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Advancements in Pediatric Allergology and Immunology

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Abstract **Review Article**

Pediatric allergology and immunology have emerged as a distinct subspecialty and addressed the necessity of studying allergic and immunologic disorders in the pediatric population, further progressing therapeutic regimens and treatment approaches, especially for children. The main objective of this study was to review the updates of the literature regarding the advancements of pediatric allergology and immunology. Main research engines were employed to extract the appropriate data. Literature showed the importance of this topic and its diagnosis and therapeutic approached.

Keywords: Allergy, immunology, pediatric, pharmacology, intervention, treatment.

1. INTRODUCTION TO PEDIATRIC ALLERGOLOGY AND IMMUNOLOGY

Pediatric allergology and immunology have emerged as a distinct subspecialty and addressed the necessity of studying allergic and immunologic disorders in the pediatric population, further progressing therapeutic regimens and treatment approaches, especially for children (Sultész *et al.*, 2020). Allergic disorders are common in children, with a systemic prevalence of about 20% to 30% of school-aged children (Pakkasela *et al.*, 2020). Pediatric allergology and immunology primarily address the prevalence of allergic disorders in children, which significantly impact their quality of life and differ from the adult population with the same disorder (Ha *et al.*, 2020).

The main reason for focusing on child allergies is that clinical presentations of typically pediatric patients may differ significantly from those of adult patients (Jutzeler *et al.*, 2020). These presentations are more common with a diagnosis of childhood-onset allergies, multi-diagnoses, familial burden, and asthmatic clinical situations rather than conventional atrophic manifestations (Yonker *et al.*, 2020). In children, it may be possible to prevent or achieve tolerance by determining the causes of allergies. Nurses, dieticians, and social services (when needed) are essentially involved in the follow-up and education of allergic patients to provide comprehensive care (Alsohime *et al.*, 2020). Additionally, the healthcare team, rather than individuals, is skilled and experienced in this field, and a multidisciplinary approach and consensus among team members are indispensable for up-to-date healthcare provision (Du *et al.*, 2020). Allergic patient history and physical examination are significantly important, and the process from the first medical assessment to therapy and important choices is called allergic roadmap management (De *et al.*, 2020). This roadmap is the basis for patient follow-up (Badal *et al.*, 2021). With this framework for the follow-up of diagnosis and therapy, we summarized general and practical techniques, test methodologies, and treatment strategies for the pediatric population (Du *et al.*, 2021). We named the protocols we use for roadmaps, and while there are some similarities, we select methods and controls that minimize discomfort and ensure the specificity and sensitivity of the results (Weisberg *et al.*, 2021). We edited the roadmap with respect to previous research, addressing the spectrum of diseases and populations, and this research highlights the lack of a specific roadmap for pediatric immunological diseases, providing the first-of-its-kind article for both research and pediatric immunology in the form of a roadmap (DeBiasi *et al.*, 2020).

2. Basic Concepts in Pediatric Allergology

All defined allergic reactions, including anaphylactic ones, refer to alterations of non-infectious and non-malignant nature called allergic diseases (Spolidoro *et al.*, 2023). It seems that the frequency of allergies has been increasing in recent years (Spolidoro *et al.*, 2023). Until now, specific preventive interventions

and therapeutic options have been suggested to address these alterations in the immune system (Messina and Venter, 2020). In this context, children seem attractive to invest in various research studies since allergic diseases usually start from childhood (Warren *et al.,* 2020). From the beginning of the twentieth century, it was shown that in the course of many allergic diseases, immune responses are involved (Warren *et al.,* 2020). These conditions are often hereditary, and the rise in allergic reactions has been linked to generalized alterations in lifestyle and behavior (Zhang *et al.,* 2021). The immune system is divided into two main arms. The acquired immune system is usually the combat system against viral and bacterial assaults and the part that allergists assume to be aberrant in cases of hypersensitivity (Dierick *et al.,* 2020). Allergic reactions are inappropriate responses resulting from the enhanced engagement of the human immune system to usually harmless antigens (Dierick *et al.,* 2020). The immune system of children is under construction, whereby the occurrence of an immune reaction is closely linked to the stage of development in the life of the child (Peters *et al.,* 2021). The reactions of immunologically relevant diseases in children and adults differ in many respects (Peters *et al.,* 2021). Pediatric allergology, the study of allergic diseases in children, will introduce its basic views in this paper (Alkhatib, 2022a). In children, it is fundamentally important to differentiate between the immune systems of neonates, infants, and older children (Ha *et al.,* 2020). An acquired system represents a delayed response that results in the differentiation of cells intended to specifically recognize these antigens (Alkhatib, 2022b). These unique proteins induce changes in the host's immune responses that distinguish them from non-allergenic proteins (Xing and Wong, 2021). An effective acquired immune response results in the neutralization of invasive viruses and bacteria, as well as their degradation and exclusion (Alkhatib, 2022c). While T cell functions are present in the embryo, the capacity for chemotaxis and phagocytosis of newborn neutrophils and monocytic macrophages is significantly lower than in adults (Sampath *et al.,* 2021). Cell communication of embryonic and immature T cells, but not B cells, is less effective. It is acknowledged that once activated, a small number of T cells in embryos and neonates need these essential relationships (Durham and Shamji, 2023). It is appropriate to note that many components of neonatal immunity, especially the acquired system, are linked to the mother's uterus (Durham and Shamji, 2023).

2.1. Immune System Development in Children

The development of the child's immune system begins in the fetus (Moraes-Pinto *et al.,* 2021). The development follows the so-called "windows of susceptibility," linked to the different components of the immune system, and continues from childhood until around adolescence (Jain, 2020). One of the consequences of the development of the different components of the immune system is the dysregulation of immuno-regulation, leading to an increased alteration of the Treg cells and Th2 cytokines that lead to the allergic phenotype during dysbiosis (Alkhatib, 2022d). Genetics are important for laying the foundation of the immune response, which will be further influenced by the environment, including during development in utero (Alkhatib, 2024). Umbilical cord cytokines could provide hints to predict this phenotype and immune-regulative ability (Donald and Finlay, 2023).

A careful and detailed analysis that determines the individual developmental immuno-assessment, associated with the relative environmental influences, could be a step in enabling the pediatrician or allergist to administer possible preventive or therapeutic interventions suitable for pediatric age (Renz and Skevaki, 2021). The latest epidemiological evidence shows that the timing of exposure to allergens in early life is important because allergen exposure itself can influence susceptibility or tolerance (Lu *et al.,* 2020). Some studies provide further information by defining the critical time windows during the intrauterine period and in the first 1,000 days after birth, of interaction among different components heavily influencing the child's health (To *et al.,* 2020). In this way, in addition to the major allergic diseases, other atopic manifestations and health outcomes are also framed (To *et al.,* 2020). In the last 30 years, a large number of studies have shown that the developmental phase of the immune system from fetus to child includes an age-dependent accumulation of Treg memory cells that can play a significant role in preventing diseases, both autoimmune and allergic (Esch *et al.,* 2020).

2.2. Common Pediatric Allergens

In pediatric allergology, we distinguish between environmental allergens such as pollen, mites, domestic animals, and molds; food allergens such as cow's milk, hen's eggs, and nuts; and insect allergens such as Hymenoptera venoms (Achilova and Yomgurova, 2022). Although the focus of this text is on pediatric allergology, our understanding of allergic sensitization and its clinical consequences for children would not be complete without taking into account the growing incidence of allergic diseases (Halken *et al.,* 2021). The majority of allergic children develop a clinical form of the disease after one year of age, but other forms of food allergy may persist into adulthood or develop in older patients (Hoskinson *et al.,* 2023).

The incidence of food allergy varies worldwide (Brough *et al.,* 2022). The socioeconomic factor appears to be an important determinant of food allergen exposure rates; peanuts are a common cause of food anaphylaxis in certain regions, while tree nut allergies are more common in others (Lu *et al.,* 2020). In pediatric allergology, it appears to be especially important to identify the most common allergens for certain countries or regions (Hui and Leung, 2021). It must not be forgotten that the final goal of pediatric allergology is the avoidance of allergens and, as soon as the warning signs

are identified, prevention becomes of paramount importance (Xing and Wong, 2021). The majority of allergic diseases begin in childhood (Niewiem and Grzybowska-Chlebowczyk, 2022). This is particularly true for the more common respiratory and food allergies (Niewiem and Grzybowska-Chlebowczyk, 2022). A complete knowledge of pediatric allergology relies heavily on recognizing allergic disease-oriented allergens (Renz and Skevaki, 2021). Environmental allergens, food allergens, and venom allergens have been identified for a long time. Thus, avoiding these allergens has been largely demonstrated to be beneficial for avoidance diets and is necessary for the success of avoidance diets and avoidance treatment (Nuzzi *et al.,* 2021; Venter *et al.,* 2022; Wang *et al.,* 2023).

In clinical practice, it is essential for a pediatric allergist to make as soon as possible a list of the most probable allergens, including the clinical evidence of food allergens by skin prick tests, allergen-specific immunoglobulin tests in blood, history taking, and symptomatology (Halken *et al.,* 2021). The above-mentioned in vivo methods of identifying sensitization to specific allergens provide essential information as to the allergenic power of the allergen involved, indicating whether sensitization is small, intermediate, or high (Alvaro-Lozano *et al.,* 2020). An understanding of the most common allergens and/or etiologic suspects in pediatric allergology is highly useful in designing efficient treatments for preventing allergy and anaphylaxis in children, adolescents, and young adults (Ansotegui *et al.,* 2020). Likewise, useful allergies are often prescribed in general pediatric populations in children with respiratory allergies (Fleischer *et al.,* 2021). None of them is nevertheless focused on pediatric allergology (Pfaar *et al.,* 2022). The understanding of the differences in the most common allergens helps the pediatric allergist to draw a therapy plan that must promptly help gain control of these specific allergens (Westwell-Roper *et al.,* 2022).

3. Diagnostic Techniques in Pediatric Allergology

Diagnosis is a fundamental aspect of allergy (Jutel *et al.,* 2023). A correct and prompt diagnosis can help control allergic diseases effectively, while an incorrect diagnosis may increase suffering, increase costs, and decrease the capability of the individual to perform different tasks (Tian *et al.,* 2024). Advanced diagnosis in pediatric allergology is important because the number of children with allergic and hypersensitivity diseases has increased markedly over the last 30–40 years in both European and Asian countries (Brough *et al.,* 2020). Different in vivo and in vitro tests, as well as methods, are used for diagnosing allergic diseases in children (Alotiby, 2023). This paper provides a brief overview of different diagnostic tests available for diagnosing atrophic diseases and environmental allergens, as well as allergic disease procedures and different diagnostic methods for atrophic diseases (Bahna, 2024). During history taking, pediatric allergists should ask about the presence and evolution of allergic symptoms after exposure to different environmental factors, ingestion of different foods, possible animal or insect exposure, and physical activities for daily tasks and during exercise (Zhou *et al.,* 2024). History taking can analyze many aspects of allergies and hypersensitivities, such as the characteristics of the symptoms, their duration, frequency and intensity, their association with other allergic symptoms, the severity, and the impact of the allergic symptoms on everyday life, the coexistence of other atopic diseases, and the possible triggers of allergic disease-specific reactions (Wang *et al.,* 2023). The exam should be guided by the patient's history, as well as the physical location of the reaction in the body, its nature, and the time of the reaction. The strengths and limitations of skin prick tests, patch tests, and in vitro testing are discussed (Wollenberg *et al.,* 2023). Immunoglobulin E (IgE) and non-IgE-mediated mechanisms are also discussed (Wollenberg *et al.,* 2023). Finally, recent advanced technologies and future trends in pediatric allergology are discussed. Prick tests and in vitro testing are commonly employed to determine sensitization to different food allergens and constituent molecules of sensitization (Zhou *et al.,* 2024). Prick tests and in vitro tests require a different degree of patient cooperation, hardware, and competencies of the operator. Serum measurement of specific IgE has also been used as a surrogate for prick tests in the diagnosis of atrophic diseases. This approach is also used to determine microbial and β-lactam sensitization (Alkhatib, 2022e). Data from in vivo and in vitro studies help the allergist identify the possible causal allergens in an individual atrophic patient (Alkhatib, 2022e). Due to the different pathophysiologic mechanisms of atrophic diseases, a positive specific IgE sensitization only indicates atopic liability, not atrophic disease. Skin prick testing should generally be done following the measurement of total serum IgE and, in parallel, testing from a healthy control with a negative history of atrophic disease for relevant allergen standard extracts as well as components to determine specificity (Bahna, 2024). A 10-component panel in serum is necessary if the skin prick test is negative, or if vector sensitization is identified, especially in children with more severe reactions, to broaden diagnostic utility testing in a larger panel with nuts and bananas (Bahna, 2024). Standardized test results should always be interpreted in the context of clinical case history, physical examination, immune status, and factors such as age and geographical region (Bahna, 2024). Skin prick tests and in vitro tests are simple and effective procedures for confirmation of atrophic disease (Wollenberg *et al.,* 2023).

3.1. Skin Prick Testing

Skin prick testing is a widely used procedure for diagnosing allergic diseases in the pediatric population (Muthupalaniappen and Jamil, 2021). The SPT provides a rapid result and identifies the patients who may develop immediate or type 1 hypersensitivity reactions to a defined allergen (Anggraeni *et al.,* 2021). The SPT

should be performed by allergology specialists using a standard and well-processed extract of the selected allergens (Hamilton *et al.,* 2020). A panel of allergens should be selected according to a patient's medical history, age, and living habits (Ansotegui *et al.,* 2020). Children should be in good general condition (with no acute infection and without antihistamine use before the SPT) (Stingeni *et al.,* 2020). Carefully conducted SPTs can provoke minimal discomfort; however, an excessive reaction may occur with a distinct possibility of developing anaphylaxis (Baumann *et al.,* 2021).

Common contraindications or precautions to SPT include acute skin eruption, allergic or hypersensitivity rhinitis with nasal obstruction, a previous anaphylactic reaction, and an unstable clinical situation (Pitsios *et al.,* 2022). Importantly, patients and/or parents should be provided with full instructions and clear descriptions of the skin testing techniques (Stingeni *et al.,* 2020). Certified staff who know prevention, diagnosis, and treatment strategies for possible adverse reactions should be constantly present at the site where SPTs are performed. Finally, it is important to remember that the SPT should be just one part of a comprehensive approach to diagnose and manage allergic diseases in children (Barbaud & Romano, 2022).

Conducting an SPT is an important step in the process of establishing the suspicion or confirmation of sensitization in children and adolescents with allergic diseases (Lau *et al.,* 2022). The SPT provides not only the advantage of rapid results to the medical staff and/or patient, but also contributes to a quick approach to the etiological diagnosis of the patient, as well as reducing the costs associated with the diagnosis of an allergic patient (Raby and Mallol, 2022). We consider that the procedure employed in the SPT and the skin testing facilities must comply fully with all the basic principles of patient safety in order to guarantee appropriate care for the patient during and after skin testing (Gupta and Anand, 2023).

3.2. Blood Tests for Allergies

Blood tests for diagnosing allergies to foods and airborne or environmental allergens are a useful tool in the pediatric setting (Ansotegui *et al.,* 2020). The specific IgE level against a particular allergen, in the form of separate IgE levels to each allergen class or component alone, is a trustworthy indicator of an allergic child (Dramburg *et al.,* 2020). It has shown early promise as a diagnostic tool for the noninvasive quantification of specific IgE antibodies in pediatric populations (Baumann *et al.,* 2021). Additionally, blood testing has some benefits over skin prick testing when the latter cannot be performed, such as in dermatographism, severe eczema, antihistamine use within three days of testing, or in patients with unstable asthma or underlying cardiovascular disease (Foong and Santos, 2021).

An alternative blood test for identifying allergen sensitization is total IgE measurement. Total IgE testing is less specific than specific IgE testing and gives relatively high levels in children without allergies or with bacterial or viral infections (Thorpe *et al.,* 2023). Blood tests are particularly useful for providing quantifiable therapeutic endpoints, including desensitization or atopy patch tests and peanut threshold levels with the aim of desensitization (Hamilton *et al.,* 2020). Its lower patient morbidity, combined with the increasing drive to develop new agents alongside increasing evidence of the importance IgE plays in these clinical conditions, has seen a resurgence in activity in this field (Riggioni *et al.,* 2024).

In summary, blood tests have several advantages over the skin test, including the absence of an active inflammatory reaction mediated through mast cell degranulation (Huber *et al.,* 2020). This may lead to their use in many children where the skin test is otherwise not possible, either due to the risk of a false positive reaction or the localized clearances of such tests (Sista *et al.,* 2020). It can be easily performed on children of all ages, including neonates, and antihistamines need not be stopped for the test (Casertano *et al.,* 2021). Blood tests are easier to manage given the paper test and latex-free nature, where the blood draw requires less skilled nursing support (Wood *et al.,* 2021). Points to consider are that the test does not increase the rate of confirming food allergy, as it correlates with the physician's diagnosis (Ge *et al.,* 2021). The test should always be interpreted alongside a detailed clinical history and considered alongside the significance and any concurrent skin prick test, not in isolation (Prentice *et al.,* 2021). In the latter case, blood tests should be considered in cases where confirmatory skin prick tests are required or for other reasons detailed above (Prentice *et al.,* 2021). The test is particularly useful in atopic dermatitis and when considering phenotyping asthma (Singh *et al.,* 2020). Its efficacy in defining the atopic march contrasts with some studies but supports other studies demonstrating an increased solubility due to aeroallergen sensitization during childhood (Śmigiel *et al.,* 2020). In short, the test is a useful stimulus that requires careful management and criteria for use (Marcotte *et al.,* 2021). The sensitivity and specificity for different allergens may alter under certain conditions based on the local populace (Vill *et al.,* 2021).

4. Treatment Modalities in Pediatric Allergology

The importance of personalized treatment for allergic diseases is particularly relevant in childhood and adolescence (Ferrante *et al.,* 2021). The better we know the patient's sensitivities, the better the allergological intervention will be (Ferrante *et al.,* 2021). Given the variability and personal characteristics, it is essential to set treatments based on a careful clinical history and on functional tests that highlight the change due to a stimulus, both in the presence of the disease and during treatment (Papapostolou and Makris, 2022).

Antihistamines are the most commonly used drugs for the treatment of allergic rhinitis associated with seasonal and perennial allergic conjunctivitis, dosed individually (Indolfi *et al.,* 2024). The effects of antihistamines are largely due to interactions with their specific receptors as inverse H1 agonists, thereby stabilizing the aryl hydrocarbon system of the mast cells and preventing the release of mast cell mediators (Breiteneder *et al.,* 2020). Mast cells are crucial in the pathogenesis of allergic diseases, and histamine is one of the substances that initiates an allergic reaction (Liu *et al.,* 2024).

The first-line treatment of allergic rhinitis symptoms is facilitated by the use of intranasal corticosteroids and antihistamines (Du *et al.,* 2020). Leukotrienes, secreted by white blood cells during inflammation, are used to induce inflammation in the upper and lower respiratory tracts (El-Raouf *et al.,* 2020). A leukotriene modifier is sometimes prescribed, either in combination with corticosteroids or separately to improve symptoms when symptoms are not fully controlled (Hossenbaccus *et al.,* 2020). Based on the severity of the disease, mast cells and eosinophils work in synergy or sequentially, and when released, the leukotrienes can cause persistent smooth muscle contractions (Hoang *et al.,* 2022). Non-pharmacological strategies include allergen control, involvement in the child's environment and diet (Ridolo *et al.,* 2023). The treatment of certain forms of allergy can generally lead to a remission in the absence of exposure; immunotherapy can also and primarily lead to a long-term solution (Linton *et al.,* 2023). Semantics is important; it is essential to personalize the therapy for the singularity: not all are laryngitis and not all people are the same (Goniotakis *et al.,* 2023). It is important to choose the right drug and have a starting dose and, if necessary, a supplementary treatment that will interfere as gently as possible and control symptoms (Afridi *et al.,* 2023). For a child, we must act where they live: allergological therapy must be seen as a pillar to strengthen because it is an aid that acts in targeted and specific places, which is associated with other non-pharmacological interventions as part of environmental and global care (Afridi *et al.,* 2023). Monitoring the clinical history and functional tests through periods of specialist visits is essential for controlling the response to treatment (Goniotakis *et al.,* 2023). Awareness of possible side effects and dosage is essential, especially with pharmacological immuno-modulating therapy (Linton *et al.,* 2023). Given the nature of drug allergy, the evaluation by medically supervised drug challenge may be required to investigate sensitization (Hoang *et al.,* 2022).

4.1. Pharmacological Interventions

Antihistamines have universally been used and represent the first-choice medication in the treatment of allergic rhinitis and urticaria, either intermittent or persistent (Canonica *et al.,* 2024). They are among the symptomatic medications with the most favorable benefit/side effects ratio, acting by blocking the H1 receptor and preventing its activation by histamine (Chadni *et al.,* 2020). Corticosteroids are the only persistent medication class used in the treatment of allergic rhinitis and asthma, based on symptoms (Klimek *et al.,* 2020). They possess anti-inflammatory and anti-edematous effects and act through various mechanisms in multiple steps during allergic response activation (Fukunaga *et al.,* 2024). When the side effects or contraindications of continuous use arise, or when patients express a preference for non-steroids, several alternative or add-on therapies are available in pediatric allergology (Ensina *et al.,* 2022). Other medications focus on mast cell stabilization and control the inflammatory response and/or T- and B-lymphocytes (MacFarlane, 2023). They include biologic therapies specific for allergic conditions and cellular response, or anti-IgE therapy (Ye, 2021; Gammeri *et al.,* 2023).

According to the response to different medications in patients, medication can be tailored to the individual improvement of a child's symptoms (Bassetti *et al.,* 2021). Young pediatric patients cannot express themselves well, and it is also complicated to determine the severity of the symptoms in the case of intermittent pediatric asthma patients (Pijnenburg and Fleming, 2020). It is critical to educate the patient and parents about the medications, how they work, and how and when treatment is effective (Turner *et al.,* 2021). Physicians should adjust the medication or switch to another medication if there is no clinical improvement following medical treatment (Walter *et al.,* 2020). Medication interactions are possible with previous or concomitant treatment the patient is receiving; therefore, adjustment according to further impairment or symptom severity is necessary under certain conditions (Fuentes *et al.,* 2021; Maj *et al.,* 2021).

4.2. Immunotherapy

Immunotherapy is the only causal and long-term treatment method for allergies (Durham and Shamji, 2023). It is based on a regular and prolonged administration of an eliminated allergen or its disease-causing fragment fitted to the immune system by means of sophisticated techniques (Fritzsching *et al.,* 2022). Although more than 100 years have passed since the first successful interventions for the administration of allergens, in practice, two methods dominate: subcutaneous and sublingual immunotherapy (Vogelberg *et al.,* 2022). There are, however, more and more minimized variants of subcutaneous immunotherapy, which are an oral-mucosal method of conventional immunotherapy (Fritzsching *et al.,* 2022). Both subcutaneous and sublingual immunotherapy are based on the principles of safe allergen administration in increasing doses (Contoli *et al.,* 2023). Immunotherapy enables the immune system to stop excessive reactions to specific allergens, at a cellular and humoral level, without providing adverse reactions to the immune response, in turn reducing the reactivity of lymphocytes,

forming IgE, decreasing the level of allergen-specific IgE, and at the same time increasing the level of allergen-specific IgG (Zemelka-Wiacek *et al.,* 2024). Prolonged treatment can give the effect of long-term remission for at least several years after possibly stopping the allergen in the future (Arshad *et al.,* 2024).

An essential issue is the use of patient selection criteria as well as appropriate tests before starting the above treatment (Guo *et al.,* 2020). Immunotherapy also has a positive safety profile. Reviewing a population regarding the initiation of immunotherapy, the type of administration or dosage determines three major effect estimates for the immediate and long-term benefits, sustained for at least 4 years, characterized as substantial (Basha *et al.,* 2021). A full course is usually carried out over a period of 3–5 years, using allergens recommended for particular allergic diseases (Liu *et al.,* 2021). As a result, the short- and long-term effects resulting from this treatment are not usually taken into account and are reduced, and the course is extended—with modifications—because the relapse of symptoms is observed in up to 70% of subjects in the year after treatment cessation (Brüssow and Brüssow, 2021). Practically, it cannot be stopped because the full effect is usually seen a year after the end of the therapy (Paderno *et al.,* 2020). Compliance of patients is very important during the therapy and monitoring by a medical professional; it is a very significant element encouraging patients to adhere to the therapeutic recommendations (Su *et al.,* 2020). In pediatric patients, the need to normalize the cost of immunotherapy is emphasized, which may translate into increased availability and inclusion in national guidelines in the future (Zanarini *et al.,* 2024).

5. Future Directions and Emerging Trends in Pediatric Allergology

1. Technical and technological advancements are more prevalent now than in any previous era. Utilizing data and integrating findings into clinical practice has become part of our daily work (Breiteneder *et al.,* 2020). The digital era has brought a variety of technical possibilities (Ansotegui *et al.,* 2020). Therefore, diagnostics and therapy for allergic diseases can sometimes work more specifically and possibly with improved treatment cost-effectiveness (Sindher *et al.,* 2022). The involvement of artificial intelligence in medicine and the possibility of telemedicine are also now being further discussed (Hamilton *et al.,* 2020). Technological breakthroughs are taking place in other fields, such as genetics, including metabolome, genome, and environmental polymorphism interactions studies (Jutel *et al.,* 2023). New approaches to allergic disease treatment have been one of the hot topics in recent years (Wang *et al.,* 2023). Integrative medicine, combining conventional and complementary therapeutic strategies, is a field of rapidly evolving interest. (Han *et al.,* 2020).
2. Today, the microbiome and its relation to the development of allergic diseases may be one of the most critical nascent scientific domains (Peroni *et al.,* 2020). The human body contains about the same number of microbial cells as human cells, depending on the body site (Aguilera *et al.,* 2020). Repopulation of 'germ-free' animals with a mix of bacteria from diseased or healthy mice shows that particular intestinal bacteria are the cause or protect against it from the development of this illness and that probiotic therapy can treat some allergic diseases (Celebi *et al.,* 2022). As a result, multidisciplinary contact and research with microbiologists, virologists, immunologists, and pneumologists is critical for medical advancement (Nance *et al.,* 2020). Innovative treatments are also being explored in a number of labs around the world (Akagawa and Kaneko, 2022). Additionally, a new prospective therapy against certain pollen rhinitis and other allergic rhinitis 'vaccination for one-shot therapy' is being researched (Augustine *et al.,* 2023). Some points must be addressed in the context of allergy/immunology training (Huang *et al.,* 2022). The most obvious is that the substantial increase in new knowledge necessitates continuous education and additional training for all healthcare professionals involved in caring for patients with allergic and immunodeficiency diseases (Wang *et al.,* 2023).

REFERENCES

- Achilova, D. N. & Yomgurova, O. R. (2022). … immunological and medico-Social aspects of allergic diseases in children, development of criteria for early diagnosis and prognosis of the course of the disease …. British Medical Journal. ejournals.id
- Afridi, A. U., Khan, R. Z., Wahab, U., Nasir, A., Ahmed, Z., & Iqbal, S. (2023). Using Intranasal Corticosteroids and Oral Antihistamines to Treat Allergic Rhinitis: A Comparison of The Mean Total Nasal Symptom Score. Annals of Punjab Medical College, 17(3), 358-360. apmcfmu.com
- Aguilera, A. C., Dagher, I. A., & Kloepfer, K. M. (2020). Role of the microbiome in allergic disease development. Current allergy and asthma reports. nih.gov
- Akagawa, S. & Kaneko, K. (2022). Gut microbiota and allergic diseases in children. Allergology International. jst.go.jp
- Alkhatib AJ (2022a). The Role of Microbes in Autoimmune Diseases. Springer, Singapore.
- Alkhatib AJ (2022b). Immunology: Principles and Applications. InThe Role of Microbes in Autoimmune Diseases: New Mechanisms of

Microbial Initiation of Autoimmunity, May 10 (pp. 1-8). Singapore: Springer Nature Singapore.

- Alkhatib AJ (2022c). Immunology and Microbes. InThe Role of Microbes in Autoimmune Diseases: New Mechanisms of Microbial Initiation of Autoimmunity, May 10 (pp. 9-19). Singapore: Springer Nature Singapore.
- Alkhatib AJ (2022d). Types of Hypersensitivities (Updates). InThe Role of Microbes in Autoimmune Diseases: New Mechanisms of Microbial Initiation of Autoimmunity, May 10 (pp. 21-28). Singapore: Springer Nature Singapore.
- Alkhatib AJ (2022e). Intestinal Flora as Initiatives of Autoimmunity. The Role of Microbes in Autoimmune Diseases: New Mechanisms of Microbial Initiation of Autoimmunity. 2022 May 10:81-103.
- Alotiby, A. A. (2023). The role of breastfeeding as a protective factor against the development of the immune-mediated diseases: A systematic review. Frontiers in Pediatrics. frontiersin.org
- Alsohime, F., Temsah, M. H., Al-Nemri, A. M., Somily, A. M., & Al-Subaie, S. (2020). COVID-19 infection prevalence in pediatric population: Etiology, clinical presentation, and outcome. Journal of infection and public health, 13(12), 1791-1796. sciencedirect.com
- Alvaro-Lozano, M., Akdis, C. A., Akdis, M., Alviani, C., Angier, E., Arasi, S., ... & Vazquez-Ortiz, M. (2020). Allergen immunotherapy in children user's guide. Pediatric allergy and immunology, 31, 1-101. wiley.com
- Anggraeni, S., Umborowati, M. A., Endaryanto, A., & Prakoeswa, C. R. S. (2021). The accuracy of Indonesian new local Skin Prick Test (SPT) allergen extracts as diagnostic tool of IgE-mediated atopic dermatitis. Indian Journal of Forensic Medicine & Toxicology, 15(3), 4278-4285. semanticscholar.org
- Ansotegui, I. J., Melioli, G., Canonica, G. W., Caraballo, L., Villa, E., Ebisawa, M., ... & Zuberbier, T. (2020). IgE allergy diagnostics and other relevant tests in allergy, a World Allergy Organization position paper. World allergy organization journal, 13(2), 100080. sciencedirect.com
- Apostol, A. C., Jensen, K. D. C., & Beaudin, A. E. (2020). Training the fetal immune system through maternal inflammation—a layered hygiene hypothesis. Frontiers in immunology. frontiersin.org
- Arıkoğlu, T., Kuyucu, S., & Caubet, J. C. (2022). New diagnostıc perspectives in the management of pediatrıc beta-lactam allergy. Pediatric Allergy and Immunology, 33(3), e13745. [HTML]
- Arshad, H., Lack, G., Durham, S. R., Penagos, M., Larenas-Linnemann, D., & Halken, S. (2024). Prevention is better than cure: impact of allergen immunotherapy on the progression of airway disease. The Journal of Allergy and Clinical Immunology: In Practice, 12(1), 45-56. [HTML]
- Augustine, T., Kumar, M., Al Khodor, S., & van Panhuys, N. (2023). Microbial dysbiosis tunes the immune response towards allergic disease outcomes. Clinical Reviews in Allergy & Immunology, 65(1), 43-71. springer.com
- Badal, S., Bajgain, K. T., Badal, S., Thapa, R., Bajgain, B. B., & Santana, M. J. (2021). Prevalence, clinical characteristics, and outcomes of pediatric COVID-19: a systematic review and meta-analysis. Journal of Clinical Virology, 135, 104715. nih.gov
- Bahna, S. L. (2024). History of food allergy and where we are today. World Allergy Organization Journal. sciencedirect.com
- Barbaud, A. & Romano, A. (2022). Skin testing approaches for immediate and delayed hypersensitivity reactions. Immunology and Allergy Clinics of North America. sciencedirect.com
- Barbaud, A., Goncalo, M., Mockenhaupt, M., Copaescu, A., & Phillips, E. J. (2024). Delayed skin testing for systemic medications: helpful or not?. The Journal of Allergy and Clinical Immunology: In Practice, 12(9), 2268-2277. jaci-inpractice.org
- Barber, D., Diaz-Perales, A., Escribese, M. M., Kleine-Tebbe, J., Matricardi, P. M., Ollert, M., ... & Sastre, J. (2021). Molecular allergology and its impact in specific allergy diagnosis and therapy. Allergy, 76(12), 3642-3658. wiley.com
- Basha, J., Lakhtakia, S., Nabi, Z., Pal, P., Chavan, R., Talukdar, R., ... & Reddy, D. N. (2021). Impact of disconnected pancreatic duct on recurrence of fluid collections and new-onset diabetes: do we finally have an answer?. Gut, 70(3), 447-449. bmj.com
- Bassetti, C. L., Kallweit, U., Vignatelli, L., Plazzi, G., Lecendreux, M., Baldin, E., ... & Lammers, G. J. (2021). European guideline and expert statements on the management of narcolepsy in adults and children. European journal of neurology, 28(9), 2815-2830. wiley.com
- Baumann, R., Untersmayr, E., Zissler, U. M., Eyerich, S., Adcock, I. M., Brockow, K., ... & Schmidt-Weber, C. B. (2021). Noninvasive and minimally invasive techniques for the diagnosis and management of allergic diseases. Allergy, 76(4), 1010-1023. wiley.com
- Breiteneder, H., Peng, Y. Q., Agache, I., Diamant, Z., Eiwegger, T., Fokkens, W. J., ... & Akdis, C. A. (2020). Biomarkers for diagnosis and prediction of therapy responses in allergic diseases and asthma. Allergy, 75(12), 3039-3068. wiley.com
- Brettig, T., Dang, T., McWilliam, V., Peters, R. L., Koplin, J. J., & Perrett, K. P. (2021). The accuracy of diagnostic testing in determining tree nut allergy: a systematic review. The Journal of Allergy and Clinical Immunology: In Practice, 9(5), 2028-2049. [HTML]

- Brough, H. A., Kalayci, O., Sediva, A., Untersmayr, E., Munblit, D., Rodriguez del Rio, P., ... & Eigenmann, P. A. (2020). Managing childhood allergies and immunodeficiencies during respiratory virus epidemics–the 2020 COVID-19 pandemic: a statement from the EAACI-section on pediatrics. Pediatric Allergy and Immunology, 31(5), 442-448. nih.gov
- Brough, H. A., Lanser, B. J., Sindher, S. B., Teng, J. M., Leung, D. Y., Venter, C., ... & Nagler, C. R. (2022). Early intervention and prevention of allergic diseases. Allergy, 77(2), 416-441. wiley.com
- Brüssow, H. & Brüssow, L. (2021). Clinical evidence that the pandemic from 1889 to 1891 commonly called the Russian flu might have been an earlier coronavirus pandemic. Microbial biotechnology. wiley.com
- Canonica, G. W., Kuna, P., Maurer, M., Mösges, R., Novak, Z., Papadopoulos, N., ... & Delphi Study Group. (2024). Bilastine for the treatment of allergic rhinoconjunctivitis and urticaria: results from an international Delphi study. Drugs in Context, 13. nih.gov
- Casertano, A., Rossi, A., Fecarotta, S., Rosanio, F. M., Moracas, C., Di Candia, F., ... & Mozzillo, E. (2021). An overview of hypoglycemia in children including a comprehensive practical diagnostic flowchart for clinical use. Frontiers in endocrinology, 12, 684011. frontiersin.org
- Cela, L., Gravina, A., Semeraro, A., Pastore, F., Morelli, R., Marchetti, L., ... & Anania, C. (2024). Oral Food Challenge in Children with Tree Nut and Peanut Allergy: The Predictive Value of Diagnostic Tests. Diagnostics, 14(18), 2069. mdpi.com
- Celebi Sozener, Z., Ozdel Ozturk, B., Cerci, P., Turk, M., Gorgulu Akin, B., Akdis, M., ... & Akdis, C. A. (2022). Epithelial barrier hypothesis: effect of the external exposome on the microbiome and epithelial barriers in allergic disease. Allergy, 77(5), 1418-1449. wiley.com
- Chadni, S. H., Banna, M. H., Mollick, N. N., Rupam, M. R., Sultana, S., & Zaman, S. U. (2020). Does Over-the-Counter Purchase of Antihistamines by Residents of Dhaka City, Bangladesh Align with the Prescribing Choices of the Physicians Practicing in That City?. Advances in Public Health, 2020(1), 2384596. wiley.com
- Cinicola, B., Conti, M. G., Terrin, G., Sgrulletti, M., Elfeky, R., Carsetti, R., ... & Duse, M. (2021). The protective role of maternal immunization in early life. Frontiers in Pediatrics, 9, 638871. frontiersin.org
- Contoli, M., Porsbjerg, C., Buchs, S., Larsen, J. R., Freemantle, N., & Fritzsching, B. (2023). Real-world, long-term effectiveness of allergy immunotherapy in allergic rhinitis: subgroup analyses of the REACT study. Journal of Allergy and Clinical Immunology, 152(2), 445-452. sciencedirect.com
- Copaescu, A., Gibson, A., Li, Y., Trubiano, J. A., & Phillips, E. J. (2021). An updated review of the diagnostic methods in delayed drug hypersensitivity. Frontiers in pharmacology, 11, 573573. frontiersin.org
- Cutler, C., Lee, S. J., Arai, S., Rotta, M., Zoghi, B., Lazaryan, A., ... & Pavletic, S. (2021). Belumosudil for chronic graft-versus-host disease after 2 or more prior lines of therapy: the ROCKstar Study. Blood, The Journal of the American Society of Hematology, 138(22), 2278-2289. sciencedirect.com
- de Silva, D., Halken, S., Singh, C., Muraro, A., Angier, E., Arasi, S., ... & European Academy of Allergy, Clinical Immunology Food Allergy, Anaphylaxis Guidelines Group. (2020). Preventing food allergy in infancy and childhood: Systematic review of randomised controlled trials. Pediatric Allergy and Immunology, 31(7), 813-826. sdu.dk
- De Souza, T. H., Nadal, J. A., Nogueira, R. J., Pereira, R. M., & Brandão, M. B. (2020). Clinical manifestations of children with COVID-19: a systematic review. Pediatric pulmonology, 55(8), 1892-1899. nih.gov
- DeBiasi, R. L., Song, X., Delaney, M., Bell, M., Smith, K., Pershad, J., ... & Wessel, D. (2020). Severe coronavirus disease-2019 in children and young adults in the Washington, DC, metropolitan region. The Journal of pediatrics, 223, 199-203. jpeds.com
- Dierick, B. J., van der Molen, T., Flokstra-de Blok, B. M., Muraro, A., Postma, M. J., Kocks, J. W., & van Boven, J. F. (2020). Burden and socioeconomics of asthma, allergic rhinitis, atopic dermatitis and food allergy. Expert review of pharmacoeconomics & outcomes research, 20(5), 437-453. tandfonline.com
- Donald, K. & Finlay, B. B. (2023). Early-life interactions between the microbiota and immune system: impact on immune system development and atopic disease. Nature Reviews Immunology. aaiito.it
- Dramburg, S., Marchante Fernández, M., Potapova, E., & Matricardi, P. M. (2020). The potential of clinical decision support systems for prevention, diagnosis, and monitoring of allergic diseases. Frontiers in Immunology, 11, 2116. frontiersin.org
- Du, H., Dong, X., Zhang, J. J., Cao, Y. Y., Akdis, M., Huang, P. Q., ... & Gao, Y. D. (2021). Clinical characteristics of 182 pediatric COVID-19 patients with different severities and allergic status. Allergy, 76(2), 510-532. nih.gov
- Du, K., Qing, H., Zheng, M., Wang, X., & Zhang, L. (2020). Intranasal antihistamine is superior to oral H1 antihistamine as an add-on therapy to intranasal corticosteroid for treating allergic rhinitis. Annals of Allergy, Asthma & Immunology, 125(5), 589-596. researchgate.net

- Du, W., Yu, J., Wang, H., Zhang, X., Zhang, S., Li, Q., & Zhang, Z. (2020). Clinical characteristics of COVID-19 in children compared with adults in Shandong Province, China. Infection. springer.com
- Durham, S. R. & Shamji, M. H. (2023). Allergen immunotherapy: past, present and future. Nature Reviews Immunology. nature.com
- Elghoudi, A. & Narchi, H. (2022). Food allergy in children—the current status and the way forward. World journal of clinical pediatrics. nih.gov
- El-Raouf, A., Shendy, M. F., Kazeem, N. G., El-Awady, M. A., & Ibrahim, M. M. S. (2020). Meta Analysis Study and Systemic Review of the Efficacy of Combination of H1 Antihistamine with Intranasal Corticosteroid in Management of Allergic Rhinitis. Benha Journal of Applied Sciences, 5(4 part (1)), 165-170. ekb.eg
- Ensina, L. F., Min, T. K., Félix, M. M. R., de Alcântara, C. T., & Costa, C. (2022). Acute urticaria and anaphylaxis: differences and similarities in clinical management. Frontiers in Allergy, 3, 840999. frontiersin.org
- Esch, B. C. V., Porbahaie, M., Abbring, S., Garssen, J., Potaczek, D. P., Savelkoul, H. F., & Neerven, R. J. V. (2020). The impact of milk and its components on epigenetic programming of immune function in early life and beyond: implications for allergy and asthma. Frontiers in immunology, 11, 2141. frontiersin.org
- Fang, H., Li, J., Wen, X., Ren, L., & Liu, E. (2024). Next-generation reference interval for total IgE in the United States: A retrospective real-world analysis. Clinica Chimica Acta. [HTML]
- Ferrante, G., Licari, A., Fasola, S., Marseglia, G. L., & La Grutta, S. (2021). Artificial intelligence in the diagnosis of pediatric allergic diseases. Pediatric Allergy and Immunology, 32(3), 405-413. [HTML]
- Fleischer, D. M., Chan, E. S., Venter, C., Spergel, J. M., Abrams, E. M., Stukus, D., ... & Greenhawt, M. (2021). A consensus approach to the primary prevention of food allergy through nutrition: guidance from the American Academy of Allergy, Asthma, and Immunology; American College of Allergy, Asthma, and Immunology; and the Canadian Society for Allergy and Clinical Immunology. The Journal of Allergy and Clinical Immunology: In Practice, 9(1), 22-43. aaaai.org
- Foong, R. X. & Santos, A. F. (2021). Biomarkers of diagnosis and resolution of food allergy. Pediatric Allergy and Immunology. wiley.com
- Fritzsching, B., Contoli, M., Porsbjerg, C., Buchs, S., Larsen, J. R., Elliott, L., ... & Freemantle, N. (2022). Long-term real-world effectiveness of allergy immunotherapy in patients with allergic rhinitis and asthma: Results from the REACT study, a retrospective cohort study. The Lancet Regional Health–Europe, 13. thelancet.com
- Fritzsching, B., Contoli, M., Porsbjerg, C., Buchs, S., Larsen, J. R., & Freemantle, N. (2022). Real-world evidence: methods for assessing long-term health and effectiveness of allergy immunotherapy. Journal of Allergy and Clinical Immunology, 149(3), 881-883. jacionline.org
- Fuentes, J., Hervás, A., Howlin, P., & (ESCAP ASD Working Party). (2021). ESCAP practice guidance for autism: a summary of evidence-based recommendations for diagnosis and treatment. European child & adolescent psychiatry, 30(6), 961-984. springer.com
- Fukunaga, A., Kakei, Y., Murakami, S., Kan, Y., Masuda, K., Jinnin, M., ... & Hide, M. (2024). Efficacy and safety of switching to bilastine, an H1-antihistamine, in patients with refractory chronic spontaneous urticaria (H1-SWITCH): a multicenter, open-label, randomized, parallel-group comparative study. Frontiers in Immunology, 15, 1441478. frontiersin.org
- Gaillard, E. A., Kuehni, C. E., Turner, S., Goutaki, M., Holden, K. A., de Jong, C. C., ... & Moeller, A. (2021). European Respiratory Society clinical practice guidelines for the diagnosis of asthma in children aged 5–16 years. European respiratory journal, 58(5). ersjournals.com
- Gammeri, L., Panzera, C., Calapai, F., Cicero, N., & Gangemi, S. (2023). Asian herbal medicine and chronic urticaria: which are the therapeutic perspectives?. Natural Product Research, 37(11), 1917-1934. [HTML]
- García-Serna, A. M., Martín-Orozco, E., Hernández-Caselles, T., & Morales, E. (2021). Prenatal and perinatal environmental influences shaping the neonatal immune system: a focus on asthma and allergy origins. International Journal of Environmental Research and Public Health, 18(8), 3962. mdpi.com
- Ge, M., Gan, M., Yan, K., Xiao, F., Yang, L., Wu, B., ... & Hu, L. (2021). Combining metagenomic sequencing with whole exome sequencing to optimize clinical strategies in neonates with a suspected central nervous system infection. Frontiers in cellular and infection microbiology, 11, 671109. frontiersin.org
- Gilaberte, Y., Pérez-Gilaberte, J. B., Poblador-Plou, B., Bliek-Bueno, K., Gimeno-Miguel, A., & Prados-Torres, A. (2020). Prevalence and comorbidity of atopic dermatitis in children: a large-scale population study based on real-world data. Journal of clinical medicine, 9(6), 1632. mdpi.com
- Gonçalo, M. (2022). Skin Tests in Evaluating Drug Eruptions. Drug Eruptions. [HTML]
- Goniotakis, I., Perikleous, E., Fouzas, S., Steiropoulos, P., & Paraskakis, E. (2023). A Clinical Approach of Allergic Rhinitis in Children. Children, 10(9), 1571. mdpi.com
- Goodman, R. E., Chapman, M. D., & Slater, J. E. (2020). The allergen: sources, extracts, and molecules for diagnosis of allergic disease. The

Journal of Allergy and Clinical Immunology: In Practice, 8(8), 2506-2514. researchgate.net

- Graham, F., Caubet, J. C., Ramadan, S., Spoerl, D., & Eigenmann, P. A. (2020). Specific IgE decision point cutoffs in children with IgE-mediated wheat allergy and a review of the literature. International archives of allergy and immunology, 181(4), 296-300. karger.com
- Guo, Y., Guo, J., Shi, X., Yao, Y., Sun, Y., Xia, Y., ... & mAF-App II Trial investigators. (2020). Mobile health technology-supported atrial fibrillation screening and integrated care: a report from the mAFA-II trial Long-term Extension Cohort. European journal of internal medicine, 82, 105-111. nih.gov
- Gupta, N. & Anand, M. (2023). Allergy Skin Testing. Journal of Pediatric Pulmonology. lww.com
- Ha, J., Lee, S. W., & Yon, D. K. (2020). Ten-year trends and prevalence of asthma, allergic rhinitis, and atopic dermatitis among the Korean population, 2008–2017. Clinical and experimental pediatrics. nih.gov.
- Haarala, A. K., Sinikumpu, S. P., Vaaramo, E., Jokelainen, J., Timonen, M., Auvinen, J., ... & Huilaja, L. (2021). Incidence and remission of aeroallergen sensitization in adults in Northern Finland: 15 years longitudinal study. Scientific Reports, 11(1), 4249. nature.com
- Halken, S., Muraro, A., de Silva, D., Khaleva, E., Angier, E., Arasi, S., ... & European Academy of Allergy and Clinical Immunology Food Allergy and Anaphylaxis Guidelines Group. (2021). EAACI guideline: Preventing the development of food allergy in infants and young children (2020 update). Pediatric Allergy and Immunology, 32(5), 843-858. wiley.com
- Hamilton, R. G., Hemmer, W., Nopp, A., & Kleine-Tebbe, J. (2020). Advances in IgE testing for diagnosis of allergic disease. The Journal of Allergy and Clinical Immunology: In Practice, 8(8), 2495-2504. [HTML]
- Han, X., Krempski, J. W., & Nadeau, K. (2020). Advances and novel developments in mechanisms of allergic inflammation. Allergy. wiley.com
- Henneke, P., Kierdorf, K., Hall, L. J., Sperandio, M., & Hornef, M. (2021). Perinatal development of innate immune topology. Elife. elifesciences.org
- Hoang, J. A., Celik, A., Lupinek, C., Valenta, R., Duan, L., Dai, R., ... & Eiwegger, T. (2021). Modeling the conversion between specific IgE test platforms for nut allergens in children and adolescents. Allergy, 76(3), 831-841. [HTML]
- Hoang, M. P., Chitsuthipakorn, W., Seresirikachorn, K., & Snidvongs, K. (2022). As-needed intranasal corticosteroid spray for allergic rhinitis: a systematic review and meta-analysis. Rhinology, 60(4), 242-251. hueuni.edu.vn
- Holuka, C., Merz, M. P., Fernandes, S. B., Charalambous, E. G., Seal, S. V., Grova, N., & Turner, J. D. (2020). The COVID-19 pandemic: does our early life environment, life trajectory and socioeconomic status determine disease susceptibility and severity?. International journal of molecular sciences, 21(14), 5094. mdpi.com
- Hoskinson, C., Dai, D. L., Del Bel, K. L., Becker, A. B., Moraes, T. J., Mandhane, P. J., ... & Turvey, S. E. (2023). Delayed gut microbiota maturation in the first year of life is a hallmark of pediatric allergic disease. Nature Communications, 14(1), 4785. nature.com
- Hossenbaccus, L., Linton, S., Garvey, S., & Ellis, A. K. (2020). Towards definitive management of allergic rhinitis: best use of new and established therapies. Allergy, Asthma & Clinical Immunology, 16, 1-17. springer.com
- Hu, T., Dong, Y., Yang, C., Zhao, M., & He, Q. (2021). Pathogenesis of children's allergic diseases: refocusing the role of the gut microbiota. Frontiers in physiology. frontiersin.org
- Hu, Y., Liu, S., Liu, P., Mu, Z., & Zhang, J. (2020). Clinical relevance of eosinophils, basophils, serum total IgE level, allergen-specific IgE, and clinical features in atopic dermatitis. Journal of Clinical Laboratory Analysis, 34(6), e23214. wiley.com
- Huang, J., Zhang, J., Wang, X., Jin, Z., Zhang, P., Su, H., & Sun, X. (2022). Effect of probiotics on respiratory tract allergic disease and gut microbiota. Frontiers in Nutrition, 9, 821900. frontiersin.org
- Huber, S., Hetzer, B., Crazzolara, R., & Orth-Höller, D. (2020). The correct blood volume for paediatric blood cultures: a conundrum?. Clinical Microbiology and Infection, 26(2), 168-173. sciencedirect.com
- Hui, J. W. & Leung, D. Y. M. (2021). Origins of allergic disease: maternal and early childhood factors. Annals of Allergy. [HTML]
- Incorvaia, C., Al-Ahmad, M., Ansotegui, I. J., Arasi, S., Bachert, C., Bos, C., ... & Canonica, G. W. (2021). Personalized medicine for allergy treatment: allergen immunotherapy still a unique and unmatched model. Allergy, 76(4), 1041-1052. wiley.com
- Indolfi, C., Klain, A., Dinardo, G., Decimo, F., & Miraglia del Giudice, M. (2024). Artificial intelligence in the transition of allergy: A valuable tool from childhood to adulthood. Frontiers in Medicine, 11, 1469161. frontiersin.org
- Jain, N. (2020). The early life education of the immune system: Moms, microbes and (missed) opportunities. Gut Microbes. tandfonline.com
- Jutel, M., Agache, I., Zemelka-Wiacek, M., Akdis, M., Chivato, T., Del Giacco, S., ... & Akdis, C. A. (2023). Nomenclature of allergic diseases and hypersensitivity reactions: Adapted to modern needs: An EAACI position paper. Allergy, 78(11), 2851-2874. ceu.es

- Jutzeler, C. R., Bourguignon, L., Weis, C. V., Tong, B., Wong, C., Rieck, B., ... & Walter, M. (2020). Comorbidities, clinical signs and symptoms, laboratory findings, imaging features, treatment strategies, and outcomes in adult and pediatric patients with COVID-19: A systematic review and meta-analysis. Travel medicine and infectious disease, 37, 101825. sciencedirect.com
- Keet, C., Plesa, M., Szelag, D., Shreffler, W., Wood, R., Dunlop, J., ... & Pistiner, M. (2021). Ara h 2–specific IgE is superior to whole peanut extract–based serology or skin prick test for diagnosis of peanut allergy in infancy. Journal of Allergy and Clinical Immunology, 147(3), 977-983. jacionline.org
- Khreesha, L., Ghunaim, M., Ramzown, M. A., Alkhoujah, M., Tawalbeh, M., Al-Iede, M., ... & Eid, S. (2020). Minimizing the number of aeroallergen extracts in skin prick test in IgE-mediated allergic disorders in both adults and children in Jordan. Journal of Asthma and Allergy, 315-321. tandfonline.com
- Klimek, L., Casper, I., Bergmann, K. C., Biedermann, T., Bousquet, J., Hellings, P., ... & Becker, S. (2020). Therapy of allergic rhinitis in routine care: evidence-based benefit assessment of freely combined use of various active ingredients: A position paper of the Medical Association of German Allergists (AEDA) in cooperation with the ENT section of the European Academy of Allergy and Clinical Immunology (EAACI), the German ARIA (Allergic Rhinitis and its Impact on Asthma) Group and the Working Group Clinical Immunology, Allergology and Environmental Medicine of the German Society for Otorhinolaryngology .... Allergo Journal International, 29, 129-138. springer.com
- Krusche, J., Basse, S., & Schaub, B. (2020). Role of early life immune regulation in asthma development. Seminars in immunopathology. springer.com
- Kuiper, I. N., Svanes, C., Markevych, I., Accordini, S., Bertelsen, R. J., Bråbäck, L., ... & Johannessen, A. (2021). Lifelong exposure to air pollution and greenness in relation to asthma, rhinitis and lung function in adulthood. Environment international, 146, 106219. sciencedirect.com
- Kuric, I. & Hadzavdic, S. L. (2022). Clinical presentation, diagnosis, differential diagnosis and management of contact allergy. CosmoDerma. cosmoderma.org
- Lau, H. X., Chen, Z., Chan, Y. H., Tham, E. H., Goh, A. E. N., Van Bever, H., ... & Loo, E. X. L. (2022). Allergic sensitization trajectories to age 8 years in the Singapore GUSTO cohort. World Allergy Organization Journal, 15(7), 100667. sciencedirect.com
- Lee, K. H., Song, Y., Wu, W., Yu, K., & Zhang, G. (2020). The gut microbiota, environmental factors, and links to the development of food allergy. Clinical and Molecular Allergy. springer.com
- Li, N., Chen, H., Cheng, Y., Xu, F., Ruan, G., Ying, S., ... & Wei, Y. (2021). Fecal microbiota transplantation relieves gastrointestinal and autism symptoms by improving the gut microbiota in an open-label study. Frontiers in cellular and infection microbiology, 11, 759435. frontiersin.org
- Lin, I. H., Tsai, M. C., Chen, J. P., & Fu, L. S. (2021). Allergic children with extremely high total IgE but no allergen identified in the initial screening panel. Journal of Microbiology, Immunology and Infection, 54(3), 474-481. sciencedirect.com
- Linton, S., Hossenbaccus, L., & Ellis, A. K. (2023). Evidence-based use of antihistamines for treatment of allergic conditions. Annals of Allergy, Asthma & Immunology. annallergy.org
- Liu, H. M., Rayner, A., Mendelsohn, A. R., Shneyderman, A., Chen, M., & Pun, F. W. (2024). Applying artificial intelligence to identify common targets for treatment of asthma, eczema, and food allergy. International Archives of Allergy and Immunology, 185(2), 99-110. [HTML]
- Liu, P., Tu, H., Zhang, A., Yang, C., Liu, Z., Lei, L., ... & Zhang, K. (2021). Brain functional alterations in MDD patients with somatic symptoms: a resting-state fMRI study. Journal of Affective Disorders, 295, 788-796. [HTML]
- Lu, C., Norbäck, D., Li, Y., & Deng, Q. (2020). Early-life exposure to air pollution and childhood allergic diseases: an update on the link and its implications. Expert review of clinical immunology, 16(8), 813-827. researchgate.net
- Lyons, S. A., Clausen, M., Knulst, A. C., Ballmer-Weber, B. K., Fernandez-Rivas, M., Barreales, L., ... & Le, T. M. (2020). Prevalence of food sensitization and food allergy in children across Europe. The Journal of Allergy and Clinical Immunology: In Practice, 8(8), 2736-2746. sciencedirect.com
- MacFarlane, B. (2023). Tailoring over-the-counter treatments for patients with allergic rhinitis and urticaria. AJP: The Australian Journal of Pharmacy. [HTML]
- Maj, M., van Os, J., De Hert, M., Gaebel, W., Galderisi, S., Green, M. F., ... & Ventura, J. (2021). The clinical characterization of the patient with primary psychosis aimed at personalization of management. World Psychiatry, 20(1), 4-33. wiley.com
- Man Liu, B. H., Rayner, A., Mendelsohn, A. R., Shneyderman, A., Chen, M., & Pun, F. W. (2023). Applying Artificial Intelligence to Identify Common Targets for Treatment of Asthma, Eczema, and Food Allergy. bioRxiv, 2023-06. biorxiv.org
- Marcotte, E. L., Spector, L. G., Mendes-de-Almeida, D. P., & Nelson, H. H. (2021). The prenatal origin of childhood leukemia: potential applications for epidemiology and newborn

screening. Frontiers in Pediatrics, 9, 639479. frontiersin.org

- Mass, E. & Gentek, R. (2021). Fetal-derived immune cells at the roots of lifelong pathophysiology. Frontiers in cell and developmental biology. frontiersin.org
- Mazur, M., Czarnobilska, M., Dyga, W., & Czarnobilska, E. (2022). Trends in the epidemiology of allergic diseases of the airways in children growing up in an urban agglomeration. Journal of Clinical Medicine, 11(8), 2188. mdpi.com
- Meher, B. K., Pradhan, D. D., Mahar, J., & Sahu, S. K. (2021). Prevalence of allergic sensitization in childhood asthma. Cureus. nih.gov
- Messina, M. & Venter, C. (2020). Recent surveys on food allergy prevalence. Nutrition Today. lww.com
- Miles, E. A., Childs, C. E., & Calder, P. C. (2021). Long-chain polyunsaturated fatty acids (LCPUFAs) and the developing immune system: a narrative review. Nutrients. mdpi.com
- Moraes-Pinto, M. I., Suano-Souza, F., & Aranda, C. S. (2021). Immune system: development and acquisition of immunological competence. Jornal de pediatria. scielo.br
- Muthupalaniappen, L., & Jamil, A. (2021). Prick, patch or blood test? A simple guide to allergy testing. Malaysian family physician: the official journal of the Academy of Family Physicians of Malaysia, 16(2), 19. nih.gov
- Nair, A. A. (2023). Provocation Tests in Allergy. IAP Case Based Reviews in Pediatric Allergy. [HTML]
- Nance, C. L., Deniskin, R., Diaz, V. C., Paul, M., Anvari, S., & Anagnostou, A. (2020). The role of the microbiome in food allergy: a review. Children, 7(6), 50. mdpi.com
- Niewiem, M. & Grzybowska-Chlebowczyk, U. (2022). Intestinal barrier permeability in allergic diseases. Nutrients. mdpi.com
- Nuzzi, G., Di Cicco, M. E., & Peroni, D. G. (2021). Breastfeeding and allergic diseases: What's new?. Children. mdpi.com
- Ogulur, I., Pat, Y., Ardicli, O., Barletta, E., Cevhertas, L., Fernandez-Santamaria, R., ... & Akdis, C. A. (2021). Advances and highlights in biomarkers of allergic diseases. Allergy, 76(12), 3659-3686. wiley.com
- Paderno, A., Mattavelli, D., Rampinelli, V., Grammatica, A., Raffetti, E., Tomasoni, M., ... & Schreiber, A. (2020). Olfactory and gustatory outcomes in COVID-19: a prospective evaluation in nonhospitalized subjects. Otolaryngology–Head and Neck Surgery, 163(6), 1144-1149. sagepub.com
- Pakkasela, J., Ilmarinen, P., Honkamäki, J., Tuomisto, L. E., Andersén, H., Piirilä, P., ... & Lehtimäki, L. (2020). Age-specific incidence of allergic and non-allergic asthma. BMC pulmonary medicine, 20, 1-9. springer.com
- Paoletti, G., Di Bona, D., Chu, D. K., Firinu, D., Heffler, E., Agache, I., ... & Canonica, G. W. (2021). Allergen immunotherapy: the growing role of observational and randomized trial "Real-World Evidence". Allergy, 76(9), 2663-2672. wiley.com
- Papamichael, M. M., Katsardis, C., Sarandi, E., Georgaki, S., Frima, E. S., Varvarigou, A., & Tsoukalas, D. (2021). Application of metabolomics in pediatric asthma: prediction, diagnosis and personalized treatment. Metabolites, 11(4), 251. mdpi.com
- Papapostolou, N. & Makris, M. (2022). Allergic asthma in the era of personalized medicine. Journal of Personalized Medicine. mdpi.com
- Peroni, D. G., Nuzzi, G., Trambusti, I., Di Cicco, M. E., & Comberiati, P. (2020). Microbiome composition and its impact on the development of allergic diseases. Frontiers in immunology, 11, 700. frontiersin.org
- Peters, R. L., Guarnieri, I., Tang, M. L., Lowe, A. J., Dharmage, S. C., Perrett, K. P., ... & Koplin, J. J. (2022). The natural history of peanut and egg allergy in children up to age 6 years in the HealthNuts population-based longitudinal study. Journal of Allergy and Clinical Immunology, 150(3), 657-665. jacionline.org
- Peters, R. L., Krawiec, M., Koplin, J. J., & Santos, A. F. (2021). Update on food allergy. Pediatric Allergy and Immunology, 32(4), 647-657. wiley.com
- Pfaar, O., Ankermann, T., Augustin, M., Bubel, P., Böing, S., Brehler, R., ... & Schwalfenberg, A. (2022). Guideline on allergen immunotherapy in IgE-mediated allergic diseases: S2K guideline of the German society of allergology and clinical immunology (DGAKI), society of pediatric allergology and environmental medicine (GPA), medical association of German allergologists (AeDA), Austrian society of allergology and immunology (ÖGAI), Swiss society for allergology and immunology (SSAI), German dermatological society (DDG), German society of oto-rhino-laryngology, head and neck surgery (DGHNO-KHC), German .... Allergologie select, 6, 167. nih.gov
- Pijnenburg, M. W. & Fleming, L. (2020). Advances in understanding and reducing the burden of severe asthma in children. The Lancet Respiratory Medicine. [HTML]
- Pitsios, C., Petalas, K., Dimitriou, A., Parperis, K., Gerasimidou, K., & Chliva, C. (2022). Workup and clinical assessment for allergen immunotherapy candidates. Cells, 11(4), 653. mdpi.com
- Prentice, S., Nassanga, B., Webb, E. L., Akello, F., Kiwudhu, F., Akurut, H., ... & Akello, M. (2021). BCG-induced non-specific effects on heterologous infectious disease in Ugandan neonates: an investigator-blind randomised controlled trial. The

Lancet Infectious Diseases, 21(7), 993-1003. thelancet.com

- Raby, P. & Mallol, J. (2022). Allergic sensitization in low-income urban children: relationship with current symptoms of asthma and rhinitis. Boletín médico del Hospital Infantil de México. scielo.org.mx
- Renz, H. & Skevaki, C. (2021). Early life microbial exposures and allergy risks: opportunities for prevention. Nature Reviews Immunology. [HTML]
- Ridolo, E., Barone, A., Nicoletta, F., Paoletti, G., Heffler, E., Malvezzi, L., & Canonica, G. W. (2023). Intranasal corticosteroid and antihistamine combinations in the treatment of allergic rhinitis: the role of the novel formulation olopatadine/mometasone furoate. Expert Review of Clinical Immunology, 19(6), 575-584. [HTML]
- Riggioni, C., Ricci, C., Moya, B., Wong, D., van Goor, E., Bartha, I., ... & Santos, A. F. (2024). Systematic review and meta-analyses on the accuracy of diagnostic tests for IgE-mediated food allergy. Allergy, 79(2), 324-352. wiley.com
- Samajdar, S. S., Mukherjee, S., Vedanthan, P. K., Moitra, S., Tripathi, S. K., Saboo, B., & Joshi, S. R. (2024). DPP4 Inhibitors and Hypersensitivity Reactions: Experiences From Clinical Pharmacology and Diabetes and Allergy-Asthma Therapeutics Specialty Clinics. Journal of Diabetology, 15(4), 460-461. lww.com
- Sampath, V., Abrams, E. M., Adlou, B., Akdis, C., Akdis, M., Brough, H. A., ... & Renz, H. (2021). Food allergy across the globe. Journal of Allergy and Clinical Immunology, 148(6), 1347-1364. jacionline.org
- Sangchan, T., Koosakulchai, V., Sangsupawanich, P., Srisuk, B., & Yuenyongviwat, A. (2024). Trends of aeroallergen sensitization among children with respiratory allergy in Southern Thailand. Asia Pacific Allergy, 10-5415. lww.com
- Schoos, A. M. M., Chawes, B. L., Bønnelykke, K., Stokholm, J., Rasmussen, M. A., & Bisgaard, H. (2022). Increasing severity of early-onset atopic dermatitis, but not late-onset, associates with development of aeroallergen sensitization and allergic rhinitis in childhood. Allergy, 77(4), 1254-1262. authorea.com
- Sepulcri, C., Dentone, C., Mikulska, M., Bruzzone, B., Lai, A., Fenoglio, D., ... & Bassetti, M. (2021, November). The longest persistence of viable SARS-CoV-2 with recurrence of viremia and relapsing symptomatic COVID-19 in an immunocompromised patient—A case study. In Open forum infectious diseases (Vol. 8, No. 11, p. ofab217). US: Oxford University Press. oup.com
- Shamji, M. H., Valenta, R., Jardetzky, T., Verhasselt, V., Durham, S. R., Würtzen, P. A., & van Neerven, R. J. (2021). The role of allergen-specific IgE, IgG and IgA in allergic disease. Allergy, 76(12), 3627-3641. wiley.com
- Sindher, S. B., Long, A., Chin, A. R., Hy, A., Sampath, V., Nadeau, K. C., & Chinthrajah, R. S. (2022). Food allergy, mechanisms, diagnosis and treatment: Innovation through a multi-targeted approach. Allergy, 77(10), 2937-2948. wiley.com
- Singh, Y., Villaescusa, J. U., da Cruz, E. M., Tibby, S. M., Bottari, G., Saxena, R., ... & Lemson, J. (2020). Recommendations for hemodynamic monitoring for critically ill children—expert consensus statement issued by the cardiovascular dynamics section of the European Society of Paediatric and Neonatal Intensive Care (ESPNIC). Critical Care, 24, 1-13. springer.com
- Sista, R. S., Ng, R., Nuffer, M., Basmajian, M., Coyne, J., Elderbroom, J., ... & Pamula, V. K. (2020). Digital microfluidic platform to maximize diagnostic tests with low sample volumes from newborns and pediatric patients. Diagnostics, 10(1), 21. mdpi.com
- Śmigiel, R., Biela, M., Szmyd, K., Błoch, M., Szmida, E., Skiba, P., ... & Płoski, R. (2020). Rapid whole-exome sequencing as a diagnostic tool in a neonatal/pediatric intensive care unit. Journal of Clinical Medicine, 9(7), 2220. mdpi.com
- Sousa-Pinto, B., Tarrio, I., Blumenthal, K. G., Araújo, L., Azevedo, L. F., Delgado, L., & Fonseca, J. A. (2021). Accuracy of penicillin allergy diagnostic tests: a systematic review and meta-analysis. Journal of Allergy and Clinical Immunology, 147(1), 296-308. jacionline.org
- Spolidoro, G. C., Amera, Y. T., Ali, M. M., Nyassi, S., Lisik, D., Ioannidou, A., ... & Nwaru, B. I. (2023). Frequency of food allergy in Europe: an updated systematic review and meta-analysis. Allergy, 78(2), 351-368. wiley.com
- Stingeni, L., Bianchi, L., Tramontana, M., Pigatto, P. D., Patruno, C., Corazza, M., ... & Hansel, K. (2020). Skin tests in the diagnosis of adverse drug reactions: a systematic review. Giornale Italiano di Dermatologia e Venereologia. unimi.it
- Su, W. W., Reddy, V. Y., Bhasin, K., Champagne, J., Sangrigoli, R. M., Braegelmann, K. M., ... & STOP Persistent AF Investigators. (2020). Cryoballoon ablation of pulmonary veins for persistent atrial fibrillation: Results from the multicenter STOP Persistent AF trial. Heart rhythm, 17(11), 1841-1847. sciencedirect.com
- Sultész, M., Horváth, A., Molnár, D., Katona, G., Mezei, G., Hirschberg, A., & Gálffy, G. (2020). Prevalence of allergic rhinitis, related comorbidities and risk factors in schoolchildren. Allergy, Asthma & Clinical Immunology, 16, 1-11. springer.com
- Tedner, S. G., Asarnoj, A., Thulin, H., Westman, M., Konradsen, J. R., & Nilsson, C. (2022). Food allergy and hypersensitivity reactions in children and adults—A review. Journal of internal medicine, 291(3), 283-302. wiley.com
- Thorpe, M., Movérare, R., Fischer, C., Lidholm, J., Rudengren, M., & Borres, M. P. (2023). History and

utility of specific IgE cutoff levels: what is the relevance for allergy diagnosis?. The Journal of Allergy and Clinical Immunology: In Practice, 11(10), 3021-3029. [HTML]

- Tian, R., Jiang, J., Ding, J., Zhao, J., & Zhou, X. (2024). To study the impact of COVID-19 on the epidemiological characteristics of allergic rhinitis based on local big data in China. Scientific Reports. nature.com
- To, T., Zhu, J., Stieb, D., Gray, N., Fong, I., Pinault, L., ... & Dell, S. (2020). Early life exposure to air pollution and incidence of childhood asthma, allergic rhinitis and eczema. European Respiratory Journal, 55(2). ersjournals.com
- Tsabouri, S., & Atanaskovic-Markovic, M. (2021). Skin eruptions in children: Drug hypersensitivity vs viral exanthema. Pediatric Allergy and Immunology, 32(5), 824-834. [HTML]
- Turner, D., Ricciuto, A., Lewis, A., D'amico, F., Dhaliwal, J., Griffiths, A. M., ... & Dignass, A. (2021). STRIDE-II: an update on the Selecting Therapeutic Targets in Inflammatory Bowel Disease (STRIDE) Initiative of the International Organization for the Study of IBD (IOIBD): determining therapeutic goals for treat-to-target strategies in IBD. Gastroenterology, 160(5), 1570-1583. gastrojournal.org
- Turner, P. J., Arasi, S., Ballmer-Weber, B., Baseggio Conrado, A., Deschildre, A., Gerdts, J., ... & Global Allergy, Asthma European Network (GA2LEN) Food Allergy Guideline Group. (2022). Risk factors for severe reactions in food allergy: rapid evidence review with meta-analysis. Allergy, 77(9), 2634-2652. wiley.com
- Vazquez-Ortiz, M., Angier, E., Blumchen, K., Comberiati, P., Duca, B., DunnGalvin, A., ... & Roberts, G. (2020). Understanding the challenges faced by adolescents and young adults with allergic conditions: a systematic review. Allergy, 75(8), 1850-1880. aston.ac.uk
- Venter, C., Palumbo, M. P., Glueck, D. H., Sauder, K. A., O'Mahony, L., Fleischer, D. M., ... & Dabelea, D. (2022). The maternal diet index in pregnancy is associated with offspring allergic diseases: the Healthy Start study. Allergy, 77(1), 162-172. nih.gov
- Venter, C., Palumbo, M. P., Sauder, K. A., Glueck, D. H., Liu, A. H., Yang, I. V., ... & Dabelea, D. (2021). Incidence and timing of offspring asthma, wheeze, allergic rhinitis, atopic dermatitis, and food allergy and association with maternal history of asthma and allergic rhinitis. World Allergy Organization Journal, 14(3), 100526. sciencedirect.com
- Vill, K., Schwartz, O., Blaschek, A., Gläser, D., Nennstiel, U., Wirth, B., ... & Müller-Felber, W. (2021). Newborn screening for spinal muscular atrophy in Germany: clinical results after 2 years. Orphanet journal of rare diseases, 16, 1-10. springer.com
- Vogelberg, C., Klimek, L., Brüggenjürgen, B., & Jutel, M. (2022). Real-world evidence for the long-term effect of allergen immunotherapy: current status on database-derived European studies. Allergy. wiley.com
- Walter, H. J., Bukstein, O. G., Abright, A. R., Keable, H., Ramtekkar, U., Ripperger-Suhler, J., & Rockhill, C. (2020). Clinical practice guideline for the assessment and treatment of children and adolescents with anxiety disorders. Journal of the American Academy of Child & Adolescent Psychiatry, 59(10), 1107-1124. partnersforkids.org
- Wang, J., Zhou, Y., Zhang, H., Hu, L., Liu, J., Wang, L., ... & Wang, Q. (2023). Pathogenesis of allergic diseases and implications for therapeutic interventions. Signal transduction and targeted therapy, 8(1), 138. nature.com
- Warren, C. M., Jiang, J., & Gupta, R. S. (2020). Epidemiology and burden of food allergy. Current allergy and asthma reports. nih.gov
- Weisberg, S. P., Connors, T. J., Zhu, Y., Baldwin, M. R., Lin, W. H., Wontakal, S., ... & Farber, D. L. (2021). Distinct antibody responses to SARS-CoV-2 in children and adults across the COVID-19 clinical spectrum. Nature immunology, 22(1), 25-31. nature.com
- Westwell-Roper, C., To, S., Andjelic, G., Lu, C., Lin, B., Soller, L., ... & Stewart, S. E. (2022). Food-allergy-specific anxiety and distress in parents of children with food allergy: A systematic review. Pediatric Allergy and Immunology, 33(1), e13695. [HTML]
- Wollenberg, A., Werfel, T., Ring, J., Ott, H., Gieler, U., & Weidinger, S. (2023). Atopic Dermatitis in Children and Adults: Diagnosis and Treatment. Deutsches Ärzteblatt International, 120(13), 224. nih.gov
- Wood, H., Acharjee, A., Pearce, H., Quraishi, M. N., Powell, R., Rossiter, A., ... & Toldi, G. (2021). Breastfeeding promotes early neonatal regulatory T-cell expansion and immune tolerance of non-inherited maternal antigens. Allergy, 76(8), 2447-2460. wiley.com
- Xepapadaki, P., Adachi, Y., Beltrán, C. F. P., El-Sayed, Z. A., Gómez, R. M., Hossny, E., ... & Papadopoulos, N. G. (2023). Utility of biomarkers in the diagnosis and monitoring of asthmatic children. World Allergy Organization Journal, 16(1), 100727. sciencedirect.com
- Xing, Y. & Wong, G. W. K. (2021). Environmental influences and allergic diseases in the Asia-Pacific Region: what will happen in next 30 years?. Allergy. nih.gov
- Ye, Y. M. (2021). The Use of Omalizumab in Chronic Urticaria: Available Data and Future Aspects of Anti-IgE Treatment. Urticaria-Diagnosis and Management. intechopen.com

- Yonker, L. M., Neilan, A. M., Bartsch, Y., Patel, A. B., Regan, J., Arya, P., ... & Fasano, A. (2020). Pediatric severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2): clinical presentation, infectivity, and immune responses. The Journal of pediatrics, 227, 45-52. jpeds.com
- Young, S., Adamo, N., Ásgeirsdóttir, B. B., Branney, P., Beckett, M., Colley, W., ... & Woodhouse, E. (2020). Females with ADHD: An expert consensus statement taking a lifespan approach providing guidance for the identification and treatment of attention-deficit/hyperactivity disorder in girls and women. BMC psychiatry, 20, 1-27. springer.com
- Zanarini, M. C., Frankenbur, F. R., Glass, I. V., & Fitzmaurice, G. M. (2024). The 24-Year Course of Symptomatic Disorders in Patients with Borderline Personality Disorder and Personality-Disordered Comparison Subjects: Description and Prediction of Recovery From BPD. The Journal of Clinical Psychiatry, 85(3), 56325. [HTML]
- Zemelka-Wiacek, M., Agache, I., Akdis, C. A., Akdis, M., Casale, T. B., Dramburg, S., ... & Jutel, M. (2024). Hot topics in allergen immunotherapy, 2023: current status and future perspective. Allergy, 79(4), 823-842. wiley.com
- Zhang, Y., Lan, F., & Zhang, L. (2021). Advances and highlights in allergic rhinitis. Allergy. wiley.com
- Zhou, H., Wang, L., Lv, W., & Yu, H. (2024). The NLRP3 inflammasome in allergic diseases: mechanisms and therapeutic implications. Clinical and Experimental Medicine. springer.com