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Association between Serum Levels of IL-17 A and Asthma characteristics in Children

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Abstract

Background: Asthma is a wide prevalence chronic inflammatory condition in children, characterized by varying degree airway obstruction and differential exacerbation exacerbations. Interleukin-17A (IL-17A), a pro-inflammatory factor is involved in pathogenesis of asthma and no longer forms of airways, isolation of isolation of steroids highlights the potential challenges in treating of disease. This study is aimed to evaluate the serum levels of IL-17A in children with asthma and to study the relation with different sociodemographic and clinical factors, including asthma severity, family history of asthma, and response to inhaled corticosteroids to improve understand its potential role in the characterization of disease. potential challenges in treating of disease. This study is aimed to evaluate the serum levels of IL-17A in children with asthma and to study the relation with different sociodemographic and clinical factors, including asthma severity, family history of asthma, and response to inhaled corticosteroids to improve understand its potential role in the characterization of disease.

Patients and Methods: This is a cross-sectional study in Karbala teaching hospital for children at asthma out-patient clinic was performed with 90 asthmatic patients aged 7 months to 16 years. Structured questionnaires were used to collect clinical data, such as medication regimen, family history, control level, and severity of asthma. Serum samples were collected to detect IL-17 in by using ELISA assay kit.

Results: The mean serum IL-17A level was 1.31 ± 1.57 pg/mL. IL-17A levels were higher in moderate asthma (1.523 ± 2.002 pg/mL) and well-controlled asthma (1.692 ± 2.414 pg/mL). notably, a significant correlation (p = 0.03) was found between increased IL-17A levels and a family history of asthma. Males, urban residents, and children without pets or tobacco smoke exposure had slightly higher IL-17A levels, though differences were not statistically significant.

Conclusion: Interleukin-17A levels were higher in patients with moderate asthma. Elevated IL-17A was associated with positive family history of asthma. These results suggest that IL-17A may be a biomarker for pediatric asthma.

الارتباط بين مستويات مصل الانترلوكين 17- A وخصائص الربو في الاطفال

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الخلاصة

المقدمة: يعد الربو من الحالات الالتهابية المزمنة شائعة الانتشار بين الاطفال، يتميز بدرجات متفاوتة من النوبات الحادة وانسداد المسالك الهوائية. الانترلوكين A-17 ,(IL-17A) ، ويكون عامل محفز للالتهاب ويشارك في الية حدوث الربو كما ان عزله من الجاري الهوائية يقود الى التحديات المحتملة في علاج المرض. تهدف الدراسة الى تقييم مستويات IL-17A في مصل الدم للاطفال المصابين بالربو ودراسة علاقته بعوامل اجتماعية وديموغرافية وسريرية مختلفة بما في ذلك شدة الربو والتاريخ العائلة للربو والاستجابة للكورتيكوستيرويدات المستنشقة ، وذلك لفهم دوره المحتمل في توصيف المرض بشكل افضل.

المرضى وطرق العمل: تم إجراء دراسة مقطعية في مستشفى كربلاء التعليمي للاطفال في عيادة الربو الخارجية وشملت 90 مريضا بالربو اعمارهم تتراوح بين 7 اشهر و 16 عاما. استخدمت الاستبيانات المنظمة لجمع البيانات السريرية مث النظام العلاج الدوائي والتاريخ العائلي ومستوى السيطرة على الربو وشدة الربو، جمعت العيناتمن مصل الدم للكشف عن انترلوكين A-17 باستخدام اختبار ELISA

النتائج: بلغ متوسط مستوى إنترلوكين-A17 في مصل الدم 1.31 ± 1.57 بيكوغرام/مل. وكانت مستويات إنترلوكين-A17 مرتفعة في حالات الربو المتوسط (1.523 ± 2.002 بيكوغرام/مل) والربو المُسيطر عليه جيدًا (1.692 ± 2.414 بيكوغرام/مل). وقد لاحظ وجود ارتباط معنوي ($p = 0.03$) بين ارتفاع مستويات إنترلوكين-A17 والتاريخ العائلي للربو. وسُجلت مستويات أعلى قليلاً من إنترلوكين-A17 لدى الذكور، والأطفال غير المُعرَّضين لحيوانات أليفة أو دخان التبغ، ,لم تكن تلك الفروق ذات دلالة إحصائية

الاستنتاج: كانت مستويات الانترلوكين 17 اعلى لدى المصابين بالربو المتوسط وارتبط مستوى الانترلوكين 17 بوجود تاريخ عائلي ايجابي للربو. تشير هذه النتائج الى انه الانترلوكين A-17 يكون مؤشر حيوي عند الاطفال.

1. Introduction

Asthma is a chronic disease marked by irritated airways that cause wheezing, shortness of breath, chest tightness and coughing which are reversible and vary in intensity (Yuan et al., 2025). In united states millions of children have a public health problem, which places a burden on children, families and their health care system. In different countries the prevalence is variable between 1-29% (Asher et al., 2020). The International Study of Asthma and Allergic in pediatrics was reported the incidence of pediatric asthma in countries, from 0.8% to 37.6% (Abood and Al-Zaubai, 2020). Global trends show that more young children are being hospitalized for asthma, which can be linked to poverty, inadequate illness treatment, and greater severity (Serebrisky and Wiznia, 2019; Barman, 2006) interleukin-17 (IL-17) Produced by Th17 cells, IL-17 which has been linked to patients' severe and steroid-resistant asthma as well as neutrophilic asthma, and its involvement in various aspects of asthma, such as mucus production and airway hyper-reactivity, has been documented (Salem et al., 2025; Long et al., 2023). Notably, studies suggest that IL-17A can elevate mucus production and is linked to structural changes in epithelial cells, thereby contributing to asthma-related symptoms and exacerbations (Hall et al., 2017). Elevated serum levels of interleukin-17A (IL-17A) in children with asthma may significantly influence treatment decisions, particularly concerning the use of biologic therapies. However, the complexity of IL-17A's functions in asthma necessitates further research to better understand its longitudinal stability and diverse effects, which are critical for optimizing treatment strategies in pediatric asthma patients (Hall et al., 2017). The variability of IL-17A levels in response to different environmental exposures, such as diesel fume and cigarette smoke, adds another layer of complexity, as these factors can influence serum IL-17 concentrations in asthmatic children (Hynes and Hinks, 2020). Furthermore, the presence of IL-17A in the serum has been linked to an increased risk of severe asthma exacerbations and has shown a correlation with reduced sensitivity to inhaled corticosteroids (ICS), highlighting the potential challenges in treating this subpopulation of asthmatics (Rahmawati et al., 2021).
The aim of our study is to estimate IL-17A in the serum of children with asthma and evaluate its relation to asthma characteristics

2. Materials, Patients and Methods

2.1. Setting and Study design

This study is cross sectional study, its about 90 patients were selected from outpatients Karbala teaching hospital for asthmatic children, during the period 2022- 2023.

2.2.Ethical approval

This study was approved by the scientific counsel of pediatric pulmonology fellowship of Arab board of health spatiality. Furthermore, consent was obtained from each child’s parents before blood sampling and

interview for data collection. The study was an independent ethics committee examined and approved all procedures, which were carried out in conformity with the Declaration of Helsinki.

2.3.Patient Selection

Asthmatic patients aged 7 months-16 years diagnosed as asthmatics by clinical evaluation and spirometry according to age was randomly selected. Those who were less than 3 years diagnosed according clinical and therapeutic trial after exclusion of other deferential diagnosis of recurrent wheeze. Modified asthma predictive index (75) supporting the clinical based diagnosis, and those who were 6 years and above diagnosed by spirometry. Strict inclusion and exclusion criteria were applied to ensure homogeneity within the asthmatic patients. The following cases were excluded from the study:

- Patient with psoriasis, inflammatory bowel diseases, rheumatoid arthritis, parasitic infestation, or immunodeficiencies.
- Patient who is chronic wheezer and has no response to controller medication and has no at least partial response to SABA.
- Helminthic infested patients were rolled out as possible, by history only.
- Asthmatic patients with other chronic airway disease like CF and PCD.
- Asthmatic patient with chronic disease like DM, CHD, CKD.

2.4.Data Collection

Demographic and clinical data were collected through an interview conducted with patients and/or their parents through a questionnaire. Socio-demographic and observed data: sex, age, weight, height, address, family history of asthma, exposure to smoking, presence of domestic and/or pet animal in the house, personal history of allergic rhinitis, asthma controller therapy, and questions to assess asthma severity. Serum samples were collected to detect IL-17 in by using ELISA assay kit.

In our study, several potential sources of bias were carefully addressed to ensure the validity of the findings:

1. Selection Bias was minimized by randomly recruiting patients from the asthma outpatient clinic based on strict inclusion and exclusion criteria. That is reducing the risk of preferential selection.

2. Recall Bias was limited by collecting clinical and demographic data through direct interviews with parents using a structured questionnaire, which enhanced the accuracy of the data obtained.

3.The laboratory personnel handling and analyzing the samples were not aware of the patients' clinical status, which prevents their expectations or knowledge from influencing the results.

2.5.Study Nature and Approval

This study was done out in order to fulfill the prerequisites for the Arab Board Fellowship in Pediatric Pulmonology. Both the Scientific Committee and the Ethical Review Board examined and approved the study

procedure, and the findings were openly argued during a scientific discussion session. The research method gained academic rigor, peer review, and transparency as a result of these process.

2.6.Statistical Analysis

The entry of data and analysis were performed using the Statistical Package for the Social Sciences (SPSS) application (version 21, San Diego, California, USA). All data were summarized using the mean, standard deviation, and percentage. Categorical variables were reported as exact numbers or percentages (%), whereas continuous variables were specified as means ± standard deviation. An Independent T-test was used to measure the serological parameters between the study groups. ANOVA test was used to test the significance level for different clinical and laboratory parameters among the study groups. $P<0.05$ was considered statistically significant, while $P<0.01$ was considered highly significant. Pearson correlation is used to measures the correlation between the anthropometric parameters and IL-17A.

3. Results

Demographic characteristics for 90 asthmatic patients were summarized in Table1. Age ranged between 7 months to 16 years old distributed into three age groups [less than 6 years N=34 (37.77%), from 6 to 11 years N=39 (43,33%), and more than 11 years N=17 (19%)], their mean age was 7.35±3.86 years. Total Males were 58 (64.4%), 20 of them were below 6 years old while 27 of them were between 6 and 11 years old and 11 patients were above 11 years, however total females were 32(35.6%),14 patients were below 6 years old and 12 were between 6 and 11 years old and just 6 were above 11 years among our study populations. Majority of the patients were living in urban areas (65.6%), most of them have no domestic animals in their houses (74.4%) and not exposed to cigarettes smoke (54.4%). the mean BMI of our study population was 16.95± 4.11kg/m^2 Table1.

Table1: Demographic Characteristics of Children with Asthma

Asthmatic patients' characteristics(N=90)		
Data presented by mean ±SD		
Age (years)		7.35±3.86
BMI (kg/m^2)		16.95±4.11
Data presented by percentage		N (%)
Sex	Male	58 (64.4%)
	Female	32 (35.6%)
Residency	Urban	59 (65.6%)
	Rural	31 (34.4%)
Animal in house	Yes	23 (25.6%)
	No	67 (74.4%)

Exposure to tobacco smoke	Yes	41 (45.6%)
	No	49 (54.4%)

Majority of the patients were ranked as moderate asthma (50%), most of asthmatic patients were partially controlled (43.3%), 63.3% were used montelukast as a maintenance therapy. those who had another family member diagnosed with asthma were (66.7%), while 22.2% were having allergic rhinitis as shown in Table2.

Table2: Patients Characteristics Related to Asthma

Characteristic of asthma		**N=90(100%)**
Family history of asthma	Yes	60 (66.7%)
	No	30 (33.3%)
Personal history of allergic rhinitis	Yes	20 (22.2%)
	No	70 (77.8%)
Asthma Severity	Mild	36 (40%)
	Moderate	45 (50%)
	Severe	9(10%)
Asthma Control	Well	34 (37.77%)
	Partial	39 (43.33%)
	Not well	17 (19%)
Asthma maintenance Treatment	Montelukast	57 (63.3%)
	Beclomethasone	18 (20%)
	Fluticasone/salmeterol	6 (6.7%)
	Budesonide	4 (4.4%)
	Montelukast and ICS	5 (5.6%)

Table3 show weak negative correlation between both age, BMI and IL-17A serum level.

Table3: Correlation Between Anthropometric Factors and Serum IL-17A Level

	Risk factor	**Pearson Correlation**	**P value**
IL-17A pg/Ml	**Age years**	-0.007	0.947
	BMI kg/m	-0.016	0.878

Table4 shows that Male group has higher serum level of IL-17A than female with mean 1.495 ±1.874. higher serum level IL-17A mean also found in patients who lived urban areas of 1.322 ±1.733, those who had no domestic animals had higher mean of IL-17A serum level was 1.312 ± 1.757SD, also higher in those who were not exposed to cigarettes smoke1.420 ± 2.001.

Table4: Association Between Demographical Factors and Serum IL-17A Level

Factors		IL-17A pg/mL	*p*-value
Sex	**Male**	1.495± 1.874	0.134
	Female	.9778 ±.6330	
Residence	**Urban**	1.322±1.7335	0.929
	Rural	1.291±1.2098	
Animal in the house	**Yes**	1.309±.809	0.994
	No	1.312±1.757	
Tobacco Smoke exposure	**Yes**	1.181±0.788	0.474
	No	1.420±2.001	

Table5: shows that IL-17A serum level mean value was highest in moderate asthma (1.523± 2.002 pg/ml) and lowest in severe asthma (0.805± 0.447 pg/ml) and the high value also recorded in well controlled asthma (1.692± 2.414 pg/ml). Patients on fluticasone had high IL-17A serum level (3.012± 4.665 pg/ml), while those on budesonide (0.9665 0.395 pg/ml) had the lowest. Patients who have asthma in their family member have high IL-17A mean than those who's not (1.476 ±1.861pg/ml). IL-17A serum level mean value was high in patients with allergic rhinitis (1.373 ±1.070 pg/ml). For most parameters (Asthma Severity, Asthma Control, Asthma Treatment, Personal History of Allergic Rhinitis), the *p*-values are greater than 0.05, suggesting no statistically significant difference in IL-17A levels. However, for Family history of asthma, the *p*-value =0.03 indicates a statistically significant difference in IL-17A levels between those with and without a family history of asthma.

Table5: Comparison Between Clinical Characteristics of Asthmatic Patients and Their Serum Level of IL-17A.

Parameter		IL-17A pg/mL	*P* value
Asthma Severity	Mild	1.123 ±1.081	0.362
	Moderate	1.523 ±2.002	
	Severe	0.805 ±0.447	
Asthma Control	Well	1.692 ±2.414	0.369
	Partial	1.258±1.1429	
	Poor	0.8456±0.3879	
Asthma Treatment	Montelukast	1.246 ±1.206	0.959
	Beclomethasone	1.055 ±0.5304	
	Fluticasone/salmetrol	3.012 ±4.665	
	Budesonide	0.9665 ± 0.395	
	Montelukast and ICS	1.063 ± 0.8416	
Family history of asthma	Yes	1.476±1.861	0.03*
	No	0.981±0.555	
Personal history of allergic rhinitis	Yes	1.095±0.959	0.488
	No	1.373±1.70	

4. Discussion

In the pathophysiology of asthma innate and adaptive immune response both are contribute as well as memory immunity. Asthma is not quite understood till now so test for cytokines release and role of other inflammatory cell in order to change or improve treatment modalities, including environmental modification and immunotherapy is required (Chang et al., 2013). Regarding demographical characteristics of asthmatic children, Age plays a role as a critical risk factor. Our patient's age was ranged from 7 months to 16 years, ranking the participants into three categories: below 6, 6-11 and above 11, we notice that highest percentage goes to 6-11 years old children with 39(43,33%), patients, from them 27 were male participants. Similar results were found by in Nigeria with the highest prevalence of clinical asthma in children (6–17 years) and adults (18–45 years) occurring in Benin (6.0%) and Lagos (13.8%) respectively (Yawn et al., 2018). Adolescents' symptoms triggered by animal dander, pollen, air pollutions, perfumes smoke and emotional. And each age group exposed to triggers differently and the maturity of the immune system and its response changed in different age play a role (Ozoh et al., 2019). Males tend to be predominant in all age-based ranks and that male affected more with asthma in early life than female, Daniela Mokra et.all found that on the base of sex discrimination: Boys are more likely than females to have allergic asthma. Women are more likely than men to have asthma in adulthood, particularly the more severe obesity-related neutrophilic subtype, which reacts poorly to corticosteroids (Mokra et al., 2023), also a study done in Japan shows prevalence of asthma was higher in boys (6%) than girls (4%), and that may be genetic predisposition in and the switch in adolescent occur due to hormonal effect and tendency for obesity in female (Mokra et al., 2023). The majority of our patients lives in urban areas 59(65.6%) similar finding of a systemic review, that found a greater asthma prevalence in urban areas than in rural areas (Rodriguez et al., 2019; Pudasainee-Kapri et al.). children from rural countries registered fewer emergency department visits for asthma exacerbations than children from urban and suburban counties (Malik et al., 2012; Rodriguez et al., 2019). Both environmental and healthcare access may contribute to these findings. on the contrary Corinne A. Keet et al. discovered that among low-income US children, metropolitan environments and a weak economy are significant risk factors for asthma complications, not recurrence. Another study conducted in Europe demonstrates that early exposure to farm animals and farming communities protect against asthma and sensitization. and extensive exposure to bacterial endotoxins may mediate this impact (Malik et al., 2012). 74.4% of our patient has no domestic animals or pets inside their houses, and this is considered a majority, this can be justified by families with allergic disease decisions not to have pets has been made, or due to a cultural issue, a study done in Sweden shows that the exposure to furry animals increase the risk of sensitization and incidence of developing asthma as well (Keet et al., 2017). During the first year of life, having a dog or cat at home may help prevent childhood allergies and asthma. We found no evidence of a synergistic relationship between

exposure to farm animals, dogs, and cats and the incidence of childhood allergies and asthma. Future studies should pinpoint the precise exposures caused by indoor pets and determine whether or not they should be advised for the avoidance of allergies. According to a systematic evaluation of 32 papers, having pets during the first two years of life was linked to a non-significant 11% increase in the chance of developing asthma (Alsamarai et al., 2009). Even in prospective studies, it is challenging to investigate the relationship between pet exposure and children asthma due to concerns about exposure duration and time, as well as potential confounding factors related to pet ownership (Alsamarai et al., 2009). Those who were not exposed to cigarette smoke represent 54.4%, that's mean 45.6% of the participants were exposed to cigarette smoke, and this considered quite a lot. When assessing asthma severity 50% of our patient ranked as moderate asthma, similar finding in Iran communities indicate that lower rate of severe asthma despite higher prevalence of ever wheezing than regional study may be due to better parent knowledge and on time diagnose and treatment of children in recent years (Jin et al., 2013). Most of the participant are partially controlled (43.3%), many factors contribute to that poor controller adherence, poor technique and poor perception of symptoms, bad environmental control and poor economic status all these factors and more involved in symptoms control. According to additional research conducted in the US, a significant percentage of school-aged children with asthma have poorly managed asthma, and there is room for improvement. In the past 12 months, about 59% of SAC with asthma experienced an exacerbation. With 3.4 million SAC experiencing an asthma attack in 2013, this has serious public health implications (Zobeiri, 2011). 63.3% have Montelukast as a controller therapy for their asthma. And that's because of LTRA was provided for free by our hospital at time of the study and the wrong paradigm combine the use of inhalers adopted by the family in our society. Similarly, a study by Suh et al. discovered that among children under six with asthma, Korean children show distinct patterns of asthma severity and treatment preferences, including a reduced prevalence of severe asthma and a preference for LTRA over low dosage inhaled corticosteroids (ICS) alone or add-on long-acting beta-agonists (LABA), which has not been anticipated in Western nations. Therefore, it is necessary to modify and provide techniques that are specific to regional status (Sullivan et al., 2018). Those who had another family history of asthma were 66.7%, similar result found by alsamiria et.al were patients with family history of asthma were 136 (53.1%, $p<0.001$) (Alsamarai et al., 2009). Additionally, a personal history of allergic rhinitis was recorded for 22.2% of the participants in our study. In addition to having a similar pathogenesis and frequently coexisting with asthma, allergic rhinitis is a significant cause of morbidity. It's crucial to identify and treat both illnesses because their co-existence has been shown to exacerbate asthma management. Research by Khan DA. Et.all and Bousquet J. et.all indicates a strong correlation between the co-occurrence of asthma and allergic rhinitis (70–80%) and the elevated risk of asthma in individuals with allergic rhinitis (Khan, 2014). Th17 cells are the main source of the pro-inflammatory cytokine IL-17A, which is essential

for both steroid resistance in asthma and neutrophilic airway inflammation (Newcomb and Peebles, 2013). Numerous investigations have revealed that patients with asthma, especially those with severe or steroid-resistant phenotypes, have higher amounts of IL-17A in their serum, sputum, and bronchoalveolar lavage (BAL) (Al-Ramli et al., 2009). Increased Th1/IFN-γ and Th17/IL-17 responses have been seen in recent human and mice studies, especially in corticosteroid-resistant severe asthma, which is frequently linked to neutrophil infiltration of the airways (Ray and Kolls, 2017). Interleukin-17A serum level mean value was found to be 1.31±1.57 pg/ml in our study population and our detection rang was from 0.006-2.188 pg/ml, a previous study in our hospital found the detection range 6.25 pg/ml-400 pg/m for IL-17A. and the cutoff value was pg/ml ≥ 0.9435 (Abo-Shanab et al., 2020). A study in Saudia Arabia shows the mean of IL-17A in asthmatic patient was, pg/mL 2.752± 2.87, (Bazzi et al., 2011) The cutoff value for IL-17 level serum level was >13.1 pg/mL, according to another study from Tunisia. This value could predict childhood asthma with a sensitivity of 83.3% and a specificity of 70%. These findings imply that it may be important in the pathogenesis of childhood asthma (Mansour et al., 2017). It appears that IL-17A plays a more significant role in the acute and severe phases of allergic disease than in the chronic phases (Hofmann et al., 2021), which explains why the value in our study was lower than anticipated. Given that IL-17A is known to promote neutrophilic inflammation and airway remodeling, especially in corticosteroid-resistant phenotypes, this could be a reflection of the cytokine's dynamic role (Al-Ramli et al., 2009). Among all of clinical characteristics of asthma just family history of Asthma has an association with serum IL-17A with significant statistical value, we found that Patients who have asthma in their family member have high IL-17A mean than those who's not 1.476 ±1.861pg/ml. genetic contribution to this finding may play a role (Schultz and Brand, 2011). Research has connected polymorphisms in the IL-17A and IL-17RA genes to heightened vulnerability and severity of asthma. It's interesting to note that although IL-17A was numerically higher in people with moderate asthma, well-controlled asthma, and those receiving fluticasone/salmeterol therapy, none of these reached statistical significance.

Conclusion

In this study the characteristics of asthma have association with serum levels of IL-17A. Higher levels of IL-17A in mild patients of asthma whose well-controlled symptoms. Family history is associated with elevated levels of IL-17A. These finding demonstrate that IL-17A may be a biomarker for childhood asthma, and further research is needed to determine its clinical efficacy.

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References

Abood, H.A. and Al-Zaubai, N. (2020). Letter from Iraq. Respirology, 25, pp.769–770. https://doi.org/10.1111/resp.13789

Abo-Shanab, A.M., Elnady, H., Helwa, I. et al. (2020). Th2 cytokines and IgE in asthmatic children. Biomedical and Pharmacology Journal, 13(4). https://dx.doi.org/10.13005/bpj/2051

Al-Ramli, W. et al. (2009). Th17 cytokines in severe asthma. Journal of Allergy and Clinical Immunology, 123(5), pp.1185–1187. https://doi.org/10.1016/j.jaci.2009.02.024

Alsamarai, A.M., Salih, M.A., Alobaidy, A.H. et al. (2009). Risk factors for asthma in Iraqi children. Journal of Tropical Pediatrics, 8, pp.45–52.

Asher, M.I., Garcia-Marcos, L., Pearce, N.E. and Strachan, D.P. (2020). Trends in worldwide asthma prevalence. European Respiratory Journal, 56(6).

Bazzi, M.D., Sultan, M.A., Al-Tassan, N. et al. (2011). IL-17A and IL-17F polymorphisms in asthma. Journal of Investigational Allergology and Clinical Immunology, 21(7), pp.551–555.

Braman, S.S. (2006). The global burden of asthma. Chest, 130(1 Suppl), pp.4S–12S. https://doi.org/10.1378/chest.130.1

Chang, T.S., Lemanske, R.F. Jr., Guilbert, T.W. et al. (2013). Evaluation of the modified asthma predictive index in high-risk preschool children. Journal of Allergy and Clinical Immunology: In Practice, 1(2), pp.152–156.

Hall, S.L., Baker, T., Lajoie, S., Richgels, P.K., Yang, Y., McAlees, J.W. et al. (2017). IL-17A enhances IL-13 activity by enhancing IL-13–induced STAT6 activation. Journal of Allergy and Clinical Immunology, 139(2), pp.462–471. https://doi.org/10.1016/j.jaci.2016.04.0372

Hofmann, M.A., Fluhr, J.W., Ruwwe-Glösenkamp, C. et al. (2021). Role of IL-17 in atopy: systematic review. Allergy, 76(6), e12047.

Hynes, G.M. and Hinks, T.S. (2020). The role of interleukin-17 in asthma: a protective response? ERJ Open Research, 6(2).

Jin, Y., Seiber, E.E. and Ferketich, A.K. (2013). Secondhand smoke and asthma: healthcare utilization in children. Preventive Medicine, 57(2), pp.125–128. https://doi.org/10.1016/j.ypmed.2013.05.003

Keet, C.A., Matsui, E.C., McCormack, M.C. and Peng, R.D. (2017). Urban residence and asthma morbidity among children. Journal of Allergy and Clinical Immunology, 140(3), pp.822–827. https://doi.org/10.1016/j.jaci.2017.01.036

Khan, D.A. (2014). Allergic rhinitis and asthma: epidemiology and pathophysiology. Allergy and Asthma Proceedings, 35, pp.357–361. https://doi.org/10.2500/aap.2014.35.3794

Long, X., Xie, J., Ren, L., Yu, G., Liu, E., Deng, Y. and Long, X. (2023). IL-17A plays a critical role in RSV infection in children and mice. Virology Journal, 20(1), p.30. https://doi.org/10.1186/s12985-023-01990-8

Malik, H.U., Kumar, K. and Frieri, M. (2012). Minimal difference in asthma prevalence between urban and rural environments. Clinical Medicine Insights: Pediatrics, 6, pp.33–39.

Mansour, A.I., Abd Almonaem, E.R., Behairy, O.G. and Gouda, T.M. (2017). Predictive value of IL-35 and IL-17 in childhood asthma. Scandinavian Journal of Clinical and Laboratory Investigation, 77(5), pp.373–378. https://doi.org/10.1080/00365513.2017.1328739

Mokra, D., Barosova, R. and Mokry, J. (2023). Sex-based differences in bronchial asthma: mechanisms. Applied Sciences, 13, p.2694. https://doi.org/10.3390/app13042694

Newcomb, D.C. and Peebles, R.S. (2013). Th17-mediated inflammation in asthma. Current Opinion in Immunology, 25(6), pp.755–760. https://doi.org/10.1016/j.coi.2013.08.002

Ozoh, O.B., Aderibigbe, S.A., Ayuk, A.C., Desalu, O.O., Oridota, O.E. et al. (2019). The prevalence of asthma and allergic rhinitis in Nigeria: a nationwide survey. PLOS ONE, 14(9), e0222281. https://doi.org/10.1371/journal.pone.0222281

Pudasainee-Kapri, S., Pontes, N.M.H. and Pontes, M.C.F. (n.d.). Sex differences in asthma and bullying victimization among high school students in the USA. https://doi.org/10.1111/josh.13353

Rahmawati, S.F., Te Velde, M., Kerstjens, H.A., Dömling, A.S., Groves, M.R. and Gosens, R. (2021). Pharmacological rationale for targeting IL-17 in asthma. Frontiers in Allergy, 2, p.694514. https://doi.org/10.3389/falgy.2021.694514

Ray, A. and Kolls, J.K. (2017). Neutrophilic inflammation in asthma. Trends in Immunology, 38(12), pp.942–954.

Rodriguez, A., Brickley, E., Rodrigues, L., Normansell, R.A. and Barreto, M. (2019). Urbanisation and asthma in low-income and middle-income countries. Thorax, 74, pp.1020–1030.

Salem, K.J., Alattabi, A.S., Hamza, D.M. and Abood, H.A. (2025). Correlation of IL-5 and IL-17 with specific allergens in pediatric asthmatic patients. Karbala Journal of Pharmaceutical Sciences, 16(26), pp.240–252.

Schultz, A. and Brand, P.L. (2011). Episodic viral wheeze in preschool children. Paediatric Respiratory Reviews, 12(3), pp.160–164. https://doi.org/10.1016/j.prrv.2011.01.008

Serebrisky, D. and Wiznia, A. (2019). Pediatric asthma: a global epidemic. Annals of Global Health, 85(1), p.6.

Sullivan, P.W., Ghushchyan, V., Navaratnam, P., et al. (2018). National prevalence of poor asthma control among school-aged children. ournal of Allergy and Clinical Immunology: In Practice, 6(2), pp.536–544.e1. https://doi.org/10.1016/j.jaip.2017.06.039

Yawn, B.P., Wollan, P.C., Rank, M.A., Bertram, S.L., Juhn, Y. and Pace, W.J. (2018). Use of asthma APGAR tools in primary care practices: a cluster-randomized controlled trial. Annals of Family Medicine, 16(2), pp.100–110. https://doi.org/10.1370/afm.2179

Yuan, L., Tao, J., Wang, J., She, W., Zou, Y., Li, R., et al. (2025). Global, regional, national burden of asthma from 1990 to 2021, with projections of incidence to 2050: a systematic analysis of the global burden of disease study 2021. EClinicalMedicine, 80.

Zobeiri, M., 2011. Prevalence, risk factors and severity of asthma symptoms in children of Kermanshah, IRAN: ISAAC phase I, II. Acta Medica Iranica, pp.184-188.