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Распространённость и факторы риска пищевой аллергии у детей: обзор эпидемиологических исследований

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АННОТАЦИЯ

Обоснование. Пищевая аллергия — актуальная проблема педиатрической практики. В последние десятилетия отмечены рост распространённости и увеличение числа тяжёлых случаев пищевой аллергии.

Цель — оценить распространённость пищевой аллергии, а также изучить роль наследственных и внешнесредовых факторов в развитии пищевой аллергии у детей по данным эпидемиологических когортных и одномоментных исследований.

Материалы и методы. Проведён систематический обзор эпидемиологических когортных и одномоментных исследований по изучению факторов развития и распространённости пищевой аллергии, опубликованных в период с 1 января 2000 г. по 31 декабря 2021 г.

Результаты. Обзор позволил обобщить и систематизировать накопленные общемировые научные данные о пищевой аллергии. Анализ эпидемиологических исследований продемонстрировал значительную распространённость пищевой аллергии и отразил закономерности её естественного течения: наиболее высокие показатели отмечены среди детей раннего возраста, а к школьному возрасту распространённость симптомов и подтверждённой пищевой аллергии постепенно снижается. На основании эпидемиологических данных основными факторами риска пищевой аллергии являются наследственная предрасположенность и внешнесредовые факторы, модифицирующие микробное окружение.

Заключение. Необходимы дальнейшие исследования генетических маркеров пищевой аллергии и изучение роли микробиотических факторов в реализации наследственной предрасположенности к аллергическим заболеваниям.

Ключевые слова: пищевая аллергия; распространённость; факторы риска; дети.

Как цитировать

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Prevalence and risk factors for food allergy in children: a review of epidemiological studies

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ABSTRACT

BACKGROUND: Food allergy is an actual problem in pediatric practice. In recent decades, there has been an increase in the prevalence of food allergies, as well as an increase in the number of severe cases.

AIM: To assess the prevalence of food allergy and the role of hereditary and environmental factors in food allergy development in children according to epidemiological cohorts and cross-sectional studies.

MATERIALS AND METHODS: A systematic review of epidemiological cohorts and cross-sectional studies published between January 1, 2000 and December 31, 2021, was conducted This review investigated the developmental factors and prevalence of food allergy.

RESULTS: This review made it possible to generalize and systematize the accumulated worldwide scientific data on food allergy. An analysis of epidemiological studies revealed a significant prevalence of food allergy, which reflected the natural course of the disease; the highest rates were found among young children, and by school age, the prevalence of symptoms and confirmed food allergy is gradually decreasing. Based on epidemiological data, the main risk factors for food allergy are hereditary predisposition and environmental factors that modify the microbial environment.

CONCLUSION: It is necessary to further study the genetic markers of food allergy, as well as the role of microbiotic factors in the implementation of hereditary predisposition to allergic diseases.

Keywords: food allergy; prevalence; risk factors; children.

To cite this article

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BACKGROUND

Food allergy (FA) is one of the main public health problems, which is associated with the prevalence of this pathology, high risk of developing anaphylactic reactions in addition to FA, and a decrease in patients' quality of life in general [1]. According to a number of studies, FA prevalence is growing rapidly, approaching 6.5% (5% of adults and 8% of children) of the general population [2]. Economic damage due to this pathology exceeds 25 billion dollars per year, which is a significant problem for the society [1, 3, 4]. The development of allergic diseases and FA in particular is determined by hereditary predisposition, which is realized in the process of ontogenesis under the influence of several trigger factors [2, 5, 6]. Food allergen sensitization is formed in the first months of a child's life through the interaction of food antigen proteins with the intestinal lymphoid system [7]. Generally, FA represents the debut of atopic march with subsequent development of diseases including atopic dermatitis, bronchial asthma, and allergic rhinitis in later years [2, 5]. To understand the patterns of FA development, which is a milestone in the development of allergic diseases, and to explore the current scientific trends in this area, an objective assessment of this pathology's prevalence and an analysis of the factors associated with its development are necessary.

OBJECTIVES AND ALGORITHMS OF THE REVIEW

This review aims to assess the prevalence of FA and to study the role of hereditary and environmental factors in FA development in children according to epidemiological cohort and cross-sectional studies.

Data sources

An analysis of scientific publications presenting the results of epidemiological cohort and cross-sectional studies aimed at investigating FA prevalence, as well as the factors influencing its occurrence, was performed. The research was conducted using database search engines PubMed and eLibrary. The review presents original articles published from January 1, 2000, to December 31, 2021.

The analysis was performed according to the following algorithm:

Stage 1. Publications on the study of FA prevalence and factors influencing its occurrence in children were initially searched. Keywords used for the search include "children's cohort study," "food allergy," "children's cross-sectional study," and "prevalence of food allergy." At this stage, 2,462 articles were obtained, selected during the initial search using keywords and titles (Fig. 1).

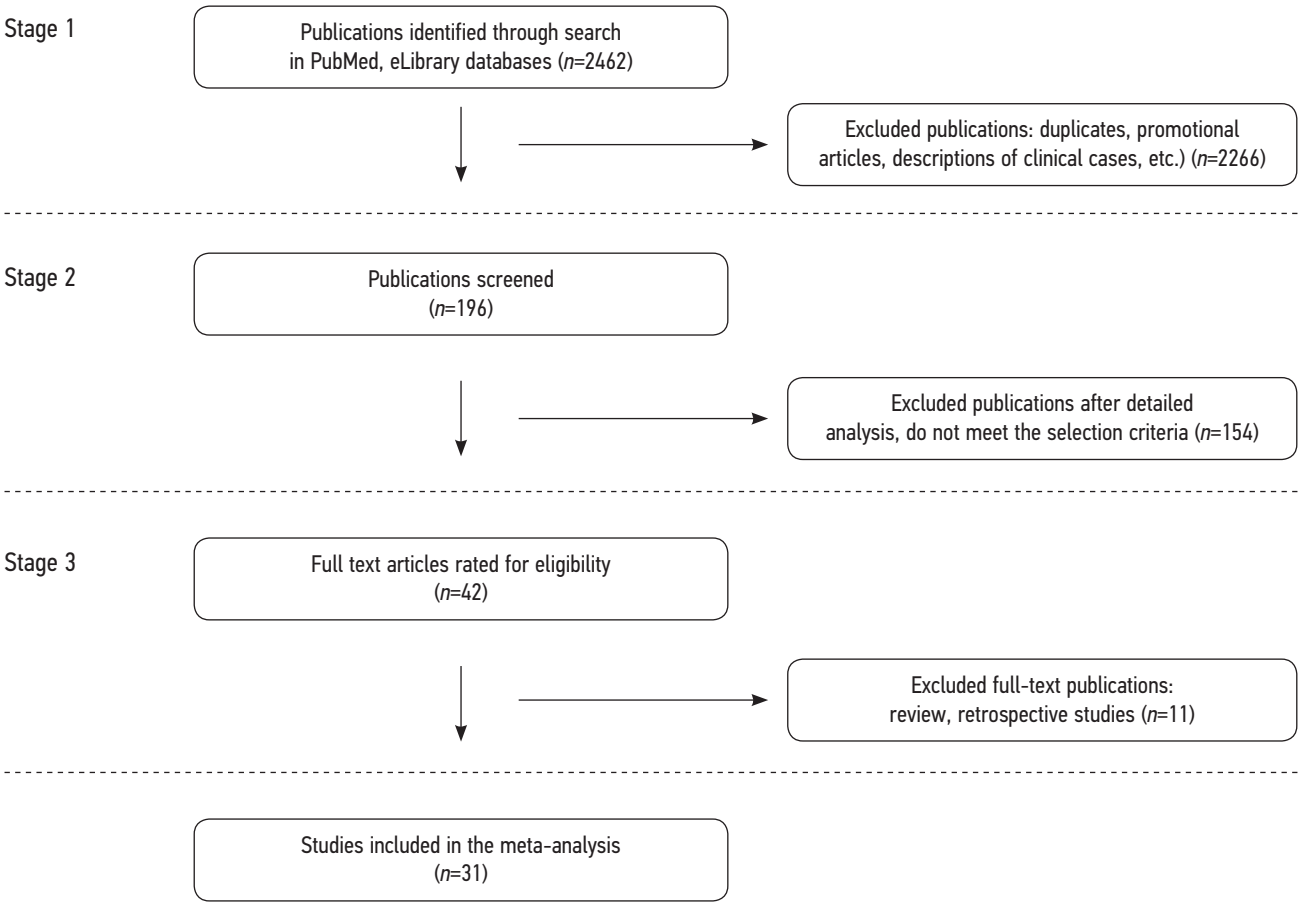

Fig. Database search algorithm.

Stage 2. Abstracts of publications obtained during the initial search were analyzed, and 2,266 papers that did not contain data on FA prevalence and/or factors of its development, as well as review articles, were excluded from the review. During the second stage, 196 publications were selected for further analysis.

Stage 3. The authors conducted a detailed analysis of the full text of 196 publications after removing duplicates. Review publications, retrospective studies, comparative clinical studies, etc., were excluded at this stage.

Based on the results of the third stage, 31 publications with data on 15 cohort and 16 cross-sectional epidemiological studies were selected for review preparation. The mandatory criteria for inclusion of articles in the final analysis included availability of the full text version of the article; comprehensiveness of the study design, including sample characteristics, selection criteria, and age of participants; and methods of FA diagnostics. Firstly, data availability on the prevalence of FA symptoms and/or the prevalence of FA, confirmed by allergological examination (skin allergy testing and assessment of specific IgE in blood serum), had been assessed in the articles. Selected studies evaluated the available data on the influence of hereditary and various environmental factors (antibiotics use, smoking, socioeconomic status, living conditions, etc.) that affect FA development (see figure).

PREVALENCE OF FOOD ALLERGY

This review presents an analysis of the epidemiological studies' results (*n*=31), including cohort prospective and cross-sectional studies conducted in the 1989–2018 period. In the course of these studies, children were monitored from birth or from the age of the first clinical manifestations. In prospective cohort studies, follow-up ranged from 6 months to 6 years. Cross-sectional studies were performed in different age groups [8, 9]. The review includes four studies performed in Russia within the limits of cross-sectional epidemiological projects (Tables 1, 2). The largest cohorts were observed in the EuroPrevall study, which sample size exceeded 30,000 children [20] (see Tables 1, 2).

The presence of allergic sensitization in children (the level of specific IgE, positive skin prick tests with most common food allergens) combined with clinical manifestations of FA was used as an FA diagnostic criteria. In some papers, authors studied only the prevalence of FA symptoms based on interview results. Noting that authors primarily assessed sensitization to food allergens of the "big eight," which has the greatest clinical significance, is important. However, due to traditional food preferences in different countries, significant geographical differences were observed in the prevalence of food allergens, such as, for example, allergies to peanuts or tropical fruits and seafood [39–41].

According to the conducted study, the prevalence of FA symptoms varies significantly depending on the age of patients and evaluation criteria. Before the age of 2–3 years, food-related symptoms occur in more than 1/3 of children [11, 12, 23, 37]. Significantly, the development of reactions within 2–4 hours after eating food is recorded much less frequently: most commonly, approximately in 5% of subjects or less (see Tables 1, 2) [25, 31].

A number of studies have revealed a regular decrease in FA symptoms during the first six years of a child's life [6, 37]. In a United States study (*n*=1387), the prevalence of FA symptoms in children in a continuous sample during the first 4 months was 36.2%; by 12 months, it was 24.8% [11]. However, persistent symptoms of FA from birth to the age of 6 years were detected only in 3.7% of children from the total cohort [11].

Data on the prevalence of IgE-mediated allergies also vary significantly depending on the age of children and the region of residence. To confirm the presence of IgE-mediated sensitization to food allergens, using skin prick tests with food allergens and determining the level of specific IgE in blood serum by enzyme immunoassay (ELISA) are currently recommended [42–44]. It is important to note that FA prevalence rates peak during the first 2 years of life and then decline as tolerance to certain foods develops [14, 16, 17, 34]. In a number of studies, authors estimated the FA prevalence in children from birth up to 3 years of age [15, 18, 27, 45]. At the age of 1–2 years, confirmed FA varies within 13%–18% [14, 15]. In a study in Korea (*n*=16,749), according to the results of observation, FA in the first year of life was 15.1% with a further decrease by 6 years of age to 3.3%, which is associated with the development of food tolerance [25]. With age, the indicators decrease, and according to study results, by the age of 3–4 years, FA is detected in 3%–7% of the examined children [12, 14, 16, 17, 22, 34]. A study in Taiwan (*n*=186) showed that FA, confirmed by skin prick tests and assessment of specific IgE level, was registered in more than 1/3 of cases by the age of 4 years. The lowest prevalence (<2%) in this age group was found in studies in South Africa and Finland (see Tables 1, 2) [9, 34, 32].

For school age children, the highest prevalence was shown in an Australian study [28]; the lowest is in Russia (according to the results of two studies, it barely exceeds 1%) (see Tables 1, 2) [35, 38].

In nondomestic clinical practice, the gold standard for FA diagnostics is a double-blind placebo-controlled test. Notably, this diagnostic method is used infrequently, which is primarily due to the complexity of performing this type of diagnostics and the risk of adverse reactions [46, 47]. This review includes three studies performed using this method [19, 21, 30]. According to obtained results, FA prevalence rates also vary depending on age: The highest rates were registered among children under 5 years of age (see Tables 1, 2). It is significant that only in 1/3 of children with sensitization (according to IgE assessment), FA was confirmed (according to placebo-controlled tests) [19]. The lowest prevalence of FA was registered by the age of 15 years in a Turkish study (*n*=10,096) [30].

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Table 1. Prevalence of food allergy and its development factors according to cohort prospective research (*n*=15)

Author, year of publication	Country, year of study	Sample size, age	Food allergy diagnostic criteria*	Allergens	Prevalence rate**	Food allergy development factors***
Joseph et al., 2016 [10]	USA, 2003–2009	*n*=590 0–6 years	EIA sIgE (IgE >0,35 kU/l) SPT (>3 mm) Interview	Peanut CMP Chicken egg	8,8%	African population (OR 1,80; 95% CI 1,22–2,65; *p*=0,003)
Mathias et al., 2019 [11]	USA, 2005–2012	*n*=1387 0–6 years	Interview	CMP Wheat	23,6% — symptoms	Mixed feeding (OR 1,54; 95% CI 1,04–2,29) Formula feeding (OR 1,34; 95% CI 0,89–2,02) Prenatal smoking of the mother (OR 2,97; 95% CI 1,53–5,79)
Simons et al., 2019 [12]	Canada, 2008–2012	*n*=2669 0–3 years	Interview SPT (>3 mm)	Peanut CMP Chicken egg	7,1%	Introduction of peanuts after 12 months (OR 2,38; 95% CI 1,39–4,07)
Gao et al., 2019 [13]	China, 2015	*n*=976 0–1 year	Interview	Chicken egg	22,1% — symptoms	Positive family history of allergies (OR 2,45; 95% CI 1,75–3,42) Seafood intake during pregnancy (OR 1,73; 95% CI 1,12–2,67) Antibiotics use during pregnancy (OR 1,76; 95% CI 1,12–2,76)
Chiu et al., 2020 [14]	Taiwan, 2007–2011	*n*=186 0–4 years	EIA sIgE (IgE >0,35 kU/l) Interview (ISAAC questionnaire)	Chicken egg CMP	13,4%	-
Hua et al., 2017 [15]	Taiwan, 2012–2014	*n*=272 0–1 year	EIA sIgE (IgE >0,35 kU/l) Interview	Peanut Egg yolk CMP Fish	13,6%	Avoidance of egg white and egg yolk (OR 1,41; 95% CI 1,11–1,79; *p*=0,002)
Jonsson et al., 2017 [16]	Sweden, 2005–2008	*n*=65 0–3 years	EIA sIgE (IgE >0,35 kU/l) Interview	Seafood Fish	3%	Formula feeding (OR 1,32; 95% CI 1,13–1,68; *p*=0,002)
Tham et al., 2018 [17]	Singapore, 2009–2013	*n*=1152 0–1 years	EIA sIgE (IgE >0,35 kU/l) Interview (ISAAC questionnaire) SPT (>3 mm)	Seafood Chicken egg Hazelnut	2,9%	Use of corticosteroids at the age of 3, 6, and 12 months ↑ the risk of FA at the age of 12 months Formula feeding (OR 28,96; 95% CI 7,84–10,7; *p* <0,001)

Table 1. Ending

Author, year of publication	Country, year of study	Sample size, age	Food allergy diagnostic criteria*	Allergens	Prevalence rate**	Food allergy development factors***
Nwaru et al., 2011 [18]	Finland, 1994–1999	*n*=1018 0–5 years	EIA sIgE (IgE >0,35 kU/l) Interview (ISAAC questionnaire)	Chicken egg Wheat Fish CMP	1,8%	Intake of oils and unsaturated fatty acids during lactation (OR 3,69; 95% CI 1,51–9,02; *p* <0,01)
Doğruel et al., 2016 [19]	Turkey, 2010–2015	*n*=1377 0–5 years	Interview SPT (>3 mm) Double-blind placebo-controlled trial	Chicken egg white Soy Fish Wheat Peanut	2,4%	Male (OR 1,7; 95% CI 0,9–3,7; *p* <0,01)
Schoemaker et al., 2015 [20]	Germany, Poland, Spain, Italy, Greece, Netherlands, 2005–2009	*n*=12 049 0–2 years	EIA sIgE (IgE >0,35 kU/l) Interview	CMP	1%	-
Clausen et al., 2018 [21]	Island, 2005–2008	*n*=1341 0–2,5 years	EIA sIgE (IgE >0,35 kU/l) Interview Double-blind placebo-controlled trial	Chicken egg Nuts Fish CMP	3,3%	Vitamin D intake during pregnancy and the first year of life (OR 0,51; 95% CI 0,32–0,82)
Venkataraman et al., 2018 [8]	Isle of Wight (England) 1989–2007	*n*=1456 0–18 years	EIA sIgE (IgE >0,35 kU/l) SPT (>3 mm) Interview	Wheat Seafood Peanut CMP	At 12 months — 5,3% At 4 years — 5% At 18 years — 4%	-
Venter et al., 2021 [22]	USA, 2009–2014	*n*=1410 0–5 years	Interview (ISAAC questionnaire)	CMP	2,46% — symptoms at 2 years 1,3% — symptoms at 5 years	Maternal smoking during pregnancy (OR 1,63; 95% CI 1,08–2,46) First child (OR 1,50; 95% CI 1,14–1,97)
Treneva, 2014 [23]	Russia	*n*=355 2 years	Interview	-	45,7% — symptoms in children at 1 years 36,9% — symptoms in children at 2 years	-

Note: Here and in Table. 2:
* Diagnostic methods: EIA, Enzyme Immunoassay; SPT, skin prick test; sIgE, specific immunoglobulin E; ISAAC questionnaire (International Study of Asthma and Allergy in Childhood).
** Prevalence of symptoms and confirmed food allergy.
*** Medical statistics indexes: OR (odds ratio); 95% CI (confidence interval), 95%; *p*, significance level
FA, food allergy; CMP, cow's milk protein.

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Table 2. Prevalence of food allergy and factors of its development according to cross-sectional studies (*n*=16)

Author, year of publication	Country, year of study	Sample size, age	Food allergy diagnostic criteria*	Allergens	Prevalence rate**	Food allergy development factors***
Ziyab et al., 2019 [24]	Kuwait, 2016–2018	*n*=3738 11–14 years	Interview (ISAAC questionnaire)	-	4,1%	Female (OR 1,44; 95% CI 1,04–1,99) Weight deficit (OR 2,13; 95% CI 1,16–3,93) Obesity (OR 1,93; 95% CI 1,28–2,90) Delivery by cesarean section (OR 1,42; 95% CI 1,05–2,16) Contact with pets in infancy (OR 3,33; 95% CI 1,92–5,79) FA in parents (OR 2,75; 95% CI 2,01–3,76)
Gupta et al., 2018 [9]	USA, 2015–2016	*n*=38 408 0–18 years	Interview EIA sIgE (IgE >0,35 kU/l) SPT (>3 mm)	Nuts Seafood Fish Soy Wheat Peanut	7,6%	-
Park et al., 2014 [25]	Korea, 2011	*n*=16 749 0–6 years	Interview	Chicken egg CMP Nuts	3,3% — symptoms	-
Wang et al., 2018 [26]	Mongolia, China, 2015	*n*=4441 1–2 years	Interview (≥1 symptom of FA in the last year)	Seafood Chicken egg Mango Peach CMP	18% — symptoms	Higher education (OR 1,45; 95% CI 1,56–2,0) Urban lifestyle (OR 1,58; 95% CI 1,222–2,051) High family income (OR 1,3; 95% CI 1,34–2,97) Positive family history of allergies (OR 2,24; 95% CI 1,917–2,626)

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Table 2. Continuation

Author, year of publication	Country, year of study	Sample size, age	Food allergy diagnostic criteria*	Allergens	Prevalence rate**	Food allergy development factors***
Sha et al., 2019 [27]	China, 2010	*n*=13 073 0–14 years	Interview EIA sIgE (IgE >0,35 kU/l) SPT (>3 mm)	Egg CMP	3,2%	Male (OR 1,56; 95% CI 1,5–2,34)
Sasaki et al., 2018 [28]	Australia, 2011–2014	*n*=9815 10–14 years	Interview EIA sIgE (IgE >0,35 kU/l) SPT (>3 mm)	Nuts Peanut Fruits (kiwi, banana, peach)	4,5%	Positive family history of allergies (OR 4,5; 95% CI 3,9–5,1)
Le et al., 2018 [29]	Vietnam, 2016	*n*=8620 2–6 years	Interview	Fish Seafood Beef Chicken egg CMP	8,4% — symptoms	-
Kaya et al., 2013 [30]	Turkey, 2011	*n*=10 096 11–15 years	Interview EIA sIgE (IgE >0,35 kU/l) SPT (>3 mm) Double-blind placebo-controlled test	Peanut, nuts Kiwi	0,15%	Positive family history of allergies (OR 11,3; 95% CI 10,7–11,9)
Kim et al., 2017 [31]	Korea, 2015	*n*=29 842 6–17 years	Interview	Chicken egg CMP Beef Nuts, peanut	15,5% — symptoms	-
Wu et al., 2012 [32]	Taiwan, 2004	*n*=30 018 3–18 years	Interview EIA sIgE (IgE >0,35 kU/l) SPT (>3 mm)	Seafood Mango CMP Chicken egg	3,4% — symptoms in 3 years	-

Table 2. Ending

Author, year of publication	Country, year of study	Sample size, age	Food allergy diagnostic criteria*	Allergens	Prevalence rate**	Food allergy development factors***
Hoyos-Bachiloglu et al., 2014 [33]	Chile, 2011–2012	*n*=455 7–18 years	Interview	Walnut, peanut Chicken egg Avocado Banana	5,5% — symptoms	Positive family history (OR 1,32; 95% CI 1,34–1,83)
Basera et al., 2015 [34]	RSA, 2013–2014	*n*=512 1–3 years	Interview SPT (>3 mm)	Chicken egg Peanut Soy Fish Seafood	12,3% — symptoms 1,4% — FA	-
Li et al., 2019 [35]	Russia, India, China, (EuroPrevall), 2009	*n*=35 549 6–11 years	Interview EIA sIgE (IgE >0,35 kU/l)	Chicken egg CMP Fish Seafood	Hong Kong — 1,5% Russia — 0,87% Guangzhou — 0,21% Shaoguan — 0,69% India — 0,14%	Urban lifestyle
Botha et al., 2018 [36]	RSA, 2013–2016	*n*=1185 1–3 years	Interview SPT (>3 mm)	Chicken egg Walnut, peanut Soy Fish Wheat	2,5%	Urban lifestyle (OR 2,5; 95% CI 1,6–3,3)
Bulatova, 2014 [37]	Russia	*n*=2463 3–17 years	Interview EIA Total and sIgE (IgE >0,35 kU/l)	CMP Chicken egg white	38,9% — symptoms	-
Fedorova, 2010 [38]	Russia	*n*=12 813 7–10 years	Interview SPT (>3 mm) EIA sIgE (IgE >0,35 kU/l)	CMP Chicken egg Fish, shrimps Peanut, hazelnut, walnut Soy Wheat et al.	1,2% — FA 38,9% — symptoms	-

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FACTORS AFFECTING THE DEVELOPMENT OF FOOD ALLERGY IN CHILDREN

In the course of prospective and cross-sectional studies, the most significant risk factor for the development of FA development was revealed to be positive allergic history (see Tables 1, 2). A number of studies have convincingly shown that allergic diseases in parents is the main factor determining FA development [13, 19, 23, 24, 28, 30, 33]. Epidemiological statistics confirms the fact that the pathophysiology of FA development is a complex interaction of genetic and environmental factors [48]. Simultaneously, most of the factors that are statistically significantly associated with FA development in one way or another were noted to modify the microbiotic composition of the body and the environment. Thus, for example, cesarean section delivery is associated with a higher risk of developing FA. This phenomenon is associated with the fact that the child, without passing through the birth canal, does not come into contact with the natural microbiota of the mother, which leads to disturbances in the formation of the newborn's digestive tract microbiota and subsequent changes in the local immune response to food allergens [49-51]. One study showed (*n*=3738) that children delivered via cesarean section were almost 1.5 times more likely to develop FA than those delivered vaginally [28].

One of the common risk factors affecting the development of allergic diseases in older age is the lack of breastfeeding during the first year of life [11, 23, 16, 17, 52]. For example, 10%–15% of children with FA symptoms were shown to have not been breastfed during the neonatal period [11]. Another study (*n*=65) found that exclusive breastfeeding was a significant protective factor in children only up to 1 month of age [16].

According to the "hygienic hypothesis," a decrease in the microbial load on the body increases the risk of developing allergic diseases and atopy [53]. For example, the risk factors for the development of allergic diseases have been to include living in an urban environment, frequent hygiene procedures, and cleaning, while the protective factors include living in a rural area and the presence of pets and older children in the family [24, 35, 36, 53]. Significantly, high social status of the family and the mother and father's higher education are also associated with a higher risk of developing FA [26, 38].

In addition to the factors that modify the microbial composition of the body and the environment, studies also revealed the characteristic of the specific region of residence as a protective factor [10, 24, 38]. For example, in Iceland, which is a country with northern climate, the authors found that earlier introduction of fish and vitamin D into the diet of a child is accompanied by lower prevalence rates of allergic diseases at an older age. Moreover, FA incidence was determined to be significantly lower in children who received fish and fish oil [21].

A large-scale epidemiological study conducted in Russia (*n*=12,813) showed that living in rural areas with high levels of endemic helminth infection *Opisthorchis felineus* is associated with reduced risk of developing FA compared to that of an urban sample. The data obtained are explained by the modulating effect of helminth infections, and, particularly, *Opisthorchis felineus*, on the immune response [38].

A study [10] (*n*=590) showed that sensitization to food allergens, confirmed by allergy skin testing (cow's milk protein, 22.6%; chicken egg, 17.8%), is 3 times more common in African American children than those in the Caucasian race. This fact is most likely explained by the characteristics of skin reactivity in people of different races than by the characteristics of immune response [10, 54].

Significant factors positively associated with FA development also include infectious diseases suffered by the mother during pregnancy, smoking, and poor nutrition of the pregnant and lactating mothers [11, 13, 17, 22, 29]. The relationship between excessive weight gain in the mother and subsequent development of allergic diseases in the fetus has been described [24, 55].

A number of studies have registered that taking medications during pregnancy, most often antibiotics, subsequently increases the risk of developing FA in a child [13, 17]. The authors attribute this fact to the antibiotics' ability to disrupt bacterial colonization, which in turn can cause immunopathological reactions in fetus [56].

Various data on risk factors are of great practical importance, being a scientific basis for preventive measures, including the formation of risk groups and population-based preventive measures, as well as theoretical significance of understanding the foundations of FA development and choosing further areas of scientific research.

CONCLUSION

This review made generalizing and systematizing the accumulated worldwide scientific data on FA possible. A significant prevalence of this pathology has been demonstrated worldwide. Epidemiological studies also demonstrated the patterns of FA natural course: the highest rates were noted among young children, and by school age, the prevalence of both symptoms and confirmed FA in children gradually decreases.

Based on the obtained epidemiological data, analysis of various aspects of FA development was performed. The leading factor determining the development of hypersensitivity to food allergens is hereditary burden of allergic diseases. Genetic predisposition to FA, confirmed by a series of epidemiological studies, dictates the need for deep analysis of this pathology's hereditary nature. Currently, there is an active search for genetic markers of FA based on genome-wide association study of individuals suffering from this pathology. Studying FA markers is a necessary component of personalized preventive approach.

In addition to its genetic predisposition, FA development is influenced by a number of external factors. Among the diversity of various environmental prerequisites for FA development, studied in the framework of this review, factors that modify the microbiotic composition of the body and the environment are of leading importance. Particularly, cesarean section delivery and formula feeding have been shown to be associated with higher risk of FA development. Similar observations were recorded with respect to such factors as urban lifestyle, high social status, and higher education of parents. These factors to some extent affect the composition of the body's microbial environment. In this regard, in recent years, the current scientific trend is the study of microbiotic aspects of FA development. For example, currently studies on the role of various microbiotic communities in the process of realizing the genetic risk of developing allergic diseases and FA in particular are gaining more and more interest.

Thus, this review generalizing the accumulated large-scale data on the prevalence of FA prevalence possible. The data obtained during the analysis on the factors of FA development are the necessary theoretical basis for the formation of risk groups and planning of preventive measures. Epidemiological data on the conditions for allergic pathology development also determine the direction of further scientific research in relation to the fundamental principles of FA development.

ADDITIONAL INFORMATION

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