 2003, daily counts of the number of people who visited Al-Rashid Allergy Center for asthma treatment were collected from medical records. Asthma-related clinic visits to Al-Sabah Hospital emergency room for the same period were also obtained from the hospital emergency room admission records. The consultant patient diagnosis and drug prescription were used for screening the patient files for asthma cases. Patients with suspected viral infection were excluded from the study. Allergy rhinitis or allergic sinusitis cases were also excluded.

Metrological data, including temperature, relative humidity, rainfall, wind speed and wind direction data were measured hourly at the monitoring site situated at Kuwait International Airport. The data was supplied by the Kuwait Aviation/Meteorology Department, which is located at Kuwait International Airport in Farwaniya, 16 kilometers south of Kuwait City.

The daily pollen count from a single monitoring station in Kuwait City was obtained from the air biology laboratory (Al-Rashid Allergy Center). The monitoring station is located in the Mansuoryah area at a height of 12 meters above sea level. A Burkard volumetric spore trap (Burkard Manufacturing Co. Lt., Hertfordshire, England) was used to collect the air sample. The trap has a suction pump, which sucks air at 10 liters/min to draw the air sample into the trap. The air sampling was done hourly and the recording tape was collected weekly. Samples were collected on an adhesive tape mounted on a rotating drum moving at 2mm/h. Spore and pollen concentration were estimated by counting the deposit on the tape that was removed each 7 days, attached to a glass slide and stained with trypan blue. A research grade compound light microscope, with a stage vernier scale, was used for total pollen and fungi counts as well as individual pollen fungi counts for every day of the year by manual counting.

In the statistical analysis, the predictor or explanatory variables were the climatic variables and aeroallergen (fungal and pollen) levels. The climatic variables used in the regression analyses were mean daily temperature, mean daily relative humidity, and mean daily rainfall. The variables were tested for normality to decide which statistical method was the most appropriate for analysis (i.e. parametric or non parametric methods). A normality test indicated the assumption of normality was correct ($r=0.62$, $P<.03$) and hence a nonparametric method was appropriate for analysis. Spearman's rank order correlation was used to calculate the strength of the correlation between continuous variables. The relationships between the variables were assessed by sorting the data on the basis of monthly measurement and reporting of cases showing positive monthly correlations between the variables for the year 2003. The statistical software was SPSS version 13 (Statistical Package for Social Studies, Chicago, Illinois USA).

RESULTS

Our results show that climatic conditions have an influence on the abundance of the aerial fungal spores in the air in Kuwait (Tables 1, 2). All the relative humidity variables were positively related to fungal spore prevalence in air. A weak negative relationship was observed between fungal abundance and temperature but not statistically verified (Figures 1, 2). The seasonal distribution of asthmatic attacks reflected by patient admissions showed maximum rates during the autumn and winter and minimum values in the summer and spring, giving a very close inverse correlation to temperature and a direct correlation to relative humidity (Tables 2, 3). There was a significant seasonal variation with an increase in the

Table 1. Correlation between meteorological and biological variables with patient visits in 2003.

Variables	Patient visits[a]	
	Al-Rashid Allergy Center	Emergency room, Al-Sabah Hospital
Average temperature	0.245	-0.014
Maximum temperature	0.175	-0.081
Wind speed	-0.519	-0.373
Maximum humidity	-0.103	0.257
Minimum humidity	-0.259	0.046
Precipitation	-0.232	0.051
Mean pollen count	0.336	0.287
Mean fungal spore count	0.517	0.615*

[a]Correlation coefficient at the .05 level (2-tailed); *indicates significance.

number of patients with asthma referred to the allergy center for pollen in September and October (late summer, early autumn). The main peak in the number of patients occurred in October and November (early autumn) and December to February (winter). There was a smaller peak in April in correlation with the pollen count (Table 3).

In December the temperature was low (19.7°C) and wind velocity moderate (11/mps) with the highest relative humidity, and this corresponded to the maximum of emergency department visits and a high spore count in the air (Table 2). The atmospheric occurrence of high pollen and fungal spores characteristically shows a seasonal biannual pattern in Kuwait in early autumn/late summer and winter (Table 3). High relative humidity with moderate temperatures had a positive relationship with fungal abundance. When combined with high precipitation, those conditions gave the highest fungal spore counts. A decrease in maximum temperatures (25.5°C) and an increase in maximum relative humidity (100%) with extreme high precipitation reading (66.30 mm) in December 2003 gave the highest fungal spore count of 1960.[25] per m^3. This increase in fungal spore count directly influenced the total number of asthma cases (n=760) and emergency visits (n=2123) in the month of December (Figures 1, 2).

Total pollen counts, which ranged from 3.21 to 36.22 per m^3, were higher in summer than in winter and somewhat lower on the days of high precipitation. There was no significant correlation between temperature and pollen count (Figures 3, 4). Results in Table 2 show that the monthly maximum wind direction (north wind) was often associated with markedly higher counts of pollen and the fungal spores with the north and northeast wind direction, but this did not exhibit any regular correlation either with the counts of fungi spores or with the pollen count.

The emergency visit cases were significantly positively correlated with average fungal spore counts (r=0.62, $P<.03$) by Spearman's rank order correlation coefficient. There were no significant Spearman's correlations between pollen counts and asthma admission (r=0.07) (Table 1). We found no evidence of an interaction between rainfall (precipitation) and total pollen counts, but high precipitation, total fungal spore counts and asthma patient admissions seemed related.

DISCUSSION

Respiratory allergies are a common medical problem in Kuwait. Despite the fact that Kuwait is a desert country, the development of allergic diseases in general and asthma and rhinitis in particular has been recognized

Table 2. Climatological and biological readings and asthma patient admissions to Al-Rashid Allergy Center and emergency department visits to Al-Sabah Hospital for a 12-month period (January to December 2003).

Month	Wind		Temperature (°C)		Relative humidity (%)		Precipitation (mm)	Mean count (per m^3)		Patients (n)	
	Direction	Speed (mps)	Mean	Max	Max	Min		Fungal spores	Pollen	Al-Rashid Allergy Center	Emergency room, Al-Sabah Hospital
Jan	SSE	12	17.50	25.70	100	79	50.00	68.53	5.87	263	1019
Feb	SE	14	19.90	27.50	98	47	02.70	28.30	6.28	177	876
Mar	S	19	23.00	30.10	99	50	22.70	20.42	27.68	200	1055
Apr	SSE	17	31.80	44.00	98	44	04.00	43.49	32.70	383	1311
May	N	12	36.90	44.90	49	14	00.10	66.99	11.41	355	1221
Jun	NNW	14	39.40	47.10	48	11	00.00	72.36	15.96	390	1396
Jul	NW	13	40.60	49.00	29	08	00.00	50.18	7.74	332	1150
Aug	NNW	11	41.00	49.50	96	43	00.00	44.97	5.65	302	1008
Sep	N	10	39.70	48.50	47	14	00.00	49.36	36.22	458	1755
Oct	S	11	33.20	44.00	100	40	00.00	64.39	32.88	416	2118
Nov	NNE	12	26.70	33.80	100	63	07.00	70.95	6.47	317	2214
Dec	NNW	11	19.70	22.50	100	82	66.30	196.03	3.21	760	2123

n=north, S=south, SE=southeast, SSE=south southeast, NNW=north northwest, NW=northwest, NNE=north northeast.

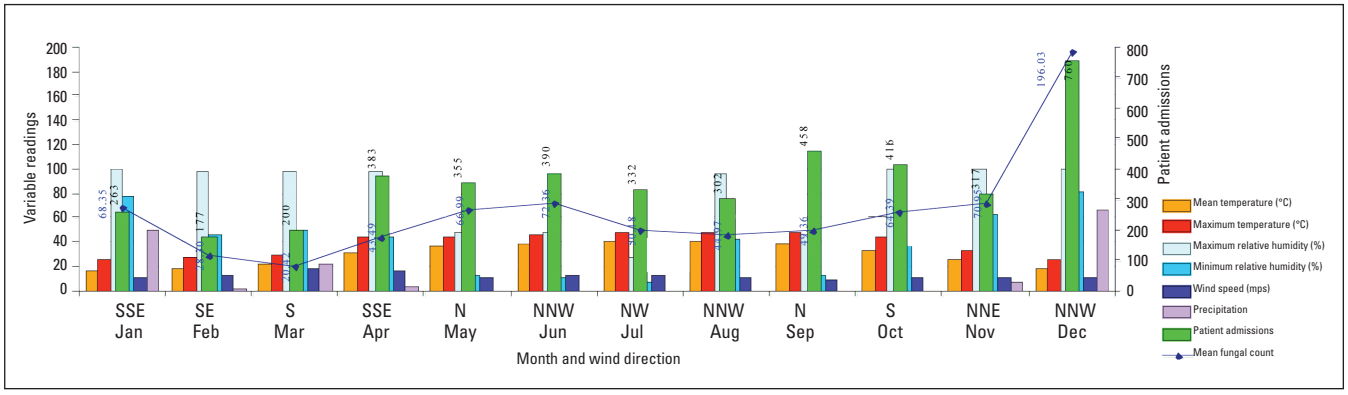

Figure 1. Climatic factors and fungal spore counts and asthma patient visits to Al-Rashid Allergy Center for treatment over 12 months. (N=north, S=south, SE=southeast, SSE=south southeast, NNW=north northwest, NW=northwest, NNE=north northeast).

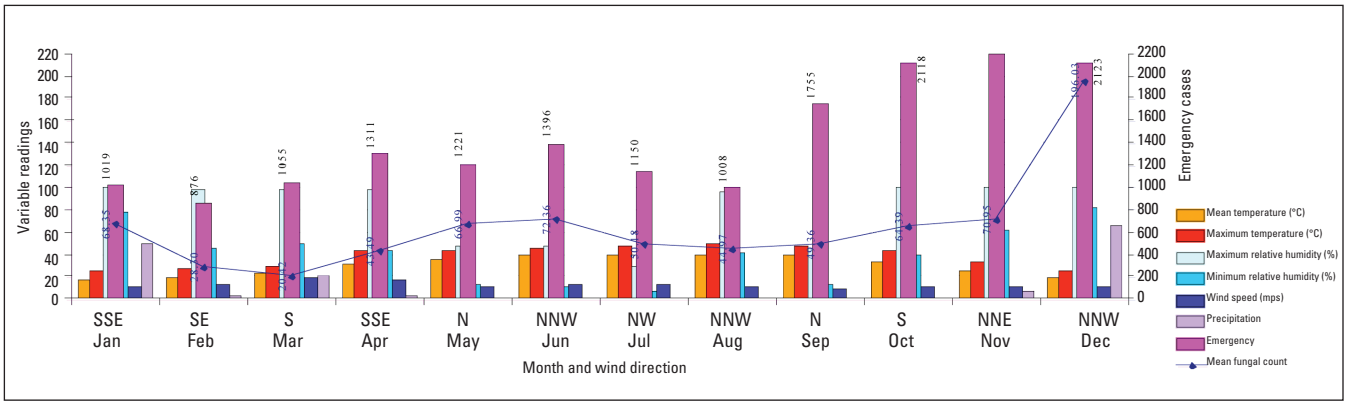

Figure 2. Climatic factors and fungal spore counts, and emergency department visits to Al-Sabah Hospital over 12 months. (N=north, S=south, SE=southeast, SSE=south southeast, NNW=north northwest, NW=northwest, NNE=north northeast).

Table 3. Patient admissions during four periods of the year compared with spore and pollen counts, temperature and relative humidity.

Months	Season	Mean fungal spore count (/m³)	Mean pollen count (/m³)	Temperature (mean) (ºC)	Humidity (mean) (%)	Patient visits	
						Al-Rashid Allergy Center	Emergency room, Al-Sabah Hospital
Jun, July, Aug, Sep	Summer	54.217	16.39	40.12	55	370.5	1327
Oct, Nov	Autumn	67.67	19.68	29.95	100	366	2166
Dec, Jan, Feb	Winter	97.62	5.12	19	99.3	400	1339
Mar, Apr, May	Spring	43.6	23.9	30.566	82	312.6	1195.6

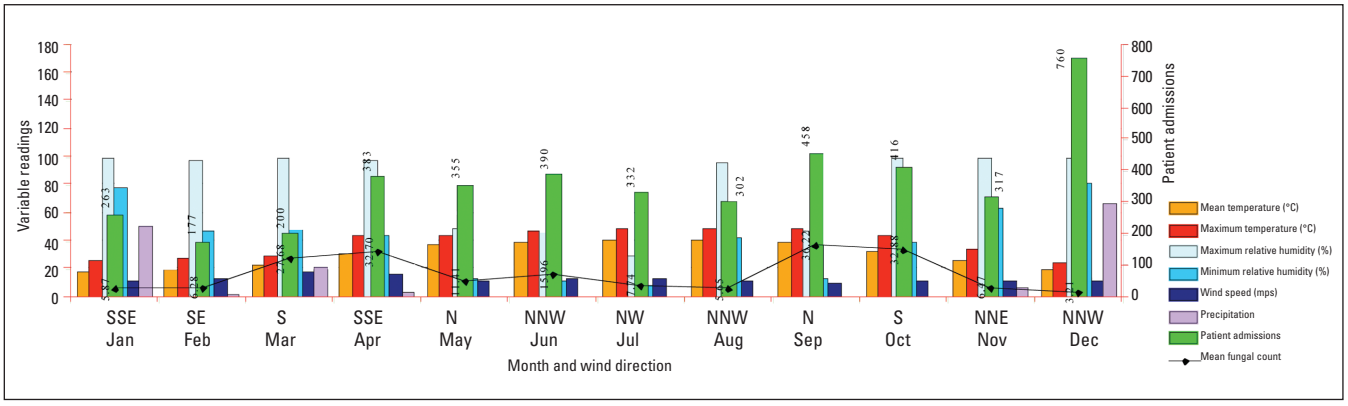

Figure 3. Climatic factors, pollen counts and asthma patient visits to Al-Rashid Allergy Center for treatment over 12 months. (N=north, S=south, SE=southeast, SSE=south southeast, NNW=north northwest, NW=northwest, NNE=north northeast).

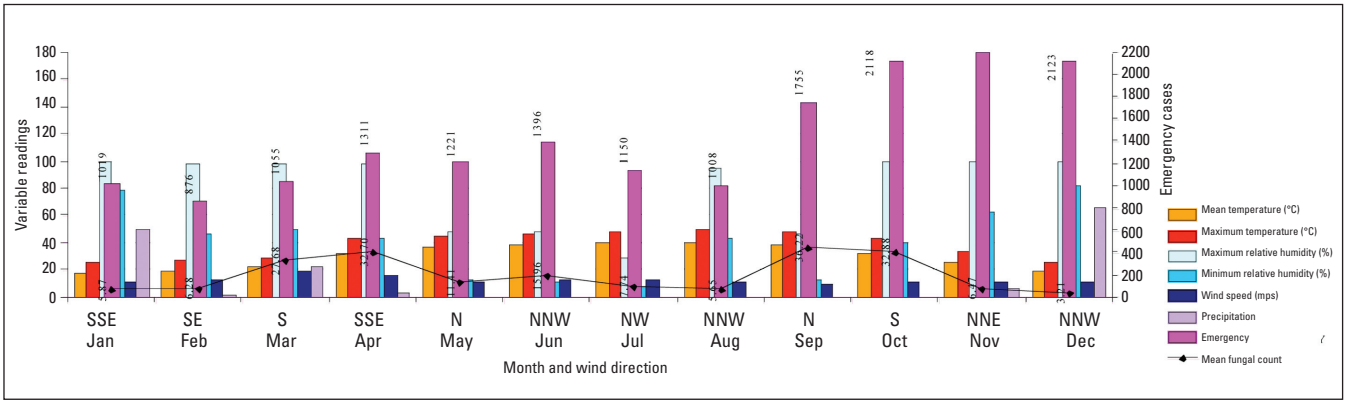

Figure 4. Influence of climatic factors and pollen counts on ERP-SH. (N=north, S=south, SE=southeast, SSE=south southeast, NNW=north northwest, NW=northwest, NNE=north northeast)., ERP-SH=Emergency room patients visiting Al-Sabah Hospital.

since the 1950s, with the first report by Wilkinson, a British physician practicing in Kuwait.[27] A central allergy unit was established in Al-Sabah Hospital in 1964. In 1984, Al-Rashid Allergy Center was established, and this center has been and still is the only specialized center in allergic diseases in Kuwait, where most of the patients with allergic problems are referred.

Fungal spores are an ever-present component of the atmosphere with concentrations known to fluctuate according to meteorological conditions. Fungal spores are found in greatest abundance in the atmosphere, characterized by high humidity, generally during the moderate winter season.[28-30] *Cladosporium* is a common fungus that is a known and documented aeroallergen usually associated with plants, wood products and leather goods. Spores are easily made airborne and as such are a common cause of respiratory problems.[31] In one study that provided useful information on the prevalence of allergic fungi in the outdoor and indoor environments of Kuwait, important fungal species such as *Aspergillus* (*A. fumigatus*, *A. flavus*), *Alternaria*, *Bipolaris*, *Cladosporium*, *Fusarium*, *Pencillium* and other aspergilli were investigated and identified in outdoor and indoor environments of Kuwait in year 1999, over a 12-month study period.[32] During our 12-month study, December showed the greatest differences in meteorological data such as temperature, humidity, wind speed, wind direction and precipitation. The monthly total fungal spore and pollen count was high (196.03 per m^3) and low (3.21 per m^3), respectively.[25] With the above meteorological and biological variations, a rapid increase in total asthma patient admissions and emergency visits was observed in the month of December of 2003. The above findings suggest that low temperatures and high relative humidity plays a major role in increasing the fungal spore counts in the air, which may lead to an increase in asthma allergy cases and emergency visits.

The season for asthma and rhinitis and the main causative aeroallergen vary in different regions of the world. Allergic asthma and rhinitis due to ragweed

is predominant in the eastern and midwest regions of North America.[33] Chenopods are widespread weeds and consist of two closely related families, the Chenopodiaceae and Amaranthaceae. Chenopods are used as hedges or garden plants, and in some parts of the world like the south of Spain and Saudi Arabia, chenopods have emerged as an important cause of asthma and rhinitis.[34,35]

In Kuwait, Chenopodiaceae species, especially *Chenopodium album* and *murale* have been deliberately seeded in waste grounds since the early 1960s for the purpose of binding the sand.[27]

There was no statistical significant correlation between temperature and relative humidity on pollen counts, but windy weather increases the pollen counts as pollens will be spread throughout the air, increasing exposure. Wind from the north was the most significant feature for the enhancement of pollen in 2003 and the month of September in particular. The significant effect of these climatic factors on pollen spore count showed only a weak influence on the total number of asthma cases and emergency visits. In conditions of high relative humidity the pollen will mix with water vapor resulting in hydroscopic nuclei that are suspended, close to the ground. Cold winds may increase the concentration of pollen and hence increase number of patients admitted to the hospital. High temperatures cause a vertical convection current whereas low temperatures with high humidity causes stagnation and a descending air current which brings the pollen and spore to the ground.[36]

Researchers noticed that the high number of asthma cases after rainfall and thunderstorms could be a consequence of the osmotic shock caused by rainfall and lightning, which disrupts the reservoir of pollen released over the previous few days, releasing starch granules that are broadcast by thunderstorms associated with wind gusts.[37]

This study is one of the most comprehensive investigations of monthly asthma admissions and levels of aeroallergens (fungal and pollen) in relation to meteorological factors yet reported in Kuwait. We found a significant association between asthma admissions and aeroallergens (fungal and pollen) at certain times of the year. The main peak occurred during September and October and a smaller peak occurred during March and April, which was similar to the results reported by Behbehani et al on seasonal variation in allergic rhinitis and its correlation with allergens in Kuwait[13] This seasonal increase in asthma admissions was mainly due to increased pollen counts, but in the month of December asthma cases visiting emergency department showed a maximum number due to the high fungal count and high precipitation. Rain influences air spores by removing them from the air.[38] These climatic conditions caused the spore count to reach maximum values in December 2003. Small peaks seen in other months did not correlate with the fungal or pollen counts and the increase in asthma cases may have been due to the direct effect of pollution or weather factors.

In conclusion, we correlated data on weather, aeroallergens and asthma admissions. The decrease in the temperature and increase in the relative humidity with extreme high precipitation readings in the December in the year 2003 was considered the major factor for the highest fungal spore counts, which resulted in a reciprocal increase in the monthly asthma patient admissions and emergency cases in this particular month. Moderate temperatures and the increase in humidity with no precipitation in October 2003 were considered the major factors for the high pollen counts which lead to an increase in the monthly total asthma patient admissions and emergency cases in that month. Other confounding anthropogenic factors such as air pollution and disruption effects may contribute to an increase in asthma cases, but temperature and precipitation seemed to be the most important metrological factors for spores and wind direction for pollen, which may be responsible for an increase in asthma cases. Although asthma-related hospital visits and emergency department visits may also be associated with other confounding factors, the results of this study may be used for generating hypotheses and designs for more comprehensive, individual-based epidemiological studies.

Acknowledgments

The authors would like to thank the Environment Public Authority (EPA) for funding this study. We would like also to express or thanks and sincere appreciation to all the staff that helped us in Biolab, Al-Rashid Allergy Center, and Al-Sabah Hospital for providing us the data on patients and aeroallergens. We also would like express our sincere gratitude to Mr. Solman Sudheer for his technical writing assistance.

REFERENCES

1. Abul AT, Nair PC, Behbehanei NA, Sharma PN. Hospital admissions and death rates from asthma in Kuwait during pre- and post-Gulf War periods. Ann Allergy Asthma Immunol 2001 Apr;86(4):465-8.
2. Carey M.J, Cordon I. Asthma and climatic conditions: experience from Bermuda, an isolated island community. BMJ 1986; 293:843-4.
3. Hobday J.D, Stewart A.J. The relationship between daily asthma attendance, weather parameters, spore count and pollen count. Aust NZJ Med 1973; 3:552-6.
4. Strannegård IL, Strannegård O. Childhood bronchial asthma in a desert country. Allergy 1990 Jul;45(5):327 PubMed -33.
5. Ezeamuzie CI, Thomson MS, Al-Ali S, Dowaisan A, Khan M, Hijazi Z. Asthma in the desert: spectrum of the sensitizing aeroallergens. Allergy 2000 Feb; 55(2):157 PubMed -62.
6. Bauman A. Asthma associated with thunderstorms. BMJ 1996; 312:590-1.
7. Davidson A.C, Emberlin J, Cook A.D, Venables K.M. A major outbreak of asthma associated with a thunderstorm: experience of accident and emergency departments and patients' characteristics. BMJ 1996; 312:601-1.
8. Celenza A, Fothergill J, Kupek E, Shaw R.J. Thunderstorm associated asthma: a detailed analysis of environmental factors. BMJ 1996; 312:604-7.
9. Antó JM, Sunyer J, Rodriguez-Roisin R, Suarez-Cervera M, Vazquez L. Community outbreaks of asthma associated with inhalation of soybean dust. Toxicoepidemiological Committee. N Engl J Med. 1989 Apr 27;320(17):1097-102.
10. Subiza J, Cabrera M, Valdivieso R, Subiza JL, Jerez M, Jiménez JA, Narganes MJ, Subiza E. Seasonal asthma caused by airborne Platanus pollen Clin Exp Allergy. 1994 Dec;24(12):1123-9.
11. Packe G.E, Ayres J.G. Asthma outbreak during a thun-derstorm. Lancet 1985; 199-204.
12. Al-Dowaisan A, Fakim N, Khan MR, Arifhodzic N, Panicker R, Hanoon A, Khan I. Salsola pollen as a predominant cause of respiratory allergies in Kuwait. Ann Allergy Asthma Immunol 2004 Feb;92(2):262-7.
13. Behbehani N. The seasonal variation in allergic rhinitis and its correlation with outdoor allergens in Kuwait. Int Arch Immunol 2004; 133: 164-167.
14. Al-Frayh A, Hasnain SM, Gad-El-Rab MO, Al-Turki T, Al-Mobeireek K, Al-Sedairy ST. Human sensitization to Prosopis juliflora antigen in Saudi Arabia. Ann Saudi Med 1999 Jul-Aug;19(4):331-6.
15 Bener A, Safa W, Abdulhalik S, Lestringant GG. An analysis of skin prick test reactions in asthmatics in a hot climate and desert environment Allerg Immunol (Paris). 2002 Oct;34(8):281-6.
16. Oei H.D, Spieksma F.T.M, Bruynzeel P.L.B. Birch pollen asthma in the Netherlands. Allergy 1986; 41:435-41.
17. Boulet L-P, Cartier A, Thomson N.C, Roberts R.S, Dolovich J, Hargreave F.E. Asthma and increases in nonallergic bronchial responsiveness from seasonal pollen exposure. J Allergy Clin Immunol 1983; 71:399-406.
18. Lowhagan O, Rak S. Modification of bronchial hyper-reactivity after treatment with sodium cromoglycate during pollen season. J Allergy Clin Immunol 1985; 75:460-7.
19. Sotomayor H, Badier M, Vervloet D, Orehek J. Seasonal increase of carbachol airway responsiveness in patients allergic to grass pollen. Am Rev Respir Dis 1984; 130i56-8.
20. Targonski P.V, Persky V.W, Ramekrishnan V. Effect of environmental molds on risk of death from asthma during die pollen season. J Allergy Clin Immunol 1995; 95:955-61.
21. Hasnain S.M, Wilson J.D, Newhook F.J. Fungi and disease. Fungal allergy and respiratory disease. NZ Med J 1985; 98:342-6.
22. Klabuschnigg A, Götz M, Horak F, Jäger S, Machalek A, Popow C, Haschke F, Skoda-Türk R. Influence of aerobiology and weather on symptoms in children with asthma. Respiration. 1981;42(1):52-60.
23. Al-Mousawi MS, Lovel H, Behbehani N, Arifhodzic N, Woodcock A, Custovic A. Asthma and sensitization in a community with low indoor allergen levels and low pet-keeping frequency. J Allergy Clin. Immunol 2004 Dec;114(6):1389 PubMed -94.
24. Ezeamuzie CI, Al-Ali S, Khan M, Hijazi Z, Dowaisan A, Thomson MS, Georgi J. IgE-mediated sensitization to mould allergens among patients with allergic respiratory diseases in a desert environment. Int Arch Allergy Immunol 2000 Apr;121(4):300-7.
25. Hasnain SM, Al-Frayh A, Gad-El-Rab MO, Al-Sedairy S. Airborne Alternaria spores: Potential allergic sensitizers in Saudi Arabia. Ann Saudi Med 1998 Nov-Dec;18(6):497.
26. Al-Subai AT. Air-borne fungi at Doha , Qatar. Aerobiologia 2002;18: 175-183.
27. Wilkinson WM. Development of allergy in the desert. J Trop Med 1964; 67: 16-18.
28. Hjelmroos M. Relationship between airborne fungal spore presence and weather variables. Grana 1993, 32, 40-47.
29. Katial RK, Zhang Y, Jones RH, Dyer PD. Atmospheric mold spore counts in relation to meteorological parameters. Int J Biometeorol 1997, 41, 17-22.
30. Timmer LW, Solel Z, Gottwald TR, Ibanez AM, Zitko SE. Environmental factors affecting production, release, and field populations of conidia of Alternaria alternata, the cause of brown spot of citrus, Phytopathology1998; 88, 1218-1223.
31. Resano A, Sanz M.L, Oehling A. Sensitization to Alternaria and Cladosporium in asthmatic patients and its in vitro diagnostic confirmation. J Invest Allergol Clin Immunol1998, 8 (6), 353-358.
32. Khan ZU, Khan MA, Chandy R, Sharma PN. Aspergillus and other moulds in the air of Kuwait. Mycopathologia 1999;146(1):25-32.
33. Bernstein J, Zeiss CR. Allergic rhinitis. Allergy Proc 1990; 11: 158-159.
34. Galan C, Infante F, Ruiz de Clavijo E, Guurrea F, Miguel R, Dominguez E. Allergy to pollen grains from Amaranthaceae and chenopodiaceae in Cordoba, Spain. Annual and daily variation of pollen concentration. Ann Allergy 1989; 63: 435-438.
35. Suliaman FA, Holmes W.F, Kwick S, Khouri F, Ratard R. Pattern of immediate type hypersensitivity reaction in the eastern province, Saudi Arabia. Ann Allergy Asthma Immunol1997; 78: 415-418.
36. Nasrallah HA, Balling RC, Jr. The Heated Debate, "greenhouse predictions versus climate reality". Middle Eastern Edition (2 ed), Pacific Research Ins, Cal 1995.
37. Davidson AC, Emberlin J, Cook A.D, Venables KM. A major outbreak of asthma associated with a thunderstorm: experience of accident and emergency departments and patients' characteristics. BMJ 1996; 312:601-1.
38. Hirst JM, Stedman OJ. Dry liberation of fungus spores by rain drops. J Gen Microbiol 1963; 33: 335-344.