ASTHMA ALLERGY IMMUNOLOGY
ASTIM ALLERJİ İMMÜNOLOJİ

doi: 10.21911/aai.2026.1427
Asthma Allergy Immunol 2026;24:273-278

RESEARCH ARTICLE

Received: 12.05.2026 • Accepted: 24.06.2026
Online Published: 08.07.2026

Temporal Comparison of Asthma Symptoms in Turkish Schoolchildren: ISAAC 2015 vs 2023 Surveys

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ABSTRACT

Objective: This study aimed to compare the results of two ISAAC-based cross-sectional surveys conducted in the same geographical region in 2015 and 2023 to evaluate changes in the prevalence of wheezing and asthma-related symptoms among children in the post-earthquake period and to explore potential environmental determinants.

Materials and Methods: This repeated cross-sectional, school-based epidemiological study included children aged 6-7 years. A total of 413 children in the 2015 survey and 431 children in the 2023 survey were analyzed. Data were collected from parents using the Turkish version of the validated ISAAC questionnaire.

Results: The prevalence of lifetime wheeze did not differ between the 2015 and 2023 surveys (20.3% vs. 20.0%; p=0.88). However, wheezing in the past 12 months was significantly more common in 2023 (18.6% vs. 12.3%; OR=1.62; 95% CI: 1.11-2.37; p=0.017). The presence of pets in the household had increased markedly in 2023 (OR=11.63; 95% CI: 5.29-25.60; p<0.001). In addition, physician-diagnosed allergic rhinitis (OR=2.06; 95% CI: 1.07-3.95; p=0.041) and family history of asthma (OR=1.55; 95% CI: 1.07-2.25; p=0.025) were more frequently reported in 2023.

Conclusion: Recent wheezing symptoms increased significantly in children during the post-earthquake period. Environmental changes following the earthquake, and particularly outdoor air pollution and deterioration of indoor air quality that may be associated with increased pet ownership, may have contributed to this increase. These findings emphasize the importance of protecting children's respiratory health after major natural disasters.

Keywords: Asthma, wheezing, children, earthquake, air pollution, ISAAC

INTRODUCTION

Asthma is one of the most common chronic inflammatory diseases of childhood (1). The prevalence and clinical course of asthma are influenced by the interaction of genetic predisposition, environmental exposures, and lifestyle factors (2). In particular, exposure to environmental factors during early childhood plays a critical role in the development of airway inflammation and hyperresponsiveness (3).

Air pollution is one of the most important environmental risk factors associated with childhood asthma and wheezing symptoms. Numerous studies have demonstrated that outdoor air pollutants, especially particulate matter ($PM_{2.5}$ and PM_{10}), adversely affect airway function and contribute to increased asthma symptoms (4-6). Children are more vulnerable to the harmful effects of air pollution than adults due to their developing respiratory systems and higher ventilation rates (7).

Natural disasters, particularly earthquakes, can substantially alter environmental air quality in both the short and long term. Following earthquakes, dust and particulate matter released from collapsed or damaged buildings, together with debris removal activities and increased traf-

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fic density, may lead to marked increases in outdoor air pollution (8,9). These environmental changes may trigger the onset of respiratory symptoms or exacerbate pre-existing asthma in susceptible children (10).

In the post-earthquake period, not only outdoor but also indoor air quality may be significantly affected. Changes in living conditions, including residence in smaller and poorly ventilated spaces and increased indoor exposure, may have adverse effects on children's respiratory health (11-13).

Recent studies suggest that large-scale disasters such as earthquakes may have detrimental effects not only on acute health outcomes but also on the prevalence and clinical course of chronic respiratory diseases (14). However, population-based epidemiological studies evaluating temporal changes in asthma and wheezing prevalence among children in the post-earthquake period remain limited.

In Türkiye, the *International Study of Asthma and Allergies in Childhood* (ISAAC) surveys constitute an important reference for assessing the prevalence of childhood asthma and allergic diseases (15). Comparisons of ISAAC-based cross-sectional surveys conducted in the same geographical region at different time points provide a robust epidemiological approach for evaluating the impact of environmental and societal changes on respiratory health.

The aim of this study was to compare the results of two ISAAC-based cross-sectional surveys conducted in the same geographical region in 2015 and 2023, in order to assess changes in the prevalence of asthma and wheezing symptoms among children in the post-earthquake period and to discuss potential environmental determinants of these changes, particularly those related to alterations in outdoor and indoor air quality.

MATERIALS and METHODS

Study Design and Population

This study was designed as a repeated cross-sectional, school-based epidemiological study conducted in Malatya, Türkiye, in 2015 and 2023. The 2015 dataset was obtained from a previously conducted independent ISAAC-based epidemiological survey performed before the earthquake period and published previously (16). The current study retrospectively compared the previously collected 2015 data with the post-earthquake 2023 survey data. To ensure methodological comparability between the two survey periods, the same geographical region, participating schools, age group, and sampling strategy were used in both the 2015 and 2023 surveys. In addition, the 2023 survey was conducted by a research team that included one of the investigators involved in the original 2015 study, and the same ISAAC-based questionnaire methodology was used in both surveys. The sample size for each survey year was determined a priori using statistical methods to adequately represent the population of children aged 6-7 years during the respective study periods.

Sample Size and Participants

In the 2015 survey, questionnaires were distributed to 480 children, and 413 children who returned fully completed forms were included in the analysis (response rate: 86%). In the 2023 survey, questionnaires were distributed to 500 children, and 431 children with complete data were included (response rate: 86.2%). In both surveys, children with incomplete questionnaires or missing key outcome variables were excluded from the study.

Data Collection

Data were collected using the standardized questionnaire of the International Study of Asthma and Allergies in Childhood (ISAAC), which has been translated into Turkish and validated for use in the Turkish population. The same core questionnaire was administered in both survey years to ensure methodological consistency.

The questionnaire included items on wheezing and asthma-related symptoms, physician-diagnosed asthma, allergic rhinitis and atopic eczema, demographic characteristics, environmental exposures (including passive smoking, presence of pets, and indoor living conditions), and family history of atopic diseases.

In both survey years, questionnaires were distributed to parents via classroom teachers after obtaining permission from school administrations. Parents were instructed to complete the questionnaires at home and return them within one week. Identical data collection procedures were applied in the 2015 and 2023 surveys to minimize potential methodological bias.

Assessment of Earthquake Exposure

The 2023 survey was conducted following a major earthquake that affected the study region. Therefore, earthquake exposure was considered a significant environmental factor potentially influencing respiratory and allergic

outcomes. Earthquake exposure was assessed indirectly based on residence in the officially defined earthquake-affected area and the temporal proximity of the survey to the earthquake event.

The impact of earthquake exposure on the prevalence of asthma and wheezing was evaluated by comparing prevalence rates between the 2015 (pre-earthquake) and 2023 (post-earthquake) surveys.

Statement on AI use: No generative artificial intelligence (AI) tools were used in the preparation, writing, or editing of this manuscript.

Statistical Analysis

Statistical analyses were performed using SPSS software (Statistical Package for the Social Sciences; SPSS Inc., Chicago, IL, USA), version 22. Data were presented as mean ± standard deviation, and number (percentage), as appropriate. The normality of continuous variables was assessed using the Kolmogorov-Smirnov test. Categorical variables were compared using the chi-square test. Continuous variables were compared using the independent samples t-test or the Mann-Whitney U test, as appropriate, based on data distribution. The results were reported as odds ratios (ORs) with 95% confidence intervals (95% CIs), and the year 2015 was used as the reference category in the analyses. P value<0.05 was considered statistically significant.

Ethical approval for this study was obtained from the ethical committee of Non-Invasive Clinical Research of Inonu University (Ethics Committee approval no: Approval No:2025/7248)

RESULTS

Study Population and Demographic Characteristics

In 2023, the mean age of the participants was 6.22 ± 0.41 years, and 232 children (53.8%) were female. Passive smoking exposure at home was reported for 175 children (40.6%). The prevalence of the history of physician-diagnosed asthma was 4.2%, the prevalence of the history of physician-diagnosed atopic eczema was 6.3%, and the prevalence of the history of physician-diagnosed allergic rhinitis was 6.7%. Family history of asthma was determined in 83 children (19.3%). The rate of breastfeeding was 91.2%. Regarding environmental exposures, 50 children (11.6%) lived in homes with cockroaches, and 72 children (16.7%) lived in households with pets. The demographic and environmental characteristics of children participating in the 2015 and 2023 surveys are summarized in Table I.

Comparison of Demographic and Environmental Factors Between 2015 and 2023 surveys

There was no statistically significant difference between the two survey years in terms of sex distribution, physician-diagnosed atopic eczema, passive smoking exposure, or presence of cockroaches in the household (p>0.05 for all). However, several significant differences were observed over time. The prevalence of physician-diagnosed asthma was significantly higher in 2015 compared with 2023 (OR=2.26, 95% CI: 1.27-4.04; p=0.005). The prevalence of physician-diagnosed allergic rhinitis was significantly higher in 2023 compared with 2015 (OR=2.06, 95% CI: 1.07-3.95; p=0.041). Similarly, a family history of asthma was more frequently reported in 2023 (OR=1.55, 95% CI: 1.07-2.25; p=0.025). The proportion of children who had been breastfed was significantly lower in 2023 than in 2015 (OR=1.9, 95% CI: 1.08-3.32; p=0.023). In contrast,

Table I: Demographic data in the 2015 and 2023 surveys

	2015 survey, (n=413) n (%)	2023 survey, (n=431) n (%)	p value
Female sex History of physician-diagnosed asthma	203 (49.1) 37 (8.9)	232 (53.8) 18 (4.2)	0.197 0.005
History of physician-diagnosed atopic eczema	30 (7.3)	27 (6.3)	0.659
History of physician-diagnosed allergic rhinitis	14 (3.4)	29 (6.7)	0.041
Family history of asthma	55 (13.3)	83 (19.3)	0.025
Breastfed during infancy	393 (95.1)	393 (91.2)	0.023
Exposure to passive smoking	192 (46.5)	175 (40.6)	0.098
Presence of pets in the household	7 (1.7)	72 (16.7)	<0.001
Presence of carpet in the child's bedroom	394 (95.3)	382 (88.6)	0.001
Presence of cockroaches in the household	37 (8.9)	50 (11.6)	0.251

the presence of pets in the household increased markedly in 2023 (OR=11.63, 95% CI: 5.29-25.60; p<0.001).

Time Trends in Wheezing and Asthma-Related Symptoms

The prevalence of lifetime wheeze was similar between the two surveys (20.3% in 2015 vs. 20% in 2023; p=0.88). In contrast, the prevalence of wheezing in the past 12 months was significantly higher in 2023 (18.6%) compared with 2015 (12.3%) (OR=1.62, 95% CI: 1.11-2.37; p=0.017).

Although the prevalence of speech limitation due to wheezing was higher in 2023 than in 2015 (4.4% vs. 1.9%), this difference did not reach statistical significance (p=0.065). No significant differences were observed between the two surveys in terms of exercise-induced wheezing or nighttime cough in the past 12 months (p>0.05 for both). The comparison of wheezing, asthma-related symptoms, and their time trends between the 2015 and 2023 surveys is presented in Table II.

DISCUSSION

The current study compared the results of two cross-sectional surveys conducted in the same geographical region in 2015 and 2023, and significant changes in the prevalence of wheezing and asthma-related symptoms were observed among children in the post-earthquake period. In particular, the observed increase in wheezing prevalence during the previous 12 months may be associated with post-earthquake environmental air pollution and changes in indoor environmental exposures.

It is well documented that earthquakes are followed by substantial increases in environmental air pollution (4,8,10,14). Dust, particulate matter ($PM_{2.5}$ and PM_{10}), asbestos, silica, and other inorganic particles released from collapsed or damaged buildings pose a significant respiratory risk, particularly during the months following the disaster. Fine particles can penetrate deep into the lower airways, inducing epithelial damage, oxidative stress, and inflammatory responses, which may increase airway hyperresponsiveness and lead to the onset or exacerbation of wheezing and asthma symptoms in children (5,6).

Children are particularly vulnerable to the adverse effects of air pollution. Increased construction activities, debris removal operations, and heavy truck traffic after earthquakes may result in prolonged outdoor air pollution (17,18). This sustained environmental burden may represent a key factor explaining the increased frequency of respiratory symptoms, especially among children predisposed to asthma. Post-earthquake changes in living conditions, including residence in smaller and poorly ventilated spaces, temporary shelters, or overcrowded households, may further compromise indoor air quality. Such conditions may facilitate the accumulation of indoor allergens, including pet-related allergens, mold, and dampness (19). Given that children spend a substantial proportion of their time indoors, these factors may amplify the clinical impact of indoor air pollution on respiratory health. In addition, the harsh winter conditions following the earthquake, combined with low temperatures and increased heating needs, may have contributed to the worsening of respi-

Table II: Time trends of prevalence of wheeze, asthma, and other symptoms

	2015 survey, (n=413) n (%)	2023 survey, (n=431) n (%)	OR (95% CI)	p value
Lifetime prevalence of wheezing	84 (20.3)	86 (20)	0.98 (0.70-1.37)	0.889
Wheezing in the past 12 months	51 (12.3)	80 (18.6)	1.62 (1.11-2.37)	**0.017**
Number of wheezing episodes in the past 12 months				
1-3 episodes	39 (9.4)	66 (15.3)		**0.010**
4-12 episodes	10 (2.4)	15 (3.5)		0.481
≥12 episodes	1 (0.2)	1 (0.2)		1
Sleep disturbances due to wheezing in the past 12 months				
Never woken up	376 (91)	374 (86.8)		0.049
<1 night per week	29 (7)	42 (9.7)		0.154
>1 night per week	8 (1.9)	15 (3.5)		0.244
Speech limitations due to severe wheezing in the past 12 months	8 (1.9)	19 (4.4)	2.33 (1.01-5.39)	0.065
Wheezing triggered by exercise in the past 12 months	16 (3.9)	23 (5.3)	1.40 (0.73-2.69)	0.397
Nighttime cough in the past 12 months	68 (16.5)	68 (15.8)	0.95 (0.66-1.37)	0.786

ratory symptoms in susceptible children by exacerbating both outdoor and indoor air pollution.

In our study, the marked increase in pet ownership observed in 2023 may have further contributed to the deterioration of indoor air quality during the post-earthquake period. Notably, pet ownership has increased substantially in our region following the COVID-19 pandemic. Pet allergens are airborne particles that can remain suspended for prolonged periods and are easily inhaled, triggering airway inflammation and exacerbating asthma symptoms in sensitized individuals (20).

Furthermore, inadequate implementation of indoor cleaning, ventilation, and allergen control measures in the post-earthquake period may have increased exposure to mold, dampness, and other particulate matter in addition to pet allergens. Combined exposure to multiple indoor allergens and pollutants may promote airway inflammation, thereby increasing the risk of wheezing episodes and asthma exacerbations (21,22). The absence of a significant increase in lifetime wheezing prevalence in our study suggests that the observed post-earthquake changes primarily reflect an increase in symptom frequency among children with pre-existing airway susceptibility rather than the development of new asthma cases. This finding is consistent with previous studies indicating that air pollution and indoor allergens mainly influence asthma control and symptom severity rather than asthma incidence (18,23).

When the findings are evaluated together, a striking divergence is observed between the prevalence of symptoms over time and the prevalence of diagnosed diseases. In particular, the significant increase in the prevalence of wheezing over the past 12 months, despite the prevalence of lifetime wheezing remaining similar, suggests that children may have been exposed to environmental triggers to a greater extent in recent years. This increase may be associated with rising air pollution, increased exposure to indoor environments due to urbanization, a rise in the frequency of keeping pets indoors, and changes in the burden of other environmental allergens. In contrast, the significant decrease in the prevalence of physician-diagnosed asthma is noteworthy. This situation may be explained by changes in access to healthcare, shifts in diagnostic practices, variations in physicians' thresholds for diagnosing asthma, or the attribution of symptoms to temporary or environmental causes other than asthma. Furthermore, the decline in diagnosis prevalence despite increasing symptoms may also indicate the presence of a potential "undiagnosed asthma" group. Therefore, while our findings suggest that the impact of environmental factors on respiratory symptoms is increasing, they also highlight the need to assess the dynamics of the healthcare system and diagnostic processes separately.

Our study demonstrated that the breastfeeding rate among children in the 2023 survey decreased significantly compared to the 2015 survey. Previous studies have reported that breastfeeding has protective effects on the modulation of the immune system in early life and may particularly reduce the risk of developing allergic diseases (24,25). It is believed that immunological components obtained through breast milk play a role in suppressing Th2-dominant allergic responses by supporting the development of the gut microbiota. In this context, we believe that the decline in breastfeeding rates may have potentially contributed to the changes in allergic disease patterns observed in our study.

Several limitations of this study should be acknowledged. First, due to its cross-sectional design, causal relationships between earthquake exposure and asthma-related outcomes cannot be definitively established. Second, a major limitation of this study is the absence of objective assessments of environmental exposures, including ambient particulate matter ($PM_{2.5}$ and PM_{10}), nitrogen dioxide (NO_2), indoor mold contamination, and environmental allergen burden. Therefore, the proposed relationship between post-earthquake environmental conditions and increased wheezing symptoms remains speculative and should be interpreted with caution. Third, this study was limited by the lack of detailed information on pet ownership characteristics, such as pet type, indoor or outdoor keeping conditions, duration of exposure, and sensitization to pet-derived allergens. Therefore, the potential association between pet exposure and increased wheezing symptoms should be interpreted cautiously. Another limitation of the study is that asthma and allergic diseases were assessed using parent-reported questionnaires rather than objective clinical measurements. Nevertheless, the ISAAC questionnaire is a well-validated and internationally accepted tool for epidemiological research, allowing meaningful comparisons with previous national and international studies. Despite these limitations, comparing two surveys conducted in the same region using identical methodology and similar response rates provides a strong epidemiological framework for evaluating the impact of environmental factors on respiratory health.

CONCLUSION

This study suggests that the increase in asthma and wheezing symptoms among children in the post-earthquake period may be associated with increased outdoor air pollution and deterioration of indoor air quality related to higher rates of pet ownership. These findings highlight the importance of implementing environmental air quality measures and indoor allergen control strategies to protect children's respiratory health in post-disaster settings.

Conflict of Interest

The authors declare that they have no conflict of interest.

Author Contributions

Concept: **MCS, ET,** Design: **EY, ET,** Data collection or processing: **MCS, EY,** Analysis or Interpretation: **MCS, ET,** Literature search: **MCS, EY, ET,** Writing: **MCS, ET,** Approval: **MCS, EY, ET.**

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