

## Impact of Multiple Meteorological Factors on Childhood Asthma: A Systematic Review and Meta-Analysis (2000-2023)

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**ADMINISTRATIVE INFORMATION****Support** - None.**Review Stage at time of this submission** - Completed but not published.**Conflicts of interest** - None declared.**INPLASY registration number:** INPLASY202460113**Amendments** - This protocol was registered with the International Platform of Registered Systematic Review and Meta-Analysis Protocols (INPLASY) on 28 June 2024 and was last updated on 11 July 2024.**INTRODUCTION**

**Review question / Objective** Population: Review question / Objective Population: children, divided into two age groups: over 5 years old and under 5 years old, taking into account different geographical locations and climate zones.

**Intervention:** This study does not have specific intervention measures, but analyzes the impact of meteorological factors (average daily temperature, humidity, wind speed, air pressure and rainfall) on the risk of hospitalization for childhood asthma.

**Comparison:** The comparison in this study is the change of different meteorological elements, such as the situation when there is no increase in meteorological elements or the comparison of different regions and climate zones.

**Outcomes:** The primary outcome is change in risk of hospital admission for asthma in children, expressed as relative risk (RR) and 95% confidence interval.

**Study design:** Systematic review and meta-analysis, including studies on meteorological factors and risk of hospitalization for childhood

asthma published in databases such as WOS, PubMed and Embase from January 2000 to December 2023.

**Condition being studied** Definitions of asthma in children usually involve a description of the characteristics of asthma as a chronic inflammatory respiratory disease that primarily affects the airways, causing them to become narrowed and blocked, resulting in difficulty breathing. It is an environmentally sensitive respiratory disease.

**METHODS**

**Participant or population** Study population: In accordance with the Convention on the Rights of the Child, the group of children is defined as those under 18 years of age.

**Intervention** This study does not have a specific intervention, but analyzes the impact of meteorological factors (average daily temperature,

humidity, wind speed, air pressure and rainfall) on the risk of hospitalization for asthma in children.

**Comparator** The comparison in this study is the changes in different meteorological elements, such as the situation when there is no increase in meteorological elements or the comparison of different regions and climate zones.

**Study designs to be included** Included study designs: Time-series studies, case-control studies, cross-sectional studies, cohort studies, ecological studies.

**Eligibility criteria** The criteria for inclusion of literature in this study were as follows:

(1) Study population: In accordance with the Convention on the Rights of the Child, the group of children is defined as those under 18 years of age;  
 (2) Articles reporting the association of daily average meteorological factors (temperature, humidity, wind speed, barometric pressure, rainfall) with asthma exposure-response in children;  
 (3) Asthma was defined using the International Classification of Diseases ICD-9 460-519 or ICD-10 J00-J99;

(4) Concerns reported the length of the exposure period, and outcome effect sizes used relative risk (RR), odds ratio (OR), excess/attribution risk (ER/AR), and 95% confidence intervals (95% CI).

(5) Articles published in English;

(6) Time-series studies, case-control studies, cross-sectional studies, cohort studies, ecological studies;

Exclusion criteria include:

(1) A synthesis or review paper;  
 (2) Focus on adult population studies without specific estimates for child populations;  
 (3) Studies using indoor or workplace temperature as an exposure variable;  
 (4) Papers published only in abstract but not in full.

**Information sources** This study retrieved research on meteorological factors and the risk of childhood asthma hospitalization, published from January 2000 to December 2023 in databases such as WOS, PubMed, and Embase.

**Main outcome(s)** A total of 18 studies were included in the meta-analysis. The study found that a 1% increase in regional humidity increased the risk of childhood asthma hospitalization by 1% (RR: 1.01, 95% CI [1.00-1.02]), and a 1 hPa increase in atmospheric pressure increased the risk by 1% (RR: 1.01, 95% CI [1.00-1.02]). No

statistical association was found between unit increases in temperature, rainfall, and wind speed and the risk of childhood asthma hospitalization. Additionally, subgroup analyses based on regional characteristics, individual differences, and climate zones revealed: a 1-degree increase in daily average temperature in low-latitude regions reduced the risk of childhood asthma hospitalization by 2% (RR: 0.98, 95% CI [0.97-1.00]); among age groups, asthma hospitalization in children over 5 years old was related to humidity (RR: 1.01, 95% CI [1.00-1.01]), while no association was found for children under 5 years old; In Europe, a 1% increase in humidity increased the risk of childhood asthma hospitalization by 1% (RR: 1.01, 95% CI [1.00-1.02]); In the Köppen climate classification, changes in climatic factors in the warm temperate climate zone (C-type) had more significant and intense effects on childhood asthma than those in the arid desert climate zone (B-type) and the continental climate zone (D-type). However, overall, most changes in meteorological factors across the three climate zones had a relatively weak impact on childhood asthma hospitalization (RR values approaching 1).

**Quality assessment / Risk of bias analysis** In addition to the inclusion of case-control, cohort, and cross-sectional studies, the design type of the majority of the studies included in this theme was in the form of time-series studies, and since there is no standardized scale for assessing the quality of time-series studies in the current literature quality assessment tools and the number of study design types included in this study is large, we drew on the published studies of Phung, D, and Mustafic, H., respectively, to assess the quality of time-series studies. study and Mustafic, H We therefore drew on the published studies of Phung, D and Mustafic, H, respectively, to construct our literature evaluation criteria: Mustafic, H The 3-part assessment (validation of disease occurrence, measurement of exposure indicators, and control of confounders) proposed by Mustafic, H has been used to evaluate the quality of time-series studies in similar previous studies. The study was evaluated according to the Berman, N The recommended criteria for evaluating studies were set in detail for determining criteria from: sources of study information, study design, valid interpretation of results, and discussion content. This meta-analysis referred to the above evaluation criteria adjusted according to the inclusion information of this study, and constructed a literature quality assessment score ranging from 1 to 26, with a cut-off point of 13 for inclusion in the final meta-analysis. Two authors independently

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assessed the quality of each included study. Any disagreements were discussed by the reviewers and resolved by consensus.

**Strategy of data synthesis** The statistical analysis part of this meta-analysis was first based on the information from the included literature data using the general inverse variance method to summarize the estimated outcome effect of each meteorological factor on childhood asthma. Due to the diverse types of study designs in the included literature and the large variations in the study sample sizes, a meta-analysis with a random-effects model was used for the present study, as it takes into account, in addition to within-study variance, the true estimated from all included studies. potential variation between effects, allowing for better aggregation of outcome effects. Also for the assessment of the degree of heterogeneity of the included studies, we used the Higgins et al. The inconsistency coefficient recommended by Higgins et al. ( $I^2$ ) provides an indication of the degree of inconsistency of the study results by describing the percentage of total variation in the studies due to heterogeneity.

**Subgroup analysis** In order to clarify the differences in regional and population attributes of meteorological factors on childhood asthma, we also performed subgroup analyses of the aggregated results of the meteorological factors in terms of age (for the included population data were categorized into preschoolers and school-age children), gender, continental regions, and latitudinal differences. the global Köppen climate divisions for the period 2000-2020 that defines the type of climate zone for each study area included in the literature. Additionally for the presence of publication bias in the pooled studies, we used the Egger test to assess.

**Sensitivity analysis** In addition to assess the robustness of the pooled results, a sensitivity analysis was conducted using a case-by-case approach (each study was excluded to test whether individual studies had an impact on the pooled estimates). If the pooled estimates remain stable after the sensitivity analysis, it indicates that the main results are not driven by any single study. All of the above analyses were conducted using the R language "meta" package.

**Country(ies) involved** China (Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences).

**Keywords** meteorological factors, childhood asthma, Systematic review, meta-analysis.

### Contributions of each author

Author 1 - Yongkang Zhou.

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