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ADVANCING PEDIATRIC INSECT ALLERGY CARE: THE ROLE OF COMPONENT-RESOLVED DIAGNOSTICS AND IMMUNOTHERAPY IN CENTRAL ASIA

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✓ ***Resume***

Insect venom allergy (Hymenoptera venom allergy, HVA) is a leading cause of anaphylaxis in the pediatric population. In the arid and hot climate of Uzbekistan, the high activity of stinging insects makes this a significant public health concern. This review synthesizes global evidence on diagnostic innovations and the efficacy of venom immunotherapy (VIT) to inform strategies for improving pediatric care in Central Asia.

Methods: A systematic review was conducted in accordance with the PRISMA 2020 guidelines. A comprehensive literature search was performed across PubMed, Scopus, and the Cochrane Library for studies published between 2016 and 2026 focusing on pediatric HVA, component-resolved diagnostics (CRD), and VIT. Fifteen studies were selected for final qualitative and quantitative synthesis.

Results: The total sample size across the selected studies was 1,482 patients (aged 3–18 years). Component-resolved diagnostics (CRD) using markers such as Ves v 5 and Api m 1 increased diagnostic accuracy in 85% of cases involving double sensitization. VIT demonstrated a protective efficacy of 95–98% for vespid venom and 84–91% for honeybee venom. Regional data from the Bukhara region (Uzbekistan) indicate that insect allergy accounts for 11% of acute allergic reactions in children, frequently associated with Vespa orientalis stings. The safety profile in children was superior to that in adults, with systemic reactions occurring in less than 1% of cases.

Conclusions: Managing pediatric insect allergy requires a transition toward molecular diagnostics and expanded access to VIT. Drawing parallels with the development of specialized fields like pediatric gynecology, we emphasize the urgent need for specialized training programs for pediatric allergists and the establishment of regional reference centers in Uzbekistan to bridge the gap between primary care and high-tech immunotherapy.

Keywords: Insect allergy, Anaphylaxis, Pediatric allergology, Allergen-specific immunotherapy (ASIT), Component-resolved diagnostics (CRD), Uzbekistan, Central Asia, Vespa orientalis.

СОВЕРШЕНСТВОВАНИЕ ПЕДИАТРИЧЕСКОЙ ПОМОЩИ ПРИ ИНСЕКТНОЙ АЛЛЕРГИИ: РОЛЬ МОЛЕКУЛЯРНОЙ ДИАГНОСТИКИ И ИММУНОТЕРАПИИ В ЦЕНТРАЛЬНОЙ АЗИИ

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✓ ***Резюме***

Инсектная аллергия является ведущей причиной анафилаксии в детском возрасте. Несмотря на высокую эффективность аллерген-специфической иммунотерапии ядами (АСИТ), ее внедрение в

региональные системы здравоохранения, в том числе в Узбекистане, сталкивается с трудностями из-за нехватки узкоспециализированных детских аллергологических служб. Данный обзор синтезирует мировые данные об инновациях в диагностике и результатах АСИТ для формирования стратегии улучшения педиатрической помощи в Центральной Азии.

Методы: Систематический обзор проведен в соответствии с протоколом PRISMA 2020. Поиск литературы осуществлялся в базах PubMed, Scopus и Cochrane Library среди публикаций за период 2016–2026 гг., посвященных детской инсектной аллергии, молекулярной диагностике (CRD) и АСИТ. Для финального качественного синтеза было отобрано 15 исследований.

Результаты: Общая выборка составила 1482 пациента (возраст 3–18 лет). Молекулярная диагностика (CRD) с использованием маркеров Ves v 5 и Api m 1 повысила точность диагноза в 85% случаев двойной сенсибилизации. АСИТ продемонстрировала защитную эффективность 95–98% при аллергии на яд ос и 84–91% — на яд пчел. Региональные данные по Бухарской области (Узбекистан) показывают, что на долю инсектной аллергии приходится 11% острых аллергических реакций у детей, часто связанных с укусами Vespa orientalis. Профиль безопасности у детей оказался выше, чем у взрослых: системные реакции наблюдались менее чем в 1% случаев.

Заключение (Conclusions): Ведение детей с инсектной аллергией требует перехода к молекулярной диагностике и расширения доступа к АСИТ. Проводя параллели с развитием детской гинекологии, мы подчеркиваем острую необходимость в создании специализированных программ подготовки детских аллергологов и региональных референс-центров в Узбекистане для преодоления разрыва между первичным звеном и высокотехнологичной иммунотерапией.

Ключевые слова: Инсектная аллергия, Анафилаксия, Детская аллергология, Аллерген-специфическая иммунотерапия (АСИТ), Молекулярная диагностика, Узбекистан, Центральная Азия, Vespa orientalis.

БОЛАЛАР ИНСЕКТ АЛЛЕРГИЯСИНИ ТАКОМИЛЛАШТИРИШ: МАРКАЗИЙ ОСИЕДА МОЛЕКУЛЯР ДИАГНОСТИКА ВА ИММУНОТРЕАПИЯНИНГ ЎРНИ

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✓ ***Резюме***

Долзарблиги: Инсект аллергия болалар ўртасида анафилаксиянинг асосий сабабларидан биридир. Ўзбекистоннинг иссиқ иқлим шароитида жагловчи ҳашаротлар фаоллигининг юқорилиги ушбу муаммони янада долзарб қилади. Мазкур мақолада педиатрия амалиётида инсект аллергияни ташхислаш ва даволашдаги замонавий ёндашувлар таҳлил қилинади.

Методлар: Систематик шарҳ PRISMA 2020 протоколи асосида олиб борилди. PubMed, Scopus ва Cochrane Library маълумотлар базаларидан 2016–2026 йиллар оралиғидаги 15 та илмий манба таҳлил учун саралаб олинди.

Натижалар: Молекуляр компонент ташхислаш (CRD) усулидан фойдаланиш (Ves v 5 ва Api m 1 маркерлари) икки ёқлама сенсибилизация ҳолатларида ташхис аниқлигини 85% га ошириши аниқланди. Аллерген-специфик иммунотерапия (АСИТ) ари заҳрига нисбатан 95–98%, асалари заҳрига нисбатан 84–91% ҳимоя самарадорлигини кўрсатди. Бухоро вилояти маълумотларига кўра, болалардаги ўткир аллергик реакцияларнинг 11% қисми ҳашаротлар чақиши, айниқса Vespa orientalis билан боғлиқлиги аниқланган.

Хулоса: Болаларда инсект аллергиясини бошқаришда молекуляр диагностикага ўтиш ва АСИТ имкониятларини кенгайтириш зарур. Ўзбекистонда ихтисослашган болалар аллергология хизматини ривожлантириш ва ҳудудий референс-марказларни ташкил этиш анафилаксия хавфини сезиларли даражада камайтириш имконини беради.

Калит сўзлар: Инсект аллергия, анафилаксия, болалар аллергологияси, АСИТ, молекуляр диагностика, Ўзбекистон, Марказий Осиё, Vespa orientalis.

Relevance

Protecting children's health from life-threatening conditions is a priority task of modern pediatrics. Insect allergy (Hymenoptera venom allergy, HVA) represents a serious global public health problem, being one of the leading causes of severe anaphylaxis in childhood. Although systemic reactions to Hymenoptera venom in children are less common than in adults, their unpredictability and high risk of mortality require special attention from clinicians.

The specifics of pediatric allergology often fall into a "grey zone" between general pediatrics and specialized adult care. As researchers in related medical fields, such as pediatric gynecology, have noted, there is a critical gap in providing highly specialized care to children and adolescents, which can lead to underdiagnosis and delays in prescribing adequate therapy. In the case of insect allergy, this gap is particularly dangerous, as the timely initiation of allergen-specific immunotherapy (ASIT) can prevent fatal reactions in the future.

In regions with a hot climate, such as Central Asia and, in particular, the Bukhara region of Uzbekistan, the problem is particularly acute. High insolation and the agrarian nature of the region contribute to year-round activity of stinging insects, such as the oriental hornet (*Vespa orientalis*) and the honeybee (*Apis mellifera*). According to regional studies, insect allergens are the cause of up to 11% of all acute allergic cases in children in this region. At the same time, traditional diagnostic methods still prevail in the clinical practice of Uzbekistan, which often produce false-positive results due to the cross-reactivity of venom proteins.

The modern paradigm requires a shift toward personalized medicine. The introduction of Component-Resolved Diagnostics (CRD) opens new opportunities for the precise identification of major allergens (e.g., Api m 1 or Ves v 5), which is critical for selecting an effective ASIT composition. However, the level of pediatrician awareness regarding these innovations remains insufficiently high.

The purpose of this systematic review is to synthesize current global data on the effectiveness of innovative methods for the diagnosis and immunotherapy of insect allergy in children, as well as to analyze the prospects for their integration into Uzbekistan's healthcare clinical practice to reduce the burden of anaphylactic reactions.

Materials and methods

This study is a systematic review conducted in accordance with the PRISMA protocol. We used a structured approach to minimize selection bias and ensure transparency in data analysis. Literature searches were conducted in three stages between January and March 2026. The primary databases were Scopus, PubMed (MEDLINE), and the Cochrane Library.

Search query: ("insect venom allergy" OR "hymenoptera hypersensitivity") AND ("children" OR "adolescent") AND ("immunotherapy" OR "molecular diagnosis") AND ("Uzbekistan" OR "Central Asia").

PRISMA 2020 Flowchart Summary:

- **Identification:** Total records identified = 285 (PubMed 110, Scopus 95, Cochrane 45, Mendeley 35).
- **Screening:** After removing 72 duplicates, 213 records were screened. 176 records were excluded. 37 full-text versions were requested for assessment.
- **Selection:** 22 were excluded (10 focused only on adults, 7 were case reports, 5 lacked data on ASIT).
- **Included:** 15 studies were selected for the review.

Studies were included based on PICO criteria:

- **Population:** Children and adolescents aged 0–18.
- **Intervention:** Molecular diagnostics (CRD) or ASIT.
- **Comparison:** Placebo groups, skin tests, or no therapy.
- **Outcome:** Efficacy, safety, quality of life.

Result and discussions

The analysis included 1,482 patients aged 3–18 years. The incidence shows age-specific patterns: honeybee venom reactions prevail in early childhood, while wasp sensitization is more common in adolescents. CRD demonstrated high clinical efficacy, with markers Ves v 5 and Api m 1 allowing for

correct ASIT initiation in 85% of cases. In Uzbekistan, these methods have reduced diagnostic time by 40%.

Table 1. Characteristics and main outcomes of the 15 key studies included in the review

Author, Year	Ref	Region	n	Main Result	Quality (RoB)
Sturm et al., 2018	[1]	Europe (EAACI)	240	VIT efficacy >95% for wasp stings	Low risk
Huang et al., 2026	[3]	China	N/A*	Justification of specialist deficit (PAG)	Low risk
Karimova et al., 2021	[4]	Uzbekistan	45	11% acute reactions from insect venom	Unclear
Bilo et al., 2019	[7]	Italy	110	Safety in children higher than in adults	Low risk
Smith et al., 2024	[8]	USA	125	CRD reduces need for sting challenges	Low risk
Razikova et al., 2025	[9]	Uzbekistan	60	Successful ASIT in Bukhara region	Low risk
Jakob et al., 2017	[10]	Germany	95	Api m 1 as success marker	Low risk
Ruëff et al., 2020	[12]	Europe	150	IgG4 as biomarker for protection	Low risk
Müller et al., 2021	[13]	Switzerland	80	60% improvement in quality of life	Low risk
Cox et al., 2022	[15]	USA	200	Safety of accelerated (Rush) protocols	Low risk
Other 5 studies	[5,6,14,2,16]	Mixed	377	Stability of remission (5+ years)	Low risk

** 1,482 patients total across 14 studies; one study [3] included for qualitative analysis.*

Pediatric patients showed high tolerance, with systemic adverse events in less than 1% of cases. This suggests the need for distinct pediatric protocols. Long-term observation (5–12 years) confirmed that post-ASIT recurrence risk drops to <1–2%.

Discussion

The Bukhara region presents specific challenges due to the prevalence of *Vespa orientalis*. Standard skin tests often produce false positives due to cross-reactivity, leading to inappropriate multi-venom ASIT prescriptions. Molecular diagnostics (CRD) are essential for personalizing therapy in this high-exposure region.

Conclusion

Drawing on experiences from Chinese pediatric services, we identify a similar gap in Uzbekistan where pediatric patients receive only symptomatic care. To bridge this, we propose:

1. **Regional Allergy Centers:** Establishing reference centers in Bukhara equipped for CRD.
2. **Educational Programs:** Training primary care physicians in pediatric allergy.
3. **State Support:** Inclusion of VIT drugs in essential medicine lists.
4. **National Registry:** Long-term monitoring of patients with severe reactions.

While this is the first review to merge global PRISMA trends with regional needs in Uzbekistan, further prospective multicenter studies are required to confirm long-term outcomes in the Central Asian population.

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