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Childhood Eczema Triggers: Role of Early-Life Dietary and Environmental Exposures

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Abstract | **Review Article**

Eczema is common in childhood, with a prevalence of approximately 15% in Western industrialized countries. The objective of this review study was to explore the updates of the literature towards childhood eczema triggers. To achieve this objective, the research team employed the main research engines including Science direct, Pub Med, Google Scholar, Springers, and others. This review included several topics such as biological and environmental factors leading to eczema. The cited literature showed that childhood eczema is a world-wide problem. Therapeutic options are varied among individuals. Food and environmental factors are important factors that participate in the development of eczema.

Keywords: Eczema, children, triggers, environment, diet.

1. INTRODUCTION

Eczema is common in childhood, with a prevalence of approximately 15% in Western industrialized countries (Liu *et al.,* 2022). Eczema negatively affects the quality of life of affected children and their family members (de *et al.,* 2021). Parents' worries and concerns about their child's discomfort and sleeping problems are substantial issues associated with the condition (Shi *et al.,* 2021). Furthermore, eczema is often the first step in what is later called the "atopic march" through other allergic diseases, such as food allergies, allergic rhinitis, and allergic asthma (Lopez *et al.,* 2022). Therefore, early prediction and prevention of eczema are seen as important (Bylund *et al.,* 2020).

It is well known that skin care is the main treatment for all children with eczema (Alkhatib, 2022a; Chong *et al.,* 2022). However, in the small group of children with a genuine food allergy, exclusion of the offending food(s) is important (Blakeway *et al.,* 2020). The remaining group of children have intrinsic problems with the permeability or barrier function of the skin, and therefore they develop neosensitizations to multiple environmental allergens (Grafanaki *et al.,* 2023). It is still being discussed whether allergy-preventive effects can be obtained when children avoid aeroallergens. The role of dietary and environmental factors behind all of this still needs to be clarified (Stefanovic *et al.,* 2021). Accordingly, there is an increasing focus on reducing these underlying allergies through early interventions (Narla and Silverberg, 2020). Eczema appears as a result of complex gene-environment interactions (Lowe *et al.,* 2023). Spontaneous improvement of eczema has been shown up to age 3; however, the majority continues to have relapses and develop other allergic diseases (Gallay *et al.,* 2020). One potential explanation for this may be late diagnosis and lack of awareness regarding the role of so-called "classic" allergies, for example, early food allergies and aero allergies in combinations (Casella *et al.,* 2024).

1.1. Overview of Childhood Eczema

Overview Childhood eczema can have profound effects on children (Gallay *et al.,* 2020). This common and long-lasting chronic skin condition is characterized by its unique dry, red, and itchy skin that can become sore and broken when scratched, also known as active eczema (Liu *et al.,* 2022). During flare-ups of active eczema, children can feel very unwell, have disturbed sleep, and experience intense itchiness (Alkhatib, 2022b; Langan *et al.,* 2023). These sensations can make it difficult to concentrate at school or play and interact with peers (García-Marcos *et al.,* 2022). Although the itchiness may lead to children scratching their skin, young children may not always be able to convey that they are experiencing itchiness and instead express discomfort or crying, which may be distressing to their families (Dastoorpoor *et al.,* 2022). Eczema is an umbrella term that encompasses a diverse range of skin conditions characterized by inflammation and itching. The most common form of eczema is atopic dermatitis (AD), which is an allergic form of eczema (Sun *et al.,*

2022). The symptoms of AD can vary from small localized patches of dry, itchy skin to much more widespread areas of skin differences (Sun *et al.,* 2022). Some children will have a history of being born with dry, itchy skin and go on to develop subsequent episodes of active eczema (Lopez *et al.,* 2022). Once the active episode has resolved, children have periods where their skin settles and looks normal clinically, known as "inactive eczema." Children are likely to transition in and out of active and inactive eczema (Rutter *et al.,* 2020). It is estimated that one in five children worldwide are affected by eczema, though this prevalence may be higher in some populations (Long *et al.,* 2022). Active and confined eczema in children can have a negative impact on their social and psychological well-being, particularly as it distorts their body image and may make them feel conscious about the way they present to their peers (Yazar and Meydanlioglu, 2022). Children with eczema may feel different from others, leading to stigmatization (Yazar and Meydanlioglu, 2022). In addition, families of children with eczema describe a sense of frustration and guilt around not being able to protect their children from the burden of a chronic, visible skin condition (Yazar and Meydanlioglu, 2022). The worldwide proportion of children with eczema has also been increasing (Mortimer *et al.,* 2022). Repeated surveys have shown that over a 2-to-3-year period, the reported cumulative prevalence of eczema in young children has been increasing. These findings are significant due to the potential to identify the causal factor behind this rise (Mortimer *et al.,* 2022). To explore the potential causes of childhood eczema and develop opportunities for prevention, we begin by discussing the triggers of confining eczema to childhood (Liu *et al.,* 2022). In the United Kingdom, one in five children under 11 years of age have eczema (Liu *et al.,* 2022). Rates of eczema vary according to demographics such as age, gender, and geographic location. Generally, in children, the risk of developing eczema decreases with age (Liu *et al.,* 2022). Before puberty, boys have a higher risk of eczema than girls, but afterward, girls are more likely to develop eczema (Langan *et al.,* 2023). No trends have been reported on ethnicity and the development of eczema, although hereditary factors can increase the susceptibility of developing eczema. While some children grow out of their eczematic skin, approximately half will continue to have some symptoms of eczema as adults (García-Marcos *et al.,* 2022). Eczema can also present in adults who did not have active eczema in their younger years (Dastoorpoor *et al.,* 2022).

2. Understanding Eczema Triggers

Eczema behaves differently in each child, and it is critical for its proper management to understand the triggers that provoke the disease and make it worse (Narla and Silverberg, 2020). Eczema triggers can be broadly categorized into diet and environment (Luger *et al.,* 2021). Both play a significant role in the development of eczema and contribute to the exacerbation of the disease (Chai *et al.,* 2023). Eczema is typically not caused by one factor; it results from individual susceptibility to several factors, which may be due to a child's genetic background (Celebi *et al.,* 2022). Some children are more susceptible to dietary factors, and others are more susceptible to environmental factors (Akdis, 2021). Genetic susceptibilities can influence the ability of an individual to repair a damaged skin barrier, tolerate certain foods, and develop a tolerant immune response when their body comes in contact with environmental allergens (Wang *et al.,* 2024). Infectious or non-infectious mechanisms or abnormal skin colonization can further compromise the skin barrier and worsen eczema (Passeron *et al.,* 2020; Alkhatib, 2022c; Thyssen *et al.,* 2022).

There is an interaction between genetic predisposition and environmental exposures that children undergo from early life, through birth, and during development, which can influence the progression of atopic eczema (Hartmane, 2024). The eczema flares vary with the severity and chronicity of the disease (Hartmane, 2024). Mild-to-moderate eczema is characterized by random flare-ups without any specific triggers (Stefanovic *et al.,* 2021). Severe and chronic eczema, on the other hand, is usually a reflection of multi-factorial triggers, which can be diet, environment, irritants, or infections. Skin prick testing and blood testing can be supportive in identifying the triggers (Chong *et al.,* 2022). Eczema signs usually present within minutes, with eczema rash flaring in one-third to half of children after one to four hours from an exposed time (Chong *et al.,* 2022). Overall, understanding dietary and environmental factors that provoke eczema is important for the parents or carers, so they can better manage the child's dietary choices, food allergen elimination, and environmental alterations with the help of healthcare providers to prevent eczema exacerbation (Mu and Zhang, 2020; Grafanaki *et al.,* 2023).

It is important to understand if the child's eczema flares in relation to certain lifestyle activities, and this is generally a guide to identifying triggers such as particular foods or environments (Rance and Hatch, 2024). The history of the child's symptoms can be supportive for the parents or carers in identifying triggers (Zohn, 2020). For example, do the child's eczema symptoms persist after eating certain foods or going to certain places? Is there a history of eczema in the family, which can contribute to the likelihood of a particular food allergen or eczema worsening from other factors (Wollenberg *et al.,* 2020; Chua *et al.,* 2023).

2.1. Biological Mechanisms of Eczema Development

Eczema is a chronic inflammatory skin disease that begins early in life in over 80% of individuals affected (Agner and Elsner, 2020). Eczema patients show a barrier defect in their skin due to aberrant differentiation of the skin barrier microenvironment, leading to a predisposition to dry and itchy skin (Alkhatib, 2022d; Thyssen *et al.,* 2022). Characteristics

of the disease include superinfections, which occur due to increased susceptibility to irritants and allergens (Schonmann *et al.,* 2020). An elevated level of IgE in the blood is often detected, with a positive response rate to various environmental allergens (Traidl *et al.,* 2021). An enhanced expression of type 2 cytokines is observed in inflamed eczematous skin, with a further increase after allergen challenge (Ziyab *et al.,* 2022). Immediate and late-phase inflammatory skin responses are indicators for the induction of sensitization and allergic skin inflammation and are often used to diagnose allergic diseases (Wollenberg *et al.,* 2020; Quaade *et al.*,2021; Long *et al.,* 2022).

Patients with atopic dermatitis and individuals with broken skin, also suffering from an unrecognized subclinical form of the disease, show a Th-2 skewed immune deviation, a characteristic trait (Shin *et al.,* 2020). It is thought that allergens, as well as some irritants, can induce Th2 immunity by interacting directly with cells of the innate immune system (Jacquet, 2021). In particular, allergens derived from house dust mites and fungi are especially potent in innately activating and polarizing dendritic cells (Soleha and Iswanti, 2021). It is possible that a prolonged and diverse interaction of environmental factors with the immune system, all converging on the same pathway, ultimately leads to the resulting outcome of a clinically overt disease also influenced by genetic susceptibility (Lamiable *et al.,* 2020). Emerging research findings also stress the role of the microbiome, which has a profound influence on our health, including skin health and the development or prevention of childhood eczema (Yasuda *et al.,* 2020). Intestinal and cutaneous microbiota interact in various manifestations with the skin immune function (Yasuda *et al.,* 2020). Multiple dysfunctional signaling and regulatory pathways contribute to the development and pathogenesis of atopic dermatitis and also dictate the disease course and the development of comorbidities (Benedé *et al.,* 2021). Skin allergy/eczema is a combination of various factors, including altered barrier function, cytokine patterns, the immune system, genetics, and environmental factors (Sarwar, 2020). This interdisciplinary field is revolutionizing our understanding and treatment of this complex condition and generating potential preventive strategies (Lin *et al.,* 2022).

3. Early-Life Dietary Exposures

Diet is thought to play a significant role in the development of childhood eczema (Das and Panda, 2021). This section will provide a focused exploration of several important questions with a biomedical emphasis. Can early-life dietary exposures influence the development of childhood eczema? If yes, through what mechanisms? While solid food allergen exposures are the most widely studied dietary determinants of childhood eczema, the role of maternal diet and breast milk remains of interest (Trikamjee *et al.,* 2021; Rustad *et al.,* 2022)

In general, greater early-life exposure to food leads to a reduced eczema risk (Zhang *et al.,* 2023). Several trials have observed a lower rate of peanut allergy among high-risk infants who first ate peanuts between 4 and 11 months of age compared with older children who avoided eating peanuts (Zeng *et al.,* 2023). The enzyme content of foods may also be relevant. For example, higher egg white ovomucoid content early in life is associated with a lower eczema risk (Pierau *et al.,* 2021). A common risk factor appears to be allergic sensitization to the triggering food (Renz and Skevaki, 2021). There may also be a dose effect, with eczema more likely when higher levels of peanut- or milk-specific IgE are acquired (Kampouri *et al.,* 2023).

In summary, there is some evidence to support a recommendation of slow introduction of solids in the first year to reduce pre-filaggrin mutations eczema risk (D'Hollander *et al.,* 2023). Nonetheless, early advice on solid food introduction and later dietary manipulation to prevent child eczema is complex (Hicke-Roberts *et al.,* 2020). We are all unique, and different infants have different dietary requirements (Rance and Hatch, 2024). Treatment in one person does not always mean treatment in another (Royal and Gray, 2020). Many diverse factors contribute to the development of eczema. Among them, dietary manipulations appear safe for most people (Williams and Chalmers, 2020). However, controlled trials have admitted that dietary management reported by dieticians is no better than usual care for childhood eczema (Trogen *et al.,* 2022). Given the evidence from the trials, having a varied diet should be encouraged (Abrams *et al.,* 2022). Practical questions about the first-time introduction of solid foods are answered in a scientific commitment titled 'Guidance: an integrated approach to infant feeding' (Venter *et al.,* 2023).

3.1. Impact of Breastfeeding

The protective role of breastfeeding against the development of eczema during early life has been documented in a number of systematic reviews and birth cohorts over the last two decades (Peters *et al.,* 2021). In general, exclusive breastfeeding for at least 3 to 4 months has been associated with a lower risk of developing eczema (Libuda *et al.,* 2023). This association may primarily be due to the nutritional composition of breast milk, which boosts the overall infant immune response and reduces allergen sensitization (Lin *et al.,* 2020). In addition, breast milk is reported to be a rich source of essential antibodies, especially immunoglobulin, immune cells, cytokines, and immune-regulating factors, which regulate immune pathways and can confer passive immune protection of the gut, lung, and skin of the infant (El-Heis *et al.,* 2022).

Breastfeeding has been reported to shape the development and composition of the gut microbiome via various prebiotic and probiotic factors (Alotiby, 2023). The infant's gut microbiota composition can also impact the metabolome and lipidomic profile (Sancaklı *et al.,*

2023). Given that a range of nutritional components of breast milk affects the development of the infant's immune system and the composition of the infant's gut microbiome, breast milk has also been implicated as a protective factor for preventing the development of eczema (Trikamjee *et al.,* 2021). The protective effect of breastfeeding on infant eczema can also be attributed to the overall growth and development patterns typically observed in breastfed infants, manifesting through lower prevalence of metabolically related diseases later in life, such as obesity and atopic conditions, including food allergy and eczema (Marras *et al.,* 2021). Variation in the exclusive breastfeeding effects on the incidence of eczema may occur between studies or in different countries due to local breastfeeding durations, compliance with guidelines, and rates of maternal employment, as well as cultural and geographical differences related to the clinical diagnosis of eczema (Dias *et al.,* 2022). A range of socioeconomic disparities, such as maternal age and parity, and maternal health factors including atopy, smoking during pregnancy, and diet and smoking behaviors of the infant's household are other factors that may influence the exclusive breastfeeding duration (Sun *et al.,* 2022).

Recently, health guidelines and recommendations have been proposed to encourage the continuation of breastfeeding and complementary feeding or the introduction of allergenic or commonly allergenic foods in the first year, especially in the first four months, for the prevention of eczema, food allergy, and asthma (Fleischer *et al.,* 2021). However, both for guidelines targeting food allergy and for those targeting eczema, it has been emphasized that an informed choice is important in making feeding decisions (Zhang *et al.,* 2023). There is no current method that can ultimately guarantee the prevention of eczema or food allergy (Lu *et al.,* 2023). In addition, the accumulated evidence of the protective effects of earlier allergenic food exposure in the first months of life has been inconsistent, and evidence from studies is limited at present (Taniguchi and Kobayashi, 2023). Variations in public recommendations across countries have resulted in conflicting consumer information (Zeng *et al.,* 2023). Thus, the development of global guidelines to prevent various allergic diseases, including eczema, is needed (Lv *et al.,* 2024). The international longitudinal birth cohorts and other studies provide a good opportunity to investigate the complex effects of a variety of maternal and infant food avoidance and exposure strategies undertaken in the first year on the development of infant eczema and other allergic diseases (Chen *et al.,* 2024).

4. Environmental Exposures

Dust mites, pet dander, and certain outdoor pollens have also been repeatedly shown to trigger eczema (Morsy *et al.,* 2021). The recommended treatment for children and adults with eczema includes reducing indoor dust mites, pet dander, and installing a pollen filter (Tripathi and Platts-Mills, 2021). Certain irritants, like cleaning agents, especially laundry detergents that come in contact with the skin, can cause skin eruptions (Strzelczyk *et al.,* 2020). The reduction in humidity that occurs during winter in some regions can drive worsening eczema (Wu *et al.,* 2021). In those with skin barrier problems, changes in humidity can increase water loss from the skin and cause localized dryness and eczema (Sparkes, 2022). Various weather variables, such as cold, humidity, and level of sunshine on the previous day, may be modifying the skin surface barrier function in some of these children (Widorn *et al.,* 2024).

Although there is a genetic tendency for some to develop eczema, it is becoming increasingly evident that the environmental factors that trigger eczema are having an effect on the population of children genetically predisposed to developing eczema (Gallay *et al.,* 2020). Given the importance of avoiding triggers and treating eczema, strategies have been recommended, for example, to minimize house dust mites in the environment, reducing key exposure, which has also been shown to improve eczema (Chong *et al.,* 2022). Tips for reducing exposure in the home include developing a bedroom strategy, such as using dust mite covers on pillows and mattresses where the child sleeps, not having carpets, and reducing the amount of soft furnishings (Hartmane, 2024). In conclusion, this highlights the importance of the nursing role in establishing eczema-based services, including continuing the work of educating and raising awareness of the impact of environmental factors among children and families as part of a multidisciplinary team (Lopez *et al.,* 2022).

4.1. Role of Allergens

Allergic sensitization and allergen triggers represent a major subset of environmental factors affecting children's eczema (Annesi-Maesano *et al.,* 2023). Pollens, pet dander, and molds are common allergens that young children with atopic dermatitis are exposed to and have been found to significantly impact their symptoms (Jung *et al.,* 2024). Allergenic pollen exposure has been shown to directly correlate with atopic dermatitis severity (Pan *et al.,* 2023). A cohort of young children with eczema found that being sensitized to foods usually occurs following aeroallergen sensitization and precedes the development of respiratory allergy (Widorn *et al.,* 2024). Immunologically, allergic sensitization to aeroallergens leads to the activation of the release of Th2 cytokines including IL-4, IL-5, and IL-13, which ultimately leads to the production of IgE antibodies by B cells (Mazur *et al.,* 2023). IgE-mediated recognition of the sensitized environmental allergen then leads to the activation of mast cells and subsequent immediate and/or late-phase allergic cutaneous inflammation in the skin. The production of IgE antibodies correlates with increased disease severity and earlier age of onset (Casella *et al.,* 2024)

The impact of the type and dose of allergen exposure and the frequency and duration of allergen exposure is also important in determining disease severity and chronicity (Ogulur *et al.,* 2021). Allergen avoidance can be beneficial, but as most of these allergens are present ubiquitously, clearing from these allergens may need to happen on a constant basis (Shamji *et al.,* 2021). Allergies are diagnosed using a skin lesion of a single allergen or a panel of allergens to identify allergens that provoke a red, raised, itchy lump and other signs of an allergy (Hinks *et al.,* 2021). Common practices to manage eczema include limiting contact with the substances known to cause sensitization, making changes in the home, such as removing carpets, getting rid of stuffed animals, and using mite-proof covers in bedding (Fiocchi *et al.,* 2021). Steered baths daily and the use of hypoallergenic soap can help to reduce pet allergens (Hesse *et al.,* 2022). Some over-the-counter eczema medications are designed to improve the damaged barrier of the skin and provide skin rehydration (Sampath *et al.,* 2021). Professional guidance and support must be in place, if possible, before attempting to undergo a home approach (Brough *et al.,* 2022).

5. CONCLUSION AND FUTURE DIRECTIONS

In conclusion, increased understanding of dietary and environmental triggers of eczema has the potential to contribute to the development of novel prevention strategies for the 'at-risk' population. Future studies are needed to replicate findings and reveal how these triggers truly contribute to the prevalence of eczema in children (Narla and Silverberg, 2020). Our findings stress the importance of considering the intricate interplay of dietary and environmental exposures for examining trigger mechanisms of eczema (Stefanovic *et al.,* 2021). Prevention strategies, including tailored programs, should be designed and implemented for pregnant women and infants in whom a heightened risk of eczema could be expected (Chan *et al.,* 2020). A step towards this is to elucidate the effect of personalized approaches (Chu *et al.,* 2024).

Depending on the individual exposure patterns in these profiles, tailored prevention strategies could be defined, initiated, and evaluated (Narla and Silverberg, 2020). This should be designed to reduce the risk of childhood eczema and other allergic diseases by altering an individual's treatment and/or an individual's exposure with a tailor-made prevention strategy (Grafanaki *et al.,* 2023). Interdisciplinary collaboration remains important in the design of such studies (Stefanovic *et al.,* 2021). Additionally, we stress the need for studies to contribute to the design of education programs for parents and primary care professionals (Stefanovic *et al.,* 2020). This should, in the first place, lead to an increased awareness of parents and professionals about the potential relationship between dietary and environmental exposures and eczema onset and even exacerbation, and should further provide tools for the primary prevention of childhood eczema (Lu *et al.,* 2021).

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