

Asthma-related hospital admissions in an Indian megacity: role of ambient aeroallergens and inorganic pollutants

D. Ghosh*, P. Chakraborty, J. Gupta, A. Biswas, S. Gupta-Bhattacharya

Key words: asthma-related hospitalization; Generalized Linear Model; pollen; pollutant; spore.

Environmental pollution is a serious problem in rapidly developing countries like China and India (1), the latter being projected to become the world's most populous nation by the year 2050. India is also the home to around 15–20 million asthmatics; the number is steadily increasing, mainly in the cities like Kolkata (formerly known as Calcutta; 22°33'N 88°20'E).

Asthma accounts for significant economic burden worldwide, much of which is related to the episodes of exacerbation leading to hospital admissions. The objective of this pilot study was to understand the seasonality of Asthma-related hospital admissions (ARHA) in the megacity of Kolkata in relation to ambient biological and inorganic factors.

ARHA data were collected from Nilratan Sircar Medical College and Hospital, an apex hospital of the city, which is equipped with emergency medical care facilities and represents a significant portion of total ARHA in

Kolkata. Airborne pollen and spore load were recorded with a Burkard 7-day sampler following aerobiological methods described elsewhere (2, 3), while concentrations of air pollutants SO₂, NO₂, suspended particulate matter (SPM) and respirable particulate matter (RPM) were recorded and made available by the West Bengal Pollution Control Board. For statistical analyses, pollen, spore and pollutant levels were considered as predictor variables, while ARHA was taken as the outcome variable. Data were recorded over a 5-years period in 10-day time slots. Poisson regression, with and without correction for overdispersion, was used to model the data using the Statistical Analysis System (SAS Version 9.1, SAS Inc., Cary, NC, USA). All *P*-values below 0.05 were considered significant.

Concordant to a previous observation (4), we found that ARHA in Kolkata follows a bimodal distribution, with the

highest number of cases (per 10-day time period) being observed in March (17.33 ± 1.3) and September (17.83 ± 2.01). In fact, more than 40% of annual ARHA occurs just during these 2 months. The numbers are low in mid-January (1.50 ± 0.43) and in mid-July (2.17 ± 0.40). Consistency of this seasonal pattern, along with the amplitude of the peaks in relation to the rest of the yearly cycle, suggests the presence of one or more consistent factor(s) influencing asthma exacerbation.

First, we carried out the Poisson Generalized Linear Model (GLM) analysis (5) considering only biological factors (airborne allergenic pollen and spore). We calculated the regression coefficients for each variable and the corresponding Chi-square statistics with *P*-values and found that the pollens *Areca*, *Carica*, Chenopodiaceae and Cyperaceae are positively associated with ARHA. We corrected overdispersion

Table 1. Result of regression analyses using Poisson GLM with ARHA as the independent variable, while pollen, spore and pollutants as dependent variables

Parameter	Estimate	Standard error	Wald 95% confidence limits	Chi-square	Pr > chi-square
Intercept	0.9097	0.2659	0.3885 1.4309	11.7	0.0006
Arca	0.023	0.0182	-0.0126 0.0587	1.61	0.2048
Carica	0.0201	0.0782	-0.1331 0.1732	0.07	0.7973
Cheno-amaranthaceae	0.0561	0.0201	0.0168 0.0955	7.82	0.0052
Cocos	-0.0177	0.0612	-0.1377 0.1023	0.08	0.7725
Cyperaceae	0.0122	0.0035	0.0055 0.019	12.49	0.0004
Phoenix	-0.0269	0.0179	-0.0619 0.0082	2.26	0.133
Poaceae	0.0006	0.0004	-0.0003 0.0015	1.89	0.1695
Alternaria	0.0009	0.0019	-0.0029 0.0047	0.2	0.6512
Aspergilli	-0.0003	0.0007	-0.0016 0.001	0.17	0.6773
Basidiospores	0	0.0006	-0.0011 0.0011	0	0.9996
Cladospores	-0.0005	0.0005	-0.0014 0.0004	1.17	0.2789
Total Spore	0.0001	0.0001	-0.0002 0.0003	0.2	0.6549
SO ₂	-0.021	0.0109	-0.0424 0.0004	3.71	0.0542
NO ₂	0.0002	0.0018	-0.0034 0.0038	0.01	0.9256
RPM	0.0028	0.0009	0.001 0.0046	9.37	0.0022
SPM	0.0003	0.0008	-0.0013 0.0019	0.12	0.7263
Scale	1.609	0	1.609 1.609		

sion in the Poisson model by estimating a dispersion parameter based on quasi-likelihood approach and adjusted the standard errors of the regression coefficients based on this estimated dispersion parameter. After correcting overdispersion, *Areca*, Cheno-Amaranthaceae and Cyperaceae remained significantly associated with the number of ARHA. Next, we included the pollutants' data in the said model and found that when pollutants are taken into account, the pollens *Areca*, Cheno-Amaranthaceae, Cyperaceae and Poaceae showed positive associations with the number of hospital admissions. None of the spores, however, reached statistical significance. Among pollutants, SO₂ and RPM were highly significant. Finally, we, once again made adjustments for overdispersion in the model. After correcting overdispersion, the pollens Cheno-Amaranthaceae and Cyperaceae and the pollutant RPM remained significantly

associated with hospital admissions (Table 1).

The present report is the first of its kind from the Indian subcontinent, demonstrating that ARHA in a megacity exhibits a very regular seasonal pattern that might be governed by the allergenic content of the atmosphere, especially certain pollen grains and RPM. Our study will be helpful for the policy makers, researchers and health care providers.

*Allergy Lab, Internal Medicine
(Immunology)
University of Cincinnati College of Medicine
Cincinnati, OH 45267
Tel: +1-513-558-5068
Fax: +1-513-558-3799
E-mail: debajyoti.ghosh@uc.edu

Accepted for publication 21 September 2009
Allergy 2009
© 2009 John Wiley & Sons A/S
DOI: 10.1111/j.1398-9995.2009.02236.x

References

1. McGranahan G, Murray F. *Air pollution and health in rapidly developing countries*. London, UK: Earthscan Publishing Ltd, 2003.
2. Chakraborty P, Gupta S, Gupta-Bhattacharya S, Chanda S. Airborne pollen of *Borassus flabellifer*: quantification of allergen and antigen. *Aerobiologia* 1999;**15**:49–55.
3. Das S, Gupta-Bhattacharya S. Enumerating outdoor aeromycota in suburban West Bengal, India, with reference to respiratory allergy and meteorological factors. *Ann Agric Environ Med* 2008;**15**:105–112.
4. Ghosh D. Aerobiology in relation to allergy with special reference to immunological and Biochemical Studies on Pollen allergens. PhD Thesis. 2004.
5. McCullagh P, Nelder JA. *Generalized linear models*, 2nd edn. New York, USA: Chapman and Hall, 1989.