Effects of Meteorological Variation and Air Pollution on Pediatric Allergic Visits: A retrospective study

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Abstract

**Background:** The health of children can be seriously affected by adverse weather conditions and high levels of air pollution. However, it is not clear how different environmental exposures affect allergic diseases in children in different regions. The objective of this study was to determine the impact of meteorological factors and air pollutants on allergic diseases in children in Wuxi, China.

**Objectives:** The objective of this research was to measure and compare the influence of meteorological conditions and air pollutants on allergic illnesses among children residing in Wuxi, China.

**Methods:** The study collected data on children who visited Wuxi Children's Hospital from 2015 to 2023 due to asthma, allergic rhinitis (AR), and atopic dermatitis (AD). Meteorological data, including daily average temperature, air pressure, precipitation, relative humidity, and wind speed, were obtained from the China Meteorological Data website. Air pollution data, such as PM$_{10}$, PM$_{2.5}$, NO$_2$, SO$_2$, CO, and O$_3$, were downloaded from China National Environmental Monitoring Station. The paper used a combination of quasi-Poisson regression and distributed lag nonlinear model (DLNM), as well as Poisson regression and generalized linear model, to assess the impact of meteorological factors and air pollutants on allergic diseases among children in Wuxi.

**Results:** The study reported a total of 10,099 cases of asthma, 15,209 cases of AR, and 59,440 cases of AD. The findings suggest that most environmental factors were significantly associated with childhood allergic diseases. Among them, mean daily temperature (standard β: 0.017 (95% confidence interval (CI): 0.013, 0.021)) and wind speed (standard β: 0.029 (95% CI: 0, 0.058)) were found to play a more important role in the development of these allergic diseases than other environmental factors.

**Conclusions:** The relationship between climate change and air pollution and their impact on allergic diseases in children has been studied. The research suggests that while both factors are linked to allergic diseases, climate factors have a greater influence on their development. These findings have significant implications for the development of prevention strategies for allergic diseases in children.

Introduction

Asthma, allergic rhinitis, and atopic dermatitis are the primary allergic diseases found in children. The International Study of Asthma and Allergies in Childhood (ISAAC) phase III study (2000-2003) reported that globally, the prevalence of asthma, allergic rhinitis, and atopic dermatitis in the 6-7 year age group were 11.7%, 8.5%, and 7.9%, respectively$^1$. According to the Global Asthma Network (GAN) Phase I report that from 2015 to 2020, the prevalence of asthma among 157,700 adolescents aged 13-14 in 25 countries was 10.5%, while the prevalence of asthma among 101,700 school-age children aged 6-7 in 16 countries was 7.6%. The report also found that the prevalence of atopic dermatitis was 10.6% and 13.4% among the same groups, respectively$^2$. The epidemiological data on allergic diseases in Chinese children is extensive. For instance, the prevalence of asthma among children aged 0-14 in major cities across the country was 3.02% in 2010, a 52.8% increase from the 1.97% recorded in 2000$^3$. Similarly, the prevalence rate of atopic dermatitis among children aged 1 to 7 in 10 cities across the country was 2.78% in 2002$^4$, but this figure rose to 12.94% by 2014, based on an increase of two cities$^5$. The prevalence of allergic rhinitis among children aged 3 to 14 was also high, with rates of 14.46%, 20.42%, and 7.22% recorded in Beijing, Chongqing, and Guangzhou, respectively, between 2008 and 2009, as per previous studies$^6$.

Allergic diseases are a growing concern for childhood health globally, resulting in a significant economic burden and decreased quality of life$^7$$^8$. Children may experience physical discomfort such as difficulty breathing, nasal congestion, itching, and rashes, leading to related psychological issues. These symptoms negatively impact children's sleep quality and overall well-being. While genetic and environmental factors both contribute to the development of allergic diseases in children, studies indicate that environmental factors play a more prominent role$^9$$^{11}$.

Asthma is a chronic non-communicable disease that affects over 300 million people worldwide, particularly children$^{12}$$^{13}$. Recent studies have shown a correlation between ambient temperature and the development of asthma in children. Temperature extremes, whether high or low, may contribute to the development of asthma in children$^{14}$$^{20}$. Exposure to air pollutants such as SO$_2$, NO$_2$, CO, and PM$_{2.5}$ has also been positively correlated with childhood asthma$^{21}$$^{29}$. In 2015, one study estimated that 9 to 23 million emergency room visits for asthma worldwide were attributable to total ozone, and 5 to 5 million to PM$_{2.5}$, representing 8-20% and 4-9% respectively$^{26}$.

Allergic rhinitis is an upper respiratory tract immune disease where the nasal mucosa releases immune cytokines or inflammatory factors mediated by IgE. This condition has become a global public health problem, affecting 10% to 40% of the world's population$^{27}$$^{29}$. A study conducted in six different regions of Inner Mongolia in China demonstrated that AR clinical symptoms were positively correlated with
temperature and precipitation, but negatively correlated with wind speed and air pressure\(^{30}\). Another study conducted in Changchun found that exposure to SO\(_2\), NO\(_2\), PM\(_{10}\) and PM\(_{2.5}\) increases the risk of developing allergic rhinitis\(^{30}\).

Allergic dermatitis is a chronic inflammatory skin disease that commonly manifests in early childhood. According to studies, the global prevalence of AD in children ranges from 15% to 20%\(^{31}\). Furthermore, the prevalence of atopic dermatitis continues to rise in both developed and developing countries\(^{32-33}\). According to a systematic review conducted by Bonamonte\(^{34}\)and Nguyen\(^{35}\), there is a close relationship between meteorological factors such as temperature, sunlight or UV exposure, humidity, and environmental pollution due to climate change, and the occurrence and development of atopic dermatitis in children. According to a prospective cohort study conducted on children in the United States, long-term climate change has led to an increase in the prevalence of AD, particularly when there is an increase in heat and sunlight exposure\(^{36}\). Similarly, a French study that monitored children for over three years discovered that air pollutants, such as PM\(_{10}\), NO\(_2\), and CO, were significantly linked to the development of AD\(^{37}\).

According to a study conducted in 28 European countries, environmental risk exposures are responsible for an estimated 211,000 disability-adjusted life years (DALYs) in children annually, accounting for 2.6% of all DALYs in children\(^{38}\). Moreover, another study has demonstrated that a reduction of 1\(\mu\)g/m\(^3\) in particulate matter concentration could result in nearly $350 million in annual economic benefits for the US\(^{39}\). Given the impact of environmental factors on the development of childhood diseases, the associated economic burden on families and society is substantial\(^{40}\). It is of great significance to investigate the impact of meteorological factors and air pollution on allergic diseases in children. Time series data can be utilized to quantify the correlation between environmental factors and allergic diseases. This can help in assessing the role of meteorological factors and air pollutants in the occurrence of allergic diseases in Wuxi City. Effective resource allocation can then be implemented to control and prevent these diseases.

**Methods**

2.1. Study participants

This study was conducted in Wuxi, Jiangsu Province, China. Wuxi is situated in the southeastern region of Jiangsu province, with coordinates of 31°07′-32°02′ N latitude and 119°31′-120°36′ E longitude. It is also recognized as the largest economic hub in the Yangtze River delta of China. The city experiences a subtropical maritime climate with four distinct seasons, ample rainfall, and sunshine. For the period between January 1, 2015, and February 27, 2023, clinical visit data on pediatric allergic diseases such as asthma, AR, and AD were sourced from the database of the Information Department of Wuxi Children's Hospital (Fig. 1). The study used the International Classification of diseases, 10th revision of asthma (ICD-10, J45-J46), AR (ICD-10, J30), and AD (ICD-10, L23) to diagnose allergic diseases in children. Children were defined as those aged <18 years. The sample size included 10,099 asthma cases, 15,209 AR cases and 59,440 AD cases.

2.2. Meteorological factors and air pollution exposure assessment

This study collected meteorological data such as daily average temperature, pressure, precipitation, relative humidity, and wind speed from the China Meteorological Data website for the period of January 1, 2015 to February 27, 2023. Air pollution data including PM\(_{10}\), PM\(_{2.5}\), NO\(_2\), SO\(_2\), CO, and O\(_3\) were obtained from China National Environmental Monitoring Station. The daily averages of air pollutants, such as NO\(_2\), SO\(_2\), O\(_3\), CO, PM\(_{10}\), and PM\(_{2.5}\), were calculated using the 24-hour monitoring records (Fig. 1).

2.3. Statistical analysis

This study conducted a two-stage analysis to investigate the correlation between environmental factors and childhood allergic diseases. There were three steps in the first stage. Step I: Spearman's correlation analysis was used to calculate the correlation between all variables. Additionally, seasonal decomposition analysis was performed to assess seasonal patterns and long-term trends in environmental factors and childhood allergic diseases from 2015-2023. Step II: Poisson regression was used with a distributed lag nonlinear model (DLNM) to examine the relationship between each environmental factor and clinical visits for allergic diseases in children separately. Environmental factors including daily average temperature, average air pressure, average relative humidity, wind speed, NO\(_2\), SO\(_2\), PM\(_{10}\), PM\(_{2.5}\), CO, and O\(_3\) were checked for their association with clinical visits of allergic diseases in childhood. Factors that were found to be significantly associated were selected for further analysis. Step III, we constructed multivariate models that included various covariates based on the significant environmental factors identified in Step II. Quasi-Poisson regression was used to account for overdispersion with distributed lag nonlinear models. To avoid multicollinearity issues, only one model was chosen from a set of correlated variables at a time (with rs ≥ 0.7 considered highly correlated). After comparing all the models, we found that the model including mean temperature, relative humidity, wind speed, NO\(_2\),...
and O₃, or the model including mean air pressure, relative humidity, wind speed, NO₂, and O₃, performed the best with the smallest residual deviation.

In the second stage, we assessed the regression coefficients and standardized regression coefficients in multi-variate generalized linear models (GLM). The standard regression coefficient refers to the regression coefficient after eliminating the influence of the unit of the dependent variable Y and the independent variables X₁, X₂, ... Xₙ, and the magnitude of the absolute value directly reflects the degree of influence of Xi on Y.

## Results

### 3.1. Distribution and correlation of childhood allergic diseases and environmental factors

Table 1 provides a 2023 summary of childhood allergic diseases, meteorological factors, and air pollutants from 1 January to 27 February 2015. Daily mean values for atopic dermatitis (AD), allergic rhinitis dermatitis (AR), and asthma were 20, 5, and 3, respectively. The average daily temperature, air pressure, relative humidity and wind speed was 17.3 °C, 1016.3 hPa, 72.6% and 2.1 m/s, respectively. The average value of AQI, PM$_{2.5}$, PM$_{10}$, SO$_2$, NO$_2$, CO and O$_3$ was 65.9, 41.5 μg/m$^3$, 70.9 μg/m$^3$, 12.3 μg/m$^3$, 38.8 μg/m$^3$, 0.9 μg/m$^3$ and 65.1 μg/m$^3$, respectively.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Mean</th>
<th>Min</th>
<th>P25</th>
<th>P50</th>
<th>P75</th>
<th>Max</th>
<th>IQR</th>
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<td>AD</td>
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<td>0</td>
<td>9</td>
<td>20</td>
<td>29</td>
<td>60</td>
<td>20</td>
</tr>
<tr>
<td>AR</td>
<td>5</td>
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<td>1</td>
<td>4</td>
<td>7</td>
<td>44</td>
<td>6</td>
</tr>
<tr>
<td>Asthma</td>
<td>3</td>
<td>0</td>
<td>1</td>
<td>3</td>
<td>5</td>
<td>20</td>
<td>4</td>
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<td>Air pollutants (μg/m$^3$)</td>
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<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>AQI</td>
<td>65.9</td>
<td>12</td>
<td>44</td>
<td>59</td>
<td>79</td>
<td>285</td>
<td>35</td>
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<tr>
<td>PM$_{2.5}$</td>
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<td>4</td>
<td>23</td>
<td>34</td>
<td>52</td>
<td>235</td>
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<tr>
<td>PM$_{10}$</td>
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<td>7</td>
<td>43</td>
<td>61</td>
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<td>315</td>
<td>46</td>
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<tr>
<td>SO$_2$</td>
<td>12.3</td>
<td>3</td>
<td>7</td>
<td>10</td>
<td>15</td>
<td>79</td>
<td>8</td>
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<tr>
<td>NO$_2$</td>
<td>38.8</td>
<td>5</td>
<td>26</td>
<td>35.5</td>
<td>49</td>
<td>127</td>
<td>23</td>
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<td>CO</td>
<td>0.9</td>
<td>0.3</td>
<td>0.7</td>
<td>0.8</td>
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<td>2.6</td>
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<td>O$_3$</td>
<td>65.1</td>
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</tr>
<tr>
<td>Temperature (°C)</td>
<td>17.3</td>
<td>-6.1</td>
<td>9.3</td>
<td>17.7</td>
<td>25.1</td>
<td>36.3</td>
<td>15.8</td>
</tr>
<tr>
<td>Air pressure (hPa)</td>
<td>1016.3</td>
<td>988.3</td>
<td>1008.1</td>
<td>1016.6</td>
<td>1023.6</td>
<td>1041</td>
<td>15.5</td>
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<td>Relative humidity (%)</td>
<td>72.6</td>
<td>27</td>
<td>63</td>
<td>73</td>
<td>82</td>
<td>100</td>
<td>19</td>
</tr>
<tr>
<td>Wind speed (m/s)</td>
<td>2.1</td>
<td>0.1</td>
<td>1.5</td>
<td>2</td>
<td>2.6</td>
<td>6.7</td>
<td>1.1</td>
</tr>
</tbody>
</table>

AD: atopic dermatitis  AR: allergic rhinitis  Min: minimum; Max: Maximum  P25, 25th centile; P50, 50th centile; P75, 75th centile  IQR: interquartile range.

Table 2 presents the correlation between environmental factors and allergic diseases in children for the period 2015-2023. The Spearman correlation coefficients of the three allergic diseases were as follows: -0.082 for AD and AR, 0.218 for Asthma and AD, and 0.269 for AR and Asthma. The results indicate that AD was positively correlated with PM$_{2.5}$, PM$_{10}$, SO$_2$, NO$_2$, CO, and temperature, while it was negatively correlated with pressure. The study found that asthma showed a positive correlation with daily mean air temperature and NO$_2$, while AR showed a negative correlation with PM$_{2.5}$, PM$_{10}$, SO$_2$, NO$_2$, CO, pressure, and humidity. On the other hand, AR showed a positive correlation...
with $O_3$ and temperature. The study found a strong negative correlation ($r_s = -0.890 \ p < 0.01$) between the daily mean air pressure and the daily mean temperature. Additionally, pollutants such as $NO_2$, $SO_2$, $PM_{10}$, and $PM_{2.5}$ showed positive correlations with each other, while $O_3$ showed a negative correlation with other pollutants.

Table 2


<table>
<thead>
<tr>
<th>Variables</th>
<th>AD</th>
<th>AR</th>
<th>Asthma</th>
<th>AQI</th>
<th>$PM_{2.5}$</th>
<th>$PM_{10}$</th>
<th>$SO_2$</th>
<th>$NO_2$</th>
<th>CO</th>
<th>$O_3$</th>
<th>Temperature</th>
<th>Press</th>
<th>Humid</th>
</tr>
</thead>
<tbody>
<tr>
<td>AR</td>
<td>0.202</td>
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<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Asthma</td>
<td>0.218</td>
<td>0.269</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>AQI</td>
<td>0.120</td>
<td>-0.215</td>
<td>-0.003</td>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>$PM_{10}$</td>
<td>0.110</td>
<td>-0.260</td>
<td>-0.016</td>
<td>0.983</td>
<td></td>
<td></td>
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<tr>
<td>$PM_{2.5}$</td>
<td>0.147</td>
<td>-0.219</td>
<td>0.015</td>
<td>0.966</td>
<td>0.912</td>
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<tr>
<td>$SO_2$</td>
<td>0.134</td>
<td>-0.307</td>
<td>-0.030</td>
<td>0.633</td>
<td>0.648</td>
<td>0.625</td>
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</tr>
<tr>
<td>$NO_2$</td>
<td>0.203</td>
<td>-0.297</td>
<td>0.107</td>
<td>0.665</td>
<td>0.681</td>
<td>0.713</td>
<td>0.509</td>
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<tr>
<td>CO</td>
<td>0.160</td>
<td>-0.277</td>
<td>-0.007</td>
<td>0.760</td>
<td>0.817</td>
<td>0.721</td>
<td>0.579</td>
<td>0.641</td>
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<td></td>
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<tr>
<td>$O_3$</td>
<td>0.124</td>
<td>0.223</td>
<td>-0.013</td>
<td>-0.096</td>
<td>-0.201</td>
<td>-0.142</td>
<td>-0.144</td>
<td>-0.430</td>
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<tr>
<td>Temperature</td>
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<td>-0.400</td>
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<tr>
<td>Press</td>
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<td>-0.015</td>
<td>0.295</td>
<td>0.310</td>
<td>0.331</td>
<td>0.273</td>
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<td>-0.890</td>
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<tr>
<td>Humid</td>
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<td>-0.072</td>
<td>0.027</td>
<td>-0.141</td>
<td>0.012</td>
<td>-0.198</td>
<td>-0.177</td>
<td>0.004</td>
<td>0.150</td>
<td>-0.391</td>
<td>0.035</td>
<td>-0.130</td>
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<tr>
<td>Wind</td>
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<td>-0.026</td>
<td>-0.062</td>
<td>-0.245</td>
<td>-0.276</td>
<td>-0.235</td>
<td>-0.144</td>
<td>-0.403</td>
<td>-0.275</td>
<td>0.111</td>
<td>0.088</td>
<td>-0.137</td>
<td>-0.050</td>
</tr>
</tbody>
</table>

$r_s \geq 0.7$ was considered as high correlation; Bold values are statistically significant ($p < 0.05$).

AR: allergic rhinitis; AD: atopic dermatitis; Temperature: daily mean temperature; Press: daily mean air pressure. Humid: relative humidity; Wind: wind speed;

3.2. Relationships between environmental factors and childhood allergic diseases

Fig.2 show the overall exposure-response relationships of various environmental factors, including wind speed, daily mean temperature, relative humidity, daily mean air pressure, $NO_2$, and $O_3$, with asthma, allergic rhinitis (AR), and atopic dermatitis (AD) by using Poisson regression with distributed lag non-linear model. The study found that there was a linear correlation between environmental factors and daily outpatient visits for Asthma, AD, and AR within a particular threshold range. The different environmental factors had slightly different curve shapes. Specifically, low wind speed, low relative humidity, and high levels of $NO_2$ and $O_3$ were found to increase clinical visits for asthma in children. The study reveals that when the mean temperature was below 18°C, the outpatient risk increased linearly with the increase in temperature. However, there was a noticeable decrease in outpatient visits once the temperature reached 18°C. Furthermore, the study also found that asthma risk was positively associated with lower air pressure levels below 1017hpa. However, this trend decreased significantly once the air pressure reached 1017hpa. The clinical visit rate of children with AD was found to be increased by low wind speed, relative humidity, and high mean temperature, with $O_3$ being identified as a contributing factor. Similarly, children with AR were found to have an increased clinical visit rate in the presence of low wind speed, low relative humidity, and high concentrations of CO, $O_3$, and $PM_{2.5}$.

3.3. Multivariate GLM results for the relative impact of different environmental exposures on childhood allergic diseases

Table 3 This study examines the relationship between environmental factors and allergic diseases in children using a multivariate GLM. The results show that $NO_2$ and $O_3$ were positively correlated with all three allergic diseases, while daily relative humidity was negatively correlated with AR and AD. However, asthma was positively correlated with relative humidity. The study also found that the St_β value of daily average air temperature (0.017 (95% CI: 0.013, 0.021)) and the St_β value of average air pressure (-0.009 (95% CI: -0.012, -0.006)) had a greater impact on AR in children than other environmental factors. Overall, the findings suggest that environmental factors play a significant role in the development of allergic diseases in children.

Table 3

Multivariate GLM results for the relationships between environmental factors and childhood allergic diseases after adjustment for confounders.
Data were presented with St_β and 95% confidence interval; St_β: standard regression coefficient; temperature, humid, wind, NO2, O3, long-term trends, seasonal trends, the day of week effects were controlled in model 1, model 3, model 5; press, humid, wind, NO2, O3, long-term trends, seasonal trends, the day of week effects were controlled in model 2, model 4, model 6; Bold means statistical significant (p <0.05).

Discussion

The occurrence of allergic diseases is influenced by a combination of factors including genes, environment, infection, and the body's immune function. Research has shown that childhood asthma, AR, and AD can be affected by both climate change and air pollution[31]. The World Health Organization's statistics indicate that climate and environmental factors contribute to at least one in ten child deaths under the age of 5. Therefore, it is crucial to examine the correlation between meteorological and environmental factors and respiratory diseases in children.

Our study revealed a complex relationship between allergic diseases in children and meteorological and environmental factors. These factors include average air temperature, average air pressure, relative humidity, average wind speed, PM2.5, PM10, NO2, SO2, CO, and O3. Although there is a correlation between these factors and childhood allergic disease, climate variables seem to have a greater impact than air pollutants. This is evident from the significantly larger standard β of climate variables as compared to air pollution.

Research studies have shown that hot weather can result in heat stress, which can lead to changes in the immune system, increased sensitivity to allergens, and the advancement of allergic inflammation[41]. Additionally, in high temperature conditions, the concentration of fine particles, volatile organic compounds, ozone and other pollutants in the air rises, causing irritation to the respiratory tract and exacerbating symptoms such as asthma, atopic dermatitis, and allergic rhinitis[42]. Additionally, in high temperature conditions, the concentration of fine particles, volatile organic compounds, ozone and other pollutants in the air rises, causing irritation to the respiratory tract and exacerbating symptoms such as asthma, atopic dermatitis, and allergic rhinitis[42]. Our research confirmed that higher ambient temperatures are generally associated with a higher risk of these diseases in children, but this study found that very low temperatures also lead to an increased risk of these diseases. Lamet et al. (2016) observed that during the cold season, low temperature was associated with increased asthma hospitalizations in Hong Kong[43]. Another study found that low ambient temperature and low relative humidity may exacerbate AD symptoms in children[44]. In addition, this study also found that there is a negative correlation between humidity and AD and AR, and a positive correlation with asthma. The main reason is that high air humidity can moderately moisturize the skin and nasal cavity, thereby reducing their dryness and the risk of AD and AR. However, higher humidity also leads to increased concentration of allergens in the air, such as mold and mites, which can trigger asthma attacks. Additionally, when humidity is high, water molecules in the air interact with bronchial smooth muscle, causing it to contract and consequently triggering asthma symptoms.

Our study has found a correlation between higher levels of air pollutant concentrations and an increase in hospital visits among children with allergies such as asthma, allergic rhinitis, and atopic dermatitis. Several studies have established a link between allergic diseases and outdoor air pollution, with PM, NO2, SO2, CO, and O3 being the main pollutants responsible for these impacts. Specifically, our study has identified NO2 and O3 as the primary risk factors for clinical visits related to asthma in children, while AR and AD exhibit similar patterns. Other studies have also demonstrated that high concentrations of outdoor air pollution can have a direct inflammatory and irritating effect on the airway epithelium, thereby increasing the likelihood of asthma attacks[45]. Air pollutants have been found to contribute to atopic diseases through various mechanisms, including skin barrier dysfunction, oxidative stress induction, epigenetic modification, and altered immune cell responses[46–49]. One such mechanism involves the exposure of human nasal epithelial cells to PM2.5, which has been shown to decrease the integrity of the epithelial barrier[50]. This, in turn, may increase susceptibility to air allergens and inflammation, leading to a higher risk of allergic rhinitis. Additionally, PM2.5 can generate reactive oxygen species directly or indirectly, leading to oxidative stress. It has been hypothesized that damage caused by oxidative stress may impair skin barrier function, resulting in increased skin water evaporation,
decreased stratum corneum barrier lipids, and decreased keratinocyte adhesion. Ultimately the skin is dry, sensitive and prone to damage from external stimuli. This also increases the risk of atopic dermatitis in children to a certain extent.

This research presents significant strengths by conducting in-depth research on the correlation between asthma, allergic rhinitis, and atopic dermatitis and environmental factors in a subtropical climate area, Wuxi. Previous health studies of air pollution in China were limited to a few large cities and focused on specific health effects, such as respiratory and cardiovascular disease. However, this study sheds light on the impact of air pollution on other health problems, especially allergic diseases in children. The study highlights that children exposed to air pollution are more likely to develop allergic diseases such as asthma, allergic rhinitis, and atopic dermatitis. The study also considers the high humidity and warm climate conditions of subtropical climate areas that may affect the diffusion and accumulation of pollutants in the air, which in turn has an impact on the health of the human respiratory system. Furthermore, the study acknowledges the rich biodiversity and dense vegetation cover in the area, which may lead to the release of more plant pollen and fungal spores into the air, affecting the development of allergy symptoms. Therefore, we need more comprehensive and specific studies to explore the relationship between meteorological and environmental factors and allergic diseases in children. This will help fill the gaps in existing research and provide a scientific basis for developing more effective prevention and management strategies.

The present study has certain limitations that need to be taken into account. Firstly, the study was carried out in a tertiary children's hospital, which may limit the generalizability of the findings. Secondly, the study was retrospective in nature and could not analyze the mechanistic influences of environmental factors on the pathogenesis of allergic diseases, which may explain their variation. Thirdly, individual exposure data were not available, which may have introduced some degree of measurement bias. This study did not include patients with certain risk factors such as food, pollen, and life events that may contribute to allergic disease in children, due to the unavailability of data. However, previous studies have indicated that meteorological factors such as temperature, relative humidity, rainfall, and wind speed can increase airborne pollen, resulting in an increase in allergens and a higher risk of allergic diseases in children [40][41]. Despite these limitations, the study provides valuable insights into the exposure-response relationship between environmental factors and allergic disease visits. It also identifies sensitive populations, which can be useful in informing future research and prevention strategies for allergic diseases.

Conclusion

According to this study, allergic diseases in children are associated with both climate change and air pollution, but climate change seems to have a greater impact. The results suggest that if these findings are confirmed in diverse populations in different regions, effective strategies for preventing and treating these diseases globally can be developed.

Abbreviations

Allergic rhinitis: AR; Atopic dermatitis: AD; Temperature: daily mean temperature; Press: daily mean air pressure. Humid: relative humidity; Wind: wind speed;

Declarations

7. Acknowledgments

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8. Author contributions

Conception, design and critical review: XG. Data acquisition, analysis: YG, JZ, HD. Writing—original draft and interpretation, revising of the manuscript: YL. All authors read and approved the final manuscript.

9. Funding

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10. Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.
Ethics approval and consent to participate

This study was conducted per the Helsinki Declaration; the study utilized pre-existing data from a database, and since it was collected and made available in an anonymized and de-identified format, ethics approval was not required.

Consent for publication

Not applicable.

Competing interests

The authors declare no conflict of interest.

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Figures

![Figure 1](image_url)

**Fig. 1** Locations of pediatric hospital and the monitoring station in Wuxi, China.

**Figure 1**

See image above for figure legend
Figure 2

The overall exposure-response relationships between environmental factors and childhood Asthma, AR and AD. AR: allergic rhinitis; AD: atopic dermatitis; wind: wind speed; temperature: daily mean temperature; humid: relative humidity; press: daily mean air pressure.