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CLINICAL AND IMMUNOLOGICAL CHARACTERISTICS OF BRONCHIAL ASTHMA IN CHILDREN AND ADOLESCENTS IN THE ABAY REGION

Andrei Furlan[1], https://orcid.org/0009-0004-7603-8731
Gulbarshyn D. Mukasheva*[2], https://orcid.org/0000-0003-3490-5628
Saule B. Maukayeva[2], https://orcid.org/0000-0002-2679-6399
Nazym K. Kudaibergenova[2], https://orcid.org/0000-0002-6165-7677
Dariya M. Shabdarbayeva[2], https://orcid.org/0000–0001–9463–1935
Zhanargyl K. Smailova[2], https://orcid.org/0000-0002-4513-4614
Botagoz S. Turakhanova[2], http://orcid.org/0009-0003-0480-7063
Dinara B. Kozubayeva[2], https://orcid.org/0000-0003-4937-708X
Maiya V. Goremykina[2], https://orcid.org/0000-0002-5433-7771
Zhanar B. Issabekova[2], https://orcid.org/0000-0002-2744-0327
Saya S. Karimova[2], http://orcid.org/0000-0002-1167-5375
Nailya M. Urazalina[2], https://orcid.org/0000-0003-0200-1763

[1] University of Medicine and Pharmacy "Victor Babeș" Timișoara, Romania;
[2] NCJSC «Semey Medical University», Semey, Republic of Kazakhstan.

Abstract

Background: Bronchial asthma is one of the most widespread chronic respiratory conditions in children and adolescents. Its development and progression are strongly influenced by environmental exposures and immunological responses.

This study aimed to assess the clinical features and immunological profiles of asthma in pediatric patients in the Abay region of Kazakhstan, focusing on symptom patterns, biomarker levels, and allergic history.

Materials and methods: A retrospective analysis was carried out based on the medical records of 71 children aged 1 to 17 years with a confirmed diagnosis of asthma. The evaluation included clinical symptom assessment and spirometry. Statistical analyses were conducted using descriptive methods, T-tests, and chi-square tests.

Results: The most frequently reported symptoms were cough (76.1%) and dyspnea (59.2%). Nearly one-third of participants lived in damp housing conditions, which showed a statistically significant association with respiratory complaints ($p < 0.05$). Moderate asthma was observed in 80.3% of cases, and 19.7% were classified as mild. Among those tested, elevated levels of ECP and IgE were more common in moderate cases and among those exposed to allergens.

Conclusion: Children and adolescents with asthma in the Abay region are often exposed to environmental triggers such as humidity and seasonal allergens. These factors appear to influence both the severity of clinical symptoms and the levels of immunological markers. The findings highlight the importance of early identification of environmental risks and support the use of ECP and IgE levels in guiding personalized asthma management strategies.

Key words: *Bronchial asthma; Adolescents; Environmental exposure; Biomarkers; Clinical characteristics.*

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Резюме

КЛИНИКО-ИММУНОЛОГИЧЕСКАЯ ХАРАКТЕРИСТИКА БРОНХИАЛЬНОЙ АСТМЫ У ДЕТЕЙ И ПОДРОСТКОВ В АБАЙСКОЙ ОБЛАСТИ

Андрей Фурлан[1], https://orcid.org/0009-0004-7603-8731
Гүлбаршын Д. Мукашева*[2], https://orcid.org/0000-0003-3490-5628
Сауле Б. Маукаева[2], https://orcid.org/0000-0002-2679-6399
Назым К. Кудайбергенова[2], https://orcid.org/0000-0002-6165-7677

Дария М. Шабдарбаева[2], https://orcid.org/0000–0001–9463–1935
Жанаргуль К. Смаилова[2], http://orcid.org/0000-0002-4513-4614
Ботагоз С. Тураханова[2], http://orcid.org/0009-0003-0480-7063
Динара Б. Козубаева[2], https://orcid.org/0000-0003-4937-708X
Майя В. Горемыкина[2], https://orcid.org/0000-0002-5433-7771
Жанар Б. Исабекова[2], https://orcid.org/0000-0002-2744-0327
Сая С. Каримова[2], http://orcid.org/0000-0002-1167-5375
Найля М. Уразалина[1], https://orcid.org/0000-0003-0200-1763

[1] Университет медицины и фармации имени Виктора Бабеша, Тимишоара, Румыния;
[2] НАО «Медицинский университет Семей», г. Семей, Республика Казахстан.

Введение: Бронхиальная астма — одно из наиболее распространённых хронических заболеваний дыхательных путей у детей и подростков. На её развитие и течение значительное влияние оказывают факторы окружающей среды и иммунологические особенности.

Цель: Целью настоящего исследования является анализ клинических проявлений и иммунологических показателей астмы у детей в Абайской области Казахстана, с акцентом на симптоматику, уровень биомаркеров и аллергологический анамнез.

Материалы и методы: Проведено ретроспективное исследование медицинских карт 71 ребёнка в возрасте от 1 до 17 лет с подтверждённым диагнозом бронхиальной астмы. Оценка включала анализ клинических симптомов и данные спирометрии. Статистическая обработка выполнена с применением описательных методов, t-теста и χ^2-теста.

Результаты: Наиболее частыми симптомами были кашель (76,1%) и одышка (59,2%). Примерно треть участников проживала во влажных условиях, что показало статистически значимую связь с респираторными жалобами ($p < 0,05$). У 80,3% пациентов была диагностирована астма средней степени тяжести, у 19,7% — лёгкая форма. Повышенные уровни ECP и IgE чаще отмечались у пациентов с более тяжёлым течением заболевания и при наличии контакта с аллергенами.

Заключение: Дети и подростки в Абайской области часто подвергаются воздействию факторов риска, таких как влажность и сезонные аллергены, что может усугублять течение астмы. Результаты подчёркивают важность раннего выявления таких факторов и использование показателей ECP и IgE при персонализированном подходе к лечению астмы.

Ключевые слова: *Бронхиальная астма; Подростки; Факторы окружающей среды; Биомаркеры; Клинические признаки.*

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Түйіндеме

АБАЙ ОБЛЫСЫНДАҒЫ БАЛАЛАР МЕН ЖАСӨСПІРІМДЕРДЕГІ БРОНХИАЛДЫ АСТМАНЫҢ КЛИНИКАЛЫҚ ЖӘНЕ ИММУНОЛОГИЯЛЫҚ ЕРЕКШЕЛІКТЕРІ

Андрей Фурлан[1], https://orcid.org/0009-0004-7603-8731
Гүлбаршын Д. Мукашева*[2], https://orcid.org/0000-0003-3490-5628
Сауле Б. Маукаева[2], https://orcid.org/0000-0002-2679-6399
Назым К. Кудайбергенова[2], https://orcid.org/0000-0002-6165-7677
Дария М. Шабдарбаева[2], https://orcid.org/0000–0001–9463–1935
Жанаргуль К. Смаилова[2], http://orcid.org/0000-0002-4513-4614
Ботагоз С. Тураханова[2], http://orcid.org/0009-0003-0480-7063
Динара Б. Козубаева[2], https://orcid.org/0000-0003-4937-708X
Майя В. Горемыкина[2], https://orcid.org/0000-0002-5433-7771
Жанар Б. Исабекова[2], https://orcid.org/0000-0002-2744-0327
Сая С. Каримова[2], http://orcid.org/0000-0002-1167-5375
Найля М. Уразалина[1], https://orcid.org/0000-0003-0200-1763

[1] **«Виктор Бабеш» медицина және фармацевтика университеті, Тимишоара қ., Румыния;**
[2] **«Семей медицина университеті» КеАҚ, Семей қ., Қазақстан Республикасы.**

Кіріспе: Бронхиалды астма – балалар мен жасөспірімдер арасында жиі кездесетін созылмалы тыныс алу ауруы. Оның пайда болуы мен өршуіне қоршаған орта факторлары мен иммунологиялық өзгерістер елеулі әсер етеді.

Мақсаты: Бұл зерттеу Абай облысындағы балалардағы астманың клиникалық белгілері мен иммунологиялық көрсеткіштерін, сондай-ақ аллергиялық анамнезді талдауды мақсат етті.

Зерттеу материалдары мен әдістері: Зерттеу 1–17 жас аралығындағы 71 баланың медициналық карталары негізінде ретроспективті түрде жүргізілді. Қатысушыларда бронхиалды астманың расталған диагнозы болды. Клиникалық бағалау симптомдарды талдау мен спирометрияны қамтыды. Статистикалық талдау сипаттамалық әдістермен, t-тест және χ^2-тест арқылы жүргізілді.

Нәтижелер: Ең жиі кездесетін симптомдар жөтел (76,1%) және ентікпе (59,2%) болды. Қатысушылардың шамамен үштен бірі ылғалды үй жағдайында тұрып, бұл тыныс алу шағымдарымен статистикалық тұрғыда байланыс көрсетті ($p < 0.05$). Орташа ауырлықтағы астма 80,3% жағдайда, жеңіл түрі 19,7% жағдайда анықталды. Биомаркерлерді бағалау нәтижесінде ECP мен IgE деңгейлері орташа ауырлықтағы астмада және аллерген әсеріне ұшыраған балаларда жоғары болды.

Қорытынды: Абай облысындағы балалар мен жасөспірімдер жиі ылғалдылық пен маусымдық аллергендердің әсеріне ұшырайды. Бұл факторлар клиникалық симптомдардың ауырлығына және иммунологиялық көрсеткіштерге ықпал етуі мүмкін. Зерттеу қоршаған орта әсерлерін ерте анықтау мен ECP және IgE деңгейлерін астманы басқару стратегияларын жекешелендіруде қолданудың маңыздылығын көрсетеді.

Кілт сөздер: *Бронхиалды астма, Жасөспірімдер; Қоршаған орта, Биомаркерлер, Клиникалық белгілер.*

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Introduction

Asthma is a chronic inflammatory disease of the airways, characterized by intermittent episodes of wheezing, shortness of breath, and coughing, typically occurring in the early morning or at night [17]. The pathophysiology of asthma is complex and not fully understood, primarily due to the intricate interactions between genetic predispositions and environmental factors. The degree of airway obstruction and hyper-reactivity is largely determined by these interactions [9]. Asthma is increasingly recognized as a major global public health issue, currently affecting an estimated 330 million people worldwide [12]. Although various management strategies are being implemented, epidemiological data show a worrying rise in asthma cases in low- and middle-income countries (LMICs) [8]. In contrast, incidence rates in high-income nations have largely stabilized [12]. These contrasting trends highlight the need for more in-depth epidemiological studies to better understand the underlying causes—particularly environmental factors like air pollution, which has been strongly linked to both increased prevalence and severity of asthma symptoms [5].

Among the biological mechanisms associated with asthma, inflammatory mediators such as Eosinophilic Cationic Protein (ECP) and Immunoglobulin E (IgE) play a central role in triggering and intensifying symptoms. Studies have shown that higher levels of ECP mRNA and IgE are associated with more severe asthma, underscoring the importance of inflammation in the disease's progression [8].

As of now, there have been no large-scale, population-based studies specifically examining asthma in the Abay Region. Given its distinct environmental and socio-demographic conditions, there is a clear need for targeted research in this area. A comprehensive retrospective analysis could help identify whether asthma patterns in this region differ from those observed in other parts of Kazakhstan. Key aspects such as living conditions, personal and family allergy histories, and individual asthma profiles may contribute to region-specific trends and deserve closer investigation. Environmental pollutants have been shown to contribute to the severity and exacerbation of asthma symptoms, highlighting the necessity of an in-depth analysis of these factors [3].

Official statistics report asthma prevalence in Kazakhstan at 19.5 per 1000 (2%) among adults, with wheezing symptoms affecting 254 per 1000 (25.4%) individuals [18]. This discrepancy suggests a gap between reported diagnoses and symptomatic presentation, underscoring the need for improved diagnostic methods. Independent studies estimate that asthma affects 23.5% of individuals under the age of 17, indicating significant underdiagnosis in the country [4].

This study aims to offer a well-rounded understanding of the clinical and immunological features of bronchial asthma in children and adolescents living in the Abay Region of Kazakhstan. Special attention is given to their living conditions, history of allergic diseases, and the frequency of asthma-related symptoms.

Materials and Methods

A retrospective observational study was carried out to explore the clinical and immunological characteristics of asthma among children and teenagers residing in the Abay Region of the Republic of Kazakhstan.

Inclusion Criteria: Participants aged 0 to 17 years who were living in the Abay Region at the time of the study.

Exclusion Criteria: Individuals older than 17 years or those not residing in the Abay Region during the study period.

The analysis was based on the medical records of 71 pediatric patients, collected from the Family Polyclinic in the city of Semey, located at 97 Dostoevsky Street. Since the research was retrospective in nature and all patient data were anonymized, informed consent was not required. Тема исследования утверждена на заседании Этической комиссии (№ и дата Протокола заседания)

Statistical Analysis. Descriptive statistics were used to summarize the data. To determine statistically significant differences, chi-square tests and independent t-tests were applied. All analyses were conducted using SPSS software, version 26.0, with a significance threshold set at $p < 0.05$.

Results

The study examined a range of factors including socio-demographic data, clinical symptoms, living environments, allergy history, and specific asthma-related features among the participants. A detailed summary is provided in Table 1.

Table 1.

Socio-demographic, clinical, environmental, and allergy characteristics of study participants.

Variables			n	%
Socio-demographic Characteristics	Gender	male	43	60.6%
		female	28	39.4%
	Age group	1-5	21	29.6%
		5-10	39	54.9%
		11-17	11	15.5%
Clinical Characteristics	Cough	yes	54	76.1%
		no	17	23.9%
	Dyspnea	yes	42	59.2%
		no	29	40.8%
Environmental and Housing Conditions	Type of housing	apartment	35	49.3%
		house	36	50.7%
	Nasal congestion	yes	31	43.7%
		no	40	56.3%
	Dampness	yes	26	36.6%
		no	45	63.4%
Allergy History	Family allergy history	yes	51	71.8%
		no	20	28.2%
	Insect allergy	yes	28	39.4%
		no	43	60.6%
	Animals in the house	yes	28	39.4%
		no	43	60.6%
	Allergy to medications	yes	18	25.4%
		no	53	74.6%
	Seasonal allergies	yes	15	21.1%
		no	56	78.9%
	Food allergies	yes	23	32.4%
		no	48	67.6%
	Household allergies	yes	18	25.4%
		no	53	74.6%
	Skin allergies	yes	18	25.4%
		no	53	74.6%
Spirometry Results	Breathing	normal	57	80.3%
		abnormal	14	19.7%
	Spirometry	no spirometry	43	60.6%
		normal	12	16.9%
		restrictive	15	21.1%
		obstructive	1	1.4%
Asthma Characteristics	Newly diagnosed asthma	yes	40	56.3%
		no	31	43.7%
	Persistent asthma	yes	62	87.3%
		no	9	12.7%
	Severity of the asthma	mild	14	19.7%
		Moderate-severe	57	80.3%

Out of the 71 children and adolescents included in the analysis, 43 (60.6%) were boys and 28 (39.4%) were girls. The average age was 7.24 years, with participants ranging from 1 to 17 years old, offering a broad snapshot of the pediatric population. For analytical purposes, participants were divided into three age groups: 1–5 years (29.6%, n=21), 5–10 years

(54.9%, n=39), and 11–17 years (15.5%, n=11). The most represented group was the 5–10 year range, suggesting that the majority of cases occurred among younger children.

The majority of children in the study experienced typical asthma-related symptoms. Coughing was the most frequently reported complaint (76.1%, n = 54), followed by shortness of breath (59.2%, n = 42) and nasal congestion (43.7%, n = 31). These symptoms were central to evaluating the clinical status of each child and reflect common manifestations of asthma in pediatric patients.

Participants were almost evenly split between different types of housing: 36 children (50.7%) lived in standalone houses, while 35 (49.3%) lived in apartments. Dampness was present in the homes of 26 children (36.6%), which is notable given its established role in worsening respiratory conditions, including asthma.

Allergy-related factors played a significant role in the study. A family history of allergies was found in 71.4% of cases (n=51), suggesting a hereditary link to asthma. Additionally, 39.4% (n=28) reported insect allergies, and the same percentage had pets at home, both of which are potential asthma triggers. Other reported allergic conditions included drug allergies (25.4%, n=18), seasonal allergic responses (21.1%, n=15), food allergies (32.4%, n=23), sensitivity to household allergens (25.4%, n=18), and epidermal allergens (25.4%, n=18).

At the time of clinical evaluation, 80.3% (n=57) of children showed normal breathing, while 15.5% (n=11) presented with wheezing. For more than half of the participants (56.3%, n=40), the diagnosis of asthma was made for the first time during the study period. Most cases (87.3%, n=62) were classified as persistent asthma. Regarding severity, 19.7% (n=14) were mild cases, whereas 80.3% (n=57) were categorized as moderate to severe.

Spirometry was not performed in 43 cases (60.6%), which poses certain limitations in evaluating pulmonary function. Among the 28 patients who underwent testing, 16.9% (n=12) had normal results, 21.1% (n=15) demonstrated restrictive patterns, and 1.4% (n=1) showed signs of obstructive dysfunction.

Table 2 presents the analysis of clinical characteristics, ECP, and IgE levels. In participants with mild asthma, the mean ECP was 38.1 (SD=18.3) and the mean IgE was 134 (SD=81). In those with moderate asthma, the mean ECP increased to 51.0 (SD=37.2), and the mean IgE rose to 518 (SD=551). Statistically, IgE levels showed a strong correlation with asthma severity, with a p-value of 0.001.

Table 2.

ECP and IgE levels, linked to individual asthma characteristics of the participants.

Variables		ECP		p-value	IgE		p-value
		M	SD		M	SD	
Severity of the asthma	mild	38.1	18.3	0.35	134	81	**0.01**
	moderate-severe	51.0	37.2		518	551	
Dampness	yes	39.6	29.1	**0.04**	444	579	0.490
	no	53.6	36.7		441	486	
Seasonal allergies	yes	56.9	34.5	0.149	862	761	**0.009**
	no	46.2	34.5		330	364	
Food allergies	yes	55.3	41.3	0.127	612	666	0.28
	no	45.2	30.8		361	413	
Household allergies	yes	44.8	26.7	0.304	782	793	**0.001**
	no	49.7	37.0		327	319	

Environmental factors were found to influence biomarker levels. Participants living in damp conditions had a mean ECP of 39.6 (SD=29.1) and a mean IgE of 444 (SD=579). The p-values for ECP and IgE were 0.004 and 0.0490, respectively, indicating a statistically significant correlation. In contrast, those living in dry conditions had lower levels of both ECP (mean=53.6, SD=36.7) and IgE (mean=441, SD=486). Seasonal allergies were also significantly associated with elevated ECP and IgE levels (mean ECP=56.9, SD=34.5; mean IgE=862, SD=761), with p-values of 0.0149 for ECP and 0.0009 for IgE.

Food and household allergies were likewise correlated with higher biomarker levels. Participants with food allergies had an average ECP level of 55.3 (SD= 1.3) and IgE level of 612 (SD=666), with p-values of 0.0127 for ECP and 0.028 for IgE. In contrast, those with household allergies had an average ECP of 44.8 (SD=26.7) and IgE of 782 (SD=793), with p-values of 0.0304 for ECP and 0.0001 for IgE.

Table 3 shows the relationship between nasal congestion, seasonal allergies, and asthma severity in pediatric patients. It compares two groups: those with mild asthma and those with moderate-to-severe asthma.

Table 3.

Relationship between Nasal Congestion, Seasonal Allergies, and Asthma Severity in Pediatric Patients.

Variables		Severity of the asthma				p-value
		mild		moderate-severe		
		n	%	n	%	
Nasal congestion	yes	1	7.1%	30	52.6%	**0.02**
	no	13	92.9%	27	47.4%	
Seasonal allergies	yes	0	0%	15	26.3%	**0.031**
	no	14	100%	42	73.7%	

For nasal congestion, the table reveals that only 7.1% (1 out of 14) of children with mild asthma reported nasal congestion, while 52.6% (30 out of 57) of those with moderate-to-severe asthma experienced it. The p-value of 0.02 indicates that this association is statistically significant, suggesting that nasal congestion is more common in children with more severe forms of asthma. Regarding seasonal allergies, none of the children with mild asthma reported seasonal allergies, while 26.3% (15 out of 57) of those with moderate-to-severe asthma had a history of seasonal allergies. The p-value of 0.031 indicates a statistically significant relationship between seasonal allergies and asthma severity.

Discussion

The findings of this study generally align with earlier research demonstrating the role of eosinophilic cationic protein (ECP) and immunoglobulin E (IgE) in the pathogenesis and severity of bronchial asthma. However, certain discrepancies were noted, which may be attributed to the unique environmental and demographic context of the Abay Region. For instance, the variation in ECP and IgE levels among children living in damp conditions or exposed to specific allergens may reflect the influence of local environmental factors. This underlines the importance of conducting region-specific studies, as international data alone may not fully account for local variables that affect how asthma presents and progresses.

Bronchial asthma continues to pose a significant public health challenge in the Abay Region. Its prevalence appears to be driven by a combination of environmental exposures such as poor housing conditions and systemic factors, including possible gaps in early diagnosis and access to care. Addressing these challenges continues to pose difficulties for effective disease management in the regional healthcare setting. A study on respiratory diseases in countries of the Commonwealth of Independent States (CIS) revealed a prevalence of 19.5 asthma cases per 1000 individuals, with wheezing symptoms affecting approximately 25% of the adult population [16,18]. A broader trend of increasing asthma prevalence has been observed across Central Asia, suggesting that environmental and lifestyle factors significantly impact the epidemiology of asthma in the region. Specifically, industrial emissions and particulate matter (PM) in the Abay region are likely contributing to the rising number of respiratory diseases. Extensive studies on air pollution in major cities of Kazakhstan indicate that air quality often fails to meet safety standards, which correlates with increased respiratory issues among the population [6, 20]. During the cold season, elevated levels of PM exacerbate asthma attacks and other respiratory illnesses. Although direct studies on the correlation between air pollution levels and asthma symptoms in Kazakhstan are limited, data from neighboring regions suggests similar patterns [20]. High rates of smoking and obesity in the population are also contributing to the increasing number of asthma cases [16, 14]. Research on the ADRB2 gene in Kazakhstan has found certain genetic variations that might make people more prone to asthma, suggesting that genetics play a role in asthma susceptibility and development [1, 2]. The economic impact of underreporting asthma is significant, as it often leads to a loss of productivity. The differences between official statistics and independent studies highlight the need for more accurate data collection and reporting [20, 16]. Urban areas, where industrial activity is more concentrated, would benefit from better diagnostic methods and improved asthma management strategies [14, 19].

Timely diagnosis has been shown to significantly impact the long-term management of asthma. Early diagnosis can reduce the frequency and severity of asthma exacerbations. Studies indicate that children diagnosed early are less likely to experience severe symptoms compared to those diagnosed later [13]. The early implementation of diagnostic methods such as spirometry and bronchial challenge tests is crucial for recognizing asthma at its onset. Spirometry is commonly used to evaluate lung function, while bronchial challenge tests help determine airway hyperresponsiveness both are essential tools in the assessment of asthma. Research into asthma exacerbations has contributed significantly to improving approaches to diagnosis and treatment. Importantly, children diagnosed with asthma before the age of six are more likely to experience more frequent and severe symptoms of the disease. [15].

A number of previous studies have consistently demonstrated a link between elevated levels of immunoglobulin E (IgE) and eosinophilic cationic protein (ECP) and greater asthma severity [10, 11]. The results of this study support those findings, particularly with regard to IgE, which showed a statistically significant association with asthma severity ($p = 0.001$). In contrast, no significant correlation was observed between ECP levels and disease severity ($p > 0.05$), suggesting that the role of ECP in asthma may be influenced by additional factors or may vary depending on specific environmental or individual conditions. These results highlight the importance of conducting further research in the Abay Region to better understand the involvement of ECP in asthma-related inflammation.

Additionally, environmental factors, especially damp living conditions, appeared to have an impact on biomarker levels. Participants living in moisture-damaged or humid dwellings exhibited higher concentrations of both IgE and ECP, reinforcing the established understanding that environmental exposures can significantly contribute to asthma exacerbation regardless of geographic context [10]. An interesting finding in this study was that nasal congestion was more commonly seen in children with milder asthma, while a history of seasonal allergies was linked to more severe cases. This is different from what previous studies have shown, suggesting that asthma in the Abay region might have some unique characteristics that need further exploration. The clinical significance of these results is clear. With more than half of the participants (56.3%) being newly diagnosed, it highlights the importance of early detection and timely intervention. For children with a family history of allergies, keeping track of symptoms like nasal congestion and seasonal allergies could help identify asthma at an earlier stage [7].

Conclusion

This study sheds light on the role of environmental and allergic factors in the development of bronchial asthma among children and adolescents in the Abay region. Damp housing and seasonal allergens were frequently linked to more severe symptoms. Children with higher ECP and IgE levels tended to have more pronounced forms of asthma, reinforcing their potential use as clinical indicators.

The fact that over half of the children were newly diagnosed suggests that asthma remains underdiagnosed in pediatric care. These results highlight the importance of early identification—especially in children with allergic family histories or persistent respiratory symptoms.

Improving living conditions, particularly by addressing indoor dampness, and implementing allergen control strategies may help reduce asthma severity. Routine testing for ECP and IgE could also support more accurate risk assessment and individualized treatment planning.

Study Limitations: *The single-center nature of the study may limit its generalizability, and the absence of long-term follow-up data restricts the assessment of post-discharge outcomes.*

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Information about the authors:
Furlan Andrei, Student of University of Medicine and Pharmacy "Victor Babeș" Timișoara, Romania, https://orcid.org/0009-0004-7603-8731
Mukasheva Gulbarshyn Darynkyzy - Senior Teacher of the Department of Epidemiology and Biostatistics, NCJSC "Semey Medical University", Semey, Kazakhstan; E-mail: gulbarshyn_1_12@mail.ru; phone +7 775 220 07 45, https://orcid.org/0000-0003-3490-5628;
Maukayeva Saule Boranbayevna - Candidate of Medical Sciences, Associate Professor of the Department of Infectious Diseases, Dermatovenerology and Immunology, NCJSC «Semey Medical University» phone: 8 705 529 66 75, e-mail: solly66@mail.ru, https://orcid.org/0000-0002-2679-6399, Semey, Kazakhstan;
Kudaibergenova Nazym Konyrovna - Candidate of Medical Sciences, Associate Professor of the Department of Infectious Diseases, Dermatovenerology and Immunology, NCJSC «Semey Medical University», phone: 8 705 188 08 36, e-mail: nazym.kudaibergenova@smu.edu.kz, https://orcid.org/0000-0002-6165-7677, Semey, Kazakhstan;
Shabdarbayeva Dariya Muratovna – Doctor of Medical Sciences, Professor, Vice Rector for Science and Strategic Development", NCJSC «Semey Medical University», phone 8 707 365 82 71, e-mail: dariya_kz@bk.ru, https://orcid.org/0000-0001-9463-1935, Semey, Kazakhstan;
Smailova Zhanargyl Kaiyrgaliyevna - Candidate of Medical Sciences, Associate Professor, Vice Rector for Academic and Educational Work, NCJSC «Semey Medical University», phone 8 707 365 82 71, e-mail: zhanargul.smailova@smu.edu.kz; https://orcid.org/0000-0002-4513-4614
Turakhanova Botagoz Seilovna - Assistant, department of infectious diseases, dermatovenerology and immunology, NCJSC «Semey Medical University», phone: 8 778 177 12 25, Kazakhstan. E-mail: botagoz.turakhanova@smu.edu.kz, ORCID 0009-0003-0480-7063, Semey, Kazakhstan;
Kozubayeva Dinara Begimhanovna - Assistant, department of infectious diseases, dermatovenerology and immunology, NCJSC «Semey Medical University», phone: 8 775 342 16 44, Kazakhstan. E-mail: dinara_begimhanovna@mail.ru, ORCID 0000-0003-4937-708X, Semey, Kazakhstan;
Goremykina Maya Valentinovna - Candidate of Medical Sciences, Associate Professor, Department of Internal Medicine and Rheumatology, NCJSC «Semey Medical University», 103 Abay street, Semey, 071400, Kazakhstan; Email: maya.goremykina@smu.edu.kz; phone number: +7 (777) 390 8234; https://orcid.org/0000-0002-5433-7771;
Issabekova Zhanar Bakytzhanovna - Assistant of the Department of Infectious Diseases, Dermatovenerology and Immunology, NCJSC "Semey Medical University", phone: 8 775 176 08 09, e-mail: zhanara_ib87@mail.ru, https://orcid.org/0000-0002-2744-0327, Semey, Kazakhstan;
Karimova Saya Sayankyzy - Assistant, department of infectious diseases, dermatovenerology and immunology, NCJSC «Semey Medical University», phone: 8 701 106 96 13, Kazakhstan. E-mail: saya.karimova.94@mail.ru, ORCID 0000-0002-1167-5375, Semey, Kazakhstan;
Urazalina Nailya Muratkhanovna - Candidate of Medical Sciences, Associate Professor of the Department of physiological disciplines named after honored scientist of the republic of Kazakhstan, professor T.A. Nazarova, NJSC "Semey Medical University", Semey, Kazakhstan; phone: 8 777 907 55 89, e-mail: hakim_15@mail.ru, https://orcid.org/0000-0003-0200-1763,

***Correspondence author:**
Mukasheva Gulbarshyn Darynkyzy - Senior Teacher of the Department of Epidemiology and Biostatistics, NCJSC "Semey Medical University", Semey, Kazakhstan,
Postal code: Republic of Kazakhstan, 071400, Semey city, Abay Street 103.
E-mail: gulbarshyn_1_12@mail.ru
Phone: +7 775 220 07 45