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THE PREVALENCE OF ALLERGIC DISEASES IN CHILDREN AND THE EFFECTIVENESS OF IMMUNOTHERAPY METHODS

Ruzibayev Muxammad Nishanbayevich
Fergana Medical Institute of Public Health
Assistant of the Department of Pediatrics

Abstract
This review highlights the growing prevalence of allergic diseases among children, now affecting 25-30% of the pediatric population globally. It discusses key allergic conditions such as asthma, allergic rhinitis, atopic dermatitis, and food allergies, which have shown a marked increase in recent decades. The article emphasizes the role of allergen-specific immunotherapy-including subcutaneous and sublingual methods-as an effective, disease-modifying treatment. Recent clinical trials show that immunotherapy can lead to long-term remission in 70-85% of well-selected pediatric patients. The importance of early intervention during key developmental stages is also underscored, as it improves outcomes and may prevent progression of the allergic march. The review concludes with evidence-based recommendations to enhance the effectiveness of immunotherapy in pediatric clinical practice.

Keywords: pediatric allergies, immunotherapy, allergen-specific immunotherapy, subcutaneous immunotherapy, sublingual immunotherapy, allergic rhinitis, childhood asthma, atopic dermatitis, food allergies, allergic march

Introduction

Today, allergic diseases constitute one of the most pressing health concerns in pediatric populations worldwide, representing a complex interplay of genetic predisposition, environmental factors, and immunological dysregulation. The global burden of allergic conditions in children has reached unprecedented levels, with epidemiological studies consistently demonstrating increasing prevalence rates across diverse geographical regions and socioeconomic strata. Contemporary pediatric practice faces the challenge of managing not only the immediate clinical manifestations of allergic diseases but also their long-term implications for quality of life, educational achievement, and overall developmental outcomes.

evolution of our understanding regarding allergic diseases in children has progressed significantly beyond the traditional symptom-based management approach toward a more sophisticated comprehension of underlying immunological mechanisms. This paradigm shift has facilitated the development of targeted therapeutic interventions that address the fundamental pathophysiological processes responsible for allergic sensitization and clinical expression. Immunotherapy, as a cornerstone of modern allergy treatment, represents a revolutionary approach that seeks to modify the natural course of allergic diseases by inducing immune tolerance to specific allergens.

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Recent advances in molecular allergology and precision medicine have enhanced our ability to identify optimal candidates for immunotherapy while minimizing potential adverse reactions. The integration of component-resolved diagnostics with traditional allergy testing has enabled clinicians to develop more personalized treatment strategies that account for individual allergen sensitivity patterns and cross-reactivity profiles. These developments have particular significance in pediatric populations, where early intervention may prevent the progression of allergic march and reduce the overall disease burden throughout the patient's lifetime.

Main Body

The epidemiological landscape of pediatric allergic diseases reveals alarming trends that underscore the urgency of developing effective therapeutic interventions. Current data from large-scale population studies indicate that asthma affects approximately 13-15% of children globally, with significant regional variations reflecting environmental and genetic factors. Allergic rhinitis demonstrates even higher prevalence rates, affecting up to 25% of pediatric populations in developed countries, while atopic dermatitis impacts approximately 20% of infants and young children worldwide. Food allergies, once considered relatively uncommon, now affect 6-8% of children, with peanut, milk, and egg allergies representing the most frequent sensitizations.

The concept of allergic march describes the natural progression of allergic diseases throughout childhood, typically beginning with atopic dermatitis in infancy, followed by food allergies, asthma, and allergic rhinitis in successive years. This sequential development pattern suggests shared underlying mechanisms and provides a theoretical framework for early intervention strategies. Recent longitudinal studies have demonstrated that children who develop multiple allergic conditions experience more severe symptoms, require more intensive medical management, and face greater risks of persistent disease into adulthood.

Environmental factors play a crucial role in the increasing prevalence of allergic diseases among children. The hygiene hypothesis, while initially controversial, has gained substantial empirical support through studies demonstrating inverse relationships between early microbial exposure and subsequent allergic sensitization. Urban environments, characterized by reduced microbial diversity, increased air pollution, and altered dietary patterns, appear to promote allergic disease development. Climate change has emerged as an additional factor, with rising temperatures and atmospheric carbon dioxide levels leading to prolonged pollen seasons and increased allergen potency.

Genetic predisposition significantly influences allergic disease susceptibility, with family history representing the strongest predictive factor for childhood allergies. Genome-wide association studies have identified numerous susceptibility loci associated with various allergic conditions, providing insights into shared pathogenetic mechanisms. The interaction between genetic factors and environmental exposures during critical developmental periods appears to determine ultimate disease expression, highlighting the importance of personalized risk assessment and prevention strategies.

The pathophysiology of allergic diseases involves complex interactions between antigen-presenting cells, T-helper cells, and immunoglobulin E-mediated responses. Initial allergen exposure leads to sensitization through the presentation of processed allergen fragments to naive

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T-cells, resulting in differentiation toward a T-helper type 2 phenotype. These cells subsequently produce cytokines that promote immunoglobulin E synthesis and eosinophil activation, establishing the inflammatory cascade responsible for allergic symptoms. Understanding these mechanisms has been instrumental in developing targeted therapeutic approaches that interrupt specific steps in the allergic response.

Immunotherapy represents a paradigm shift from symptomatic treatment toward disease modification through the induction of allergen-specific tolerance. The fundamental principle underlying immunotherapy involves controlled exposure to gradually increasing doses of specific allergens, ultimately leading to desensitization and long-term tolerance. This process involves multiple immunological mechanisms, including the generation of regulatory T-cells, increased production of blocking antibodies, and modulation of cytokine profiles toward a more balanced immune response.

Subcutaneous immunotherapy, the traditional form of allergen-specific treatment, involves the administration of allergen extracts through injection, typically following a build-up phase lasting 3-6 months followed by maintenance therapy for 3-5 years. Clinical trials have demonstrated efficacy rates of 70-85% for appropriately selected patients with allergic rhinitis and asthma. The treatment is particularly effective for single allergen sensitivities and shows optimal results when initiated during childhood or adolescence. However, the risk of systemic allergic reactions, while rare, necessitates careful patient selection and appropriate medical supervision.

Sublingual immunotherapy has emerged as an attractive alternative to subcutaneous administration, offering improved safety profiles and enhanced patient convenience. The sublingual route takes advantage of the oral mucosa's tolerogenic properties, promoting the development of regulatory immune responses while minimizing systemic exposure. Clinical studies have shown comparable efficacy to subcutaneous immunotherapy for specific allergens, particularly grass pollens and house dust mites. The reduced risk of severe systemic reactions has made sublingual immunotherapy particularly suitable for pediatric populations, where treatment adherence and safety considerations are paramount.

The selection of appropriate candidates for immunotherapy requires careful consideration of multiple factors, including symptom severity, medication requirements, quality of life impact, and specific allergen sensitivity patterns. Component-resolved diagnostics has enhanced our ability to identify patients most likely to benefit from treatment while avoiding unnecessary interventions in those with cross-reactive antibodies or clinically irrelevant sensitizations. The timing of immunotherapy initiation appears crucial, with evidence suggesting that earlier treatment produces superior long-term outcomes and may prevent disease progression.

Recent advances in immunotherapy protocols have focused on optimizing treatment regimens to enhance efficacy while minimizing adverse reactions. Modified allergen extracts, including allergoids and recombinant allergens, offer improved safety profiles and potentially enhanced therapeutic effects. Adjuvant therapies, such as probiotics and vitamin D supplementation, are being investigated as methods to enhance immunotherapy outcomes through modulation of the immune system. The development of epicutaneous immunotherapy represents another promising approach, utilizing controlled allergen exposure through the skin to induce tolerance while minimizing systemic absorption.

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The economic impact of allergic diseases in children extends beyond direct medical costs to include indirect expenses related to reduced parental productivity, educational disruption, and long-term healthcare utilization. Economic analyses of immunotherapy demonstrate favorable cost-effectiveness ratios, particularly when considering the potential for disease modification and reduced medication requirements over time. The prevention of allergic march through early intervention may provide substantial economic benefits by reducing the overall burden of allergic diseases throughout the patient's lifetime.

Quality of life considerations are paramount in pediatric allergy management, as these conditions significantly impact not only the affected child but also family functioning and social interactions. Children with allergic diseases frequently experience sleep disruption, reduced physical activity, social isolation, and academic difficulties. Immunotherapy has been shown to produce substantial improvements in quality-of-life measures, with benefits extending beyond symptom control to include enhanced participation in normal childhood activities and reduced anxiety related to allergen exposure. The increasing prevalence of allergic diseases in pediatric populations represents a significant public health challenge that requires comprehensive, evidence-based management strategies. Current epidemiological data demonstrate that allergic conditions affect a substantial proportion of children worldwide, with trends indicating continued increases in prevalence and severity. The implementation of immunotherapy as a disease-modifying treatment approach offers unprecedented opportunities to alter the natural course of allergic diseases and prevent long-term complications.

In conclusion, Immunotherapy has proven highly effective and safe for children with allergic diseases, especially when patients are carefully selected. Subcutaneous and sublingual methods both show strong results, with sublingual options offering excellent safety. Early intervention during key developmental stages can prevent disease progression and lead to lasting remission. The future of pediatric allergy care depends on refining treatment protocols, applying precision medicine, and fostering collaboration among healthcare professionals. Continued research is essential to improve outcomes, with the ultimate goal of preventing and curing allergic diseases to enhance children's quality of life and reduce their societal impact.

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