

RESEARCH LETTER

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Relationship between local weather, air pollution and hospital attendances for urticaria in children: Time stratified analysis of 12,002 cases

To the Editor,

Ambient air pollution is an increasingly important global public health issue, accounting for significant cardiovascular¹ and respiratory² morbidity and mortality. Singapore, an island city, is routinely affected by Southeast Asia's (SEA) transboundary haze.

Air quality in Singapore is communicated by the National Environmental Agency (NEA) through the 24-h Pollutant Standards Index (PSI). PSI, originally developed by the US Environmental Protection Agency, measures six air pollutants—sulphur dioxide (SO₂), coarse particulate matter (PM₁₀), fine particulate matter (PM_{2.5}), nitrogen dioxide (NO₂), carbon monoxide (CO) and ozone (O₃).³ The PSI is calculated using an equation that considers the concentration of each of these six pollutants within a certain time frame. The final index score reported is the maximum concentration of the most prevalent pollutant within that time frame. NEA categorizes 24-h PSI into “Good” (PSI 0–50), “Moderate” (PSI 51–100), “Unhealthy” (PSI 101–200), “Very Unhealthy” (PSI 201–300) and “Hazardous” (PSI > 300).

The skin is chronically exposed to these environmental stressors. However, evidence on the association between ambient air pollution and skin conditions remains limited.⁴ Urticaria is one of the most common skin disorders presenting to the emergency department (ED),⁵ with significant associated health care costs and impact. We aimed to investigate the association between air pollution and acute urticaria using a time stratified study with linked hospital and environmental data. We performed a time stratified analysis of all cases of urticaria (International Classification of Diseases 9th Revision code 79089) from 1 January 2010 to 31 December 2015 that presented to the emergency department (ED) of KK Women's and Children's Hospital (KKH), one of two tertiary paediatric hospitals in Singapore. The primary exposure was the 24-h average PSI that was obtained from www.haze.gov.sg maintained by the NEA. Other environmental parameters such as total daily rainfall, daily highest rainfall over 30, 60 and 120 min interval, daily temperature (mean, minimum and maximum) and daily wind speed (mean, maximum) were obtained from www.weather.gov.sg.

Data entry was performed using Excel 2003 (Microsoft Corp., Redmond, WA, USA) and the data were analysed using Stata version 14 (StataCorp, College Station, TX, USA). Categorical data and continuous data were presented as frequency with percentage and

median with interquartile range (IQR) respectively. Statistical significance was set at $p < .05$. We used a conditional Poisson regression model⁶ that allowed for the analysis of short-term time-varying factors by controlling for unmeasured and unadjusted local time invariant factors (such as social status).

The Centralised Institutional Review Board and Domain Specific Review Boards approved this study with waiver of informed consent (CIRB reference: 2017/2380).

TABLE 1 Urticaria patient demographics (N = 12,002)

Attribute	Value (%)
Gender	
Male	6655 (55.4%)
Female	5347 (44.6%)
Age	
Mean	4.38
Median [Q1, Q3]	3 [1, 7]
Range	0–18
Below 1 year	3595 (30.0%)
Above 1 year	8407 (70.0%)
Race	
Chinese	7195 (60.0%)
Malay	2177 (18.1%)
Indian	1233 (10.3%)
Others ^a	1397 (11.6%)
LOS	
Mean	1.79
Median [Q1, Q3]	2 [1, 2]
Range	0–32
Disposition status ^b	
Admit	612 (5.1%)
Discharge	11390 (94.8%)

^aOthers include Bangladeshi, Burmese, Caucasian, Eurasian, Filipino, Indonesian, Japanese, Cambodian, Korean, Nepalese, Pakistani, Sikh, Sri Lankan, Thai, Vietnamese, Bhutanese and unknown races.

^bAdmit status includes admission and AOR (refused admission), while discharge status includes absconded, discharged, referred to KKH, referred to other doctors and transferred to other hospital.

There were 12,002 cases of urticaria that presented to KKH ED during the study period. The mean age was 4.38 years with the majority (70%) between aged 1 and 18 years old (see Table 1). 55.4% were male. Majority were of Chinese ethnicity (60%), followed by Malays (18.1%) and Indians (10.3%). Most of the patients were treated and discharged from the ED with only 612 children (5.1%) requiring admission.

During the study period of 1 January 2010 to 31 December 2015, the median 24-h average PSI on event days was 130.32 (IQR 109.17–150.36). There were 1721 days with “Good” PSI, 429 days with “Moderate” PSI, 40 days with “Unhealthy” PSI and 1 day with “Very Unhealthy” PSI. Median daily average temperature was 27.6 degrees Celsius (IQR 26.9–28.4) and median average rainfall per day was 1.84 mm (IQR 0–9.57). Median daily mean windspeed was 7.39 km/h (IQR 6.02–8.54).

We did not find an association between every IQR increase in PSI with the urticaria attendances between lag 0 and lag 7 days (IRR 0.97–1.00; 95% CI: 0.94–1.05), see Figure 1. Neither was there any association between urticaria presentation with total rainfall (IRR 1.00; CI 0.99–1.00) and daily wind speed (IRR 1.00; CI 0.99–1.02). Higher mean ambient temperature was only observed to have a statistically significant association with reduced urticaria occurrence on the same day (IRR 0.97; 95% CI: 0.94–0.99) not on subsequent days.

We did not find a statistically significant association between ambient air pollution and the incidence of urticaria among more than 12,002 children presenting to the paediatric ED. In contrast, a previous study of 2905 cases in Canada suggested an association between ambient air pollution and a higher incidence of urticaria lasting 2–3 days post exposure.⁷ Potential explanations include a lack of seasonality in our tropical climate, a different baseline air pollution as well as differences in population genetics and demographics.

We found a temporary inverse relationship between mean ambient temperature and urticaria incidence, lasting for 1 day. The inverse relationship was also found in Norwich and Heraklion with a decreased rate ratio of acute urticaria incidence by 3% and 7% respectively with every 1°C increase in mean ambient temperature.⁸ Higher mean ambient temperature has been associated with lower

Key Messages:

- We evaluated associations between meteorological measures and hospital attendances for urticaria in Singaporean children from 2010 to 2015.
- There was no statistically significant relationship between 12,002 urticaria attendances and pollution, rainfall or wind measures.
- In unadjusted analysis, high ambient temperature had a temporary association with reduced urticaria incidence.

rates of adenovirus, influenza A and respiratory syncytial virus infections, which may then decrease the incidence of urticaria⁹ and provide a plausible explanation for this observation.

There are several limitations to this study. Firstly, as an observational study, a causative relationship between air pollution and the incidence of urticaria is difficult to prove and our study does not show a link despite large numbers. Secondly, the data does not differentiate aetiology of urticaria or acute from chronic urticaria. Thirdly, although there are control days, there is no “control group” of ED admissions due to other causes. Hence, it is difficult to know whether the admissions were attributed to healthcare seeking behaviour or urticaria pathophysiology. However, we studied a large population using reliable environmental monitoring data. Future studies should focus on the interactions between ambient air pollution, temperature and other environmental factors that could impact the incidence of paediatric urticaria.

In this large study, there was no relationship seen between 12,002 urticaria attendances and pollution, rainfall or wind measures, however, high ambient temperature had a temporary association with reduced urticaria incidence. This topic may warrant further study and investigation, as our findings contradict a smaller previous study.⁷

CONFLICT OF INTEREST

None declared.

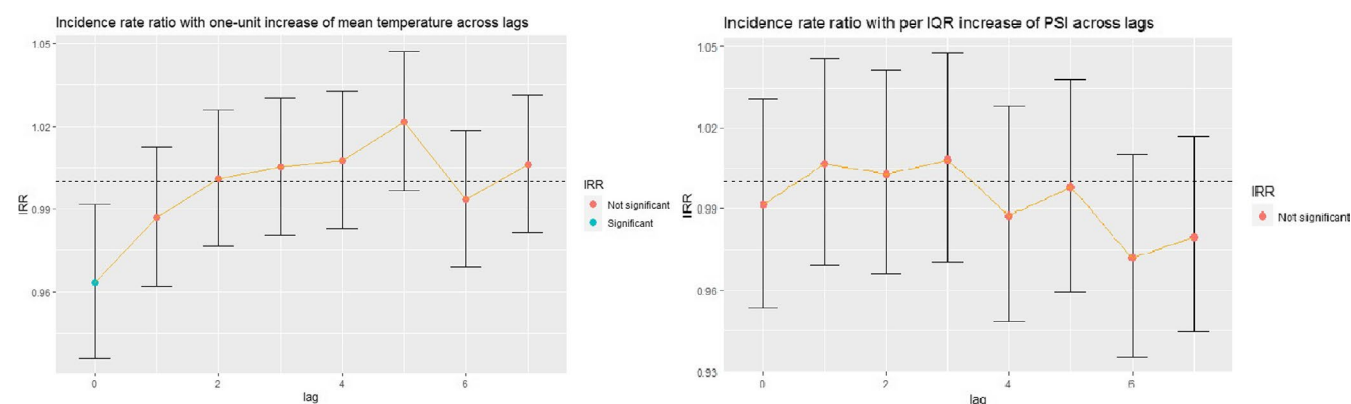


FIGURE 1 Incidence rate ratio of urticaria attendances between lag 0 to 7 for mean temperature and PSI

AUTHOR CONTRIBUTION

KJLC and AFWH conceived and designed the study. AFWH, JP, GH, AE, PP and NL did the data collection. GH, AE and JP analysed the data and provided statistical support. KJLC, AFWH, YHL, MSK, SC and MEHO reviewed the data and co-wrote the manuscript. PJMT assisted with proofreading and drafting the manuscript. All authors critically reviewed and approved the final version of the manuscript for submission.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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