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Review

Prevalence of food allergies in South Asia

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ABSTRACT

Objective: To evaluate the published medical literature on the prevalence and types of food allergies in South Asia.**Data Sources:** A PubMed search was performed using the keywords *India* and *food allergy*, *Asia* and *food allergy*, and *South Asia* and *food allergy* for any period. Articles cited in selected studies were reviewed for their appropriateness of inclusion into this review.**Study Selection:** Publications were included that were original research and fit the topic of food allergy and South Asia. South Asia is defined as region inclusive of India, Pakistan, Bangladesh, and Sri Lanka.**Results:** A total of 169 articles were initially identified, and 47 were reviewed in detail for inclusion in this review. The primary focus was placed on 10 studies that consisted of case reports of newly reported or documented food allergy, survey studies that investigated food allergy prevalence in specific demographics, and prospective and cross-sectional studies with case controls, all of which investigated food allergy prevalence by allergy testing in a selected population.**Conclusion:** The medical literature on the prevalence and types of food allergy in South Asia indicates that there is a variety of unusual and unique allergens and an overall low incidence of food allergy. There is also an association of increased food allergy prevalence in individuals who live in metropolitan regions or who migrate to communities that have adopted westernization.

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Introduction

The prevalence of childhood food allergy, sometimes referred to as the food allergy epidemic, is increasing worldwide and has been documented not only in the United States and Western Europe but also in Asia, including the Indian subcontinent.^{1,2} Data suggest that there is a concomitant increase in Asians, particularly among those in the higher socioeconomic strata who have embraced a westernized lifestyle. This increase can be analyzed from 2 perspectives: the increase in indigenous populations that reside in non-westernized countries and the increase in immigrant populations to westernized nations or in populations that have adopted westernized cooking and consumption practices. Up to 8% of US children have food allergies, and the US Asian population may represent up to 0.5% of food allergic children.³ In addition, data suggest that immigrant populations tend to develop the diseases of the society to where they migrate.⁴ Foreign-born children have a lower prevalence of atopic disease than US-born children, but an increasing

prevalence has been seen in individuals who have resided in the United States for at least 10 years.

Similar trends in Asian immigrants have been seen, especially in affluent communities that have adopted a westernized lifestyle.^{2,5} In an early Australian study, Australian-born Asians had higher odds of atopic disease compared with those seen in Asian immigrants.⁵ Large population-based epidemiologic surveys are relatively few in Asia, specifically in the Indian subcontinent. More rigorously conducted studies evaluating food allergy prevalence that are confirmed with oral food challenges are even scarcer in the Asian medical literature.

Asia is a vast continent with numerous ethnic populations, cultural practices, and cuisines. India, Pakistan, Bangladesh, Nepal, and Sri Lanka comprise the region of South Asia. These countries differ from the rest of Asia in not only the ethnicity of its people but also the foods commonly consumed. Food allergy trends may be different among different ethnic groups, and Asian Indians have a unique diet and may have unusual or different food allergies. In India, most of the population consumes a largely but not solely vegetarian diet, which consists mainly of rice, legumes, grains, and vegetables.² In addition, there are a variety of spices that are staple to the South Asian diet, including red chili, coriander, cumin, mustard seed, fenugreek, ginger, turmeric, and curry leaves, of which there has been some recognition of spice allergy in the

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Table 1
Primary Articles Discussed in the Review

Article	Food allergens discussed	Type of study	Year
Mahesh et al ⁷	Apple, fish, banana, cow's milk, melon, sesame, shrimp	Cross-sectional, questionnaire	2016
Joplin et al ²⁴	Peanut	Prospective, population-based cohort study	2014
Panjar et al ²⁵	Peanut and tree nuts	Cross-sectional, questionnaire	2016
Kamdar et al ²⁶	Tree nuts, chickpea, capsicum, Indian lentils, avocado, banana, beef, bulgur wheat, coconut, corn, eggplant, garlic, ginger, green peas, jalapeño peppers, kiwi, melon, rice, tomato	Cross-sectional, questionnaire	2015
Patil et al ²⁷	Fenugreek seed	Case report	1997
Patil et al ²⁹	Chickpea	Double-blind, double-placebo controlled prospective study	2001
Hedge et al ³⁰	Mango	Case report	2007
Hedge et al ³¹	Mushroom	Case report	2009
Harish Babu et al ³²	Eggplant	Cross-sectional	2008
Caselato-Sousa et al ³⁴	Amaranth grain	Case report	2012

literature.⁶ There is a knowledge gap regarding food allergy trends in the Asian Indian native population, and large population-based epidemiologic surveys are few in the Indian subcontinent. To the best of our knowledge, no review articles have summarized the types of food allergy seen in these countries. The objective of this review article is to evaluate the published medical literature on the prevalence and types of food allergens in the Asian population, with a focus on the South Asian population.

Methods

A PubMed search was primarily used to investigate study articles for this review, using the keywords *India* and *food allergy*, *Asia* and *food allergy*, and *South Asian* and *food allergy* from any period. Publications were included if they were original research and fit the topic of food allergy and South Asia. A total of 169 articles were initially reviewed. Of those, food allergy was the primary focus in 47 studies. Ten studies primarily focused on food allergies in South Asia (Table 1) and consisted of either case reports to newly reported or documented food allergies, survey studies that investigated food allergy prevalence in specific demographics, or prospective and cross-sectional studies with case controls that investigated food allergy by allergy testing. These 10 articles were thoroughly evaluated and are the focus of this review.

Prevalence and Types of Food Allergies in South Asia

The first major study evaluating the prevalence of food allergy on a global perspective is the EuroPrevall-INCO study, published in 2016.⁷ This multicenter study evaluated the prevalence of food allergy in randomly selected populations in 8 European countries, India, Hong Kong, and Russia. In the southern part of India, a screening survey that consisted of participant demographic information and adverse reactions to foods was given to more than 11,000 randomly selected adults between the ages of 20 and 54 years. A more detailed questionnaire was given to a subcohort of 588 individuals, including 236 cases and 352 controls. Serum samples were collected from the participants of this cohort for estimation of total and specific IgE levels to 24 foods that were considered to be common food allergies via the ImmunoCAP 250 system (Phadia, Uppsala, Sweden). Participants from India had the highest rates of sensitization to most tested foods compared with those from centers at 6 other European countries (Switzerland, Spain, Netherlands, Poland, Bulgaria, and Iceland). Probable food allergy was defined in this cohort as self-reports of adverse symptoms after consumption of food and specific IgE level to that food of 0.35 kU/L or higher.

Participants in Bangalore, India, had higher rates of sensitization than those in Mysore, with a prevalence of sensitization of 26.5%. This discrepancy was thought to be reflective of the westernization of Bangalore in recent years, a metropolitan commonly referred to

as the Silicon Valley of India. Shrimp and sesame seed were the most common sensitizers at 13% each, whereas foods most commonly associated with clinical symptoms were apple, fish, banana, cow's milk, and melon. In contrast to the high rates of sensitization, the prevalence of food allergy was very low at 1.2%, with cow's milk and apple being the most common allergens. The mean total IgE level from participants in India was higher than those observed in Europe. This finding was speculated to reflect the effect of significant exposure to air pollution, insect bites, and parasitic infections on IgE production. Although this study did not use the gold standard for diagnosing food allergy (ie, oral food challenge), it revealed interesting patterns of food sensitization in South India.

Prevalence and Types of Food Allergies in Central and East Asia

A review of the available literature suggests that in Central and East Asian countries, the prevalence of pediatric food allergy is highly variable. A study conducted in northern Thailand on 452 children between the ages of 4 and 7 years revealed a food allergy prevalence of 1.1% when food challenges were used as part of the diagnostic workup.⁸ Another food challenge–proven study (published in Mandarin) from 3 cities in China find a higher challenge-proven rate of 6.2% in a population of 1,604 children between the ages of 0 and 2 years.^{9,10} In South Korea, a questionnaire-based study revealed a food allergy prevalence as high as 12.6% in children between the ages of 12 and 15 years and 11.3% in children between the age of 6 and 12 years.¹¹

In East and Central Asian countries, the more commonly reported food triggers for severe allergic reactions include the major components of the Asian diet: fish, shellfish, bird's nest, buckwheat, and royal jelly. In Singapore,¹² Thailand,¹³ and Hong Kong,¹⁴ hospital-based studies on anaphylaxis reveal that crustacean shellfish is one of the most important food triggers in adults and children. Allergy to edible bird's nest from swiftlets has also been described in several Asian populations, including those in Singapore¹⁵ and Malaysia.¹⁶ Royal jelly has been reported to trigger anaphylaxis in individuals living in Hong Kong¹⁷ and in ethnic Chinese living in Australia.¹⁸ Buckwheat triggering anaphylaxis has also been observed in Japan, South Korea, and China.^{19–21} Interestingly, few studies have found peanut allergy to be a trigger for anaphylaxis in Asian populations.^{22,23} What remain largely unknown are the prevalence and types of food allergens seen in South Asia.

Prevalence of Food Allergy in Immigrants of Asian Origin

In 2014, Joplin et al²⁴ conducted a prospective cohort study of 5,120 Australian children between the ages of 11 and 15 months to evaluate whether there were differential effects of risk factors for

children with peanut allergy based on parental country of birth in Australia vs a country within East Asia. Of note, East Asia was not defined in terms of the specific countries that made up this particular region. This study, which confirmed food allergy with skin testing and an oral challenge, revealed an intriguing association between parental birth country and food allergy in the infant, with peanut allergy found to be 3 times more common in infants whose parents were born in East Asia than in infants whose parents were born in Australia. The prevalence of peanut sensitization among infants was 5.4% with both parents were born in Australia, 15.9% with one parent was born in East Asia, and 19.6% with both parents were born in East Asia. Peanut allergy was found in 2.3% of infants with both parents born in Australia, 6.7% with one parent born in East Asia, and 7.7% with both parents born in East Asia. There was no evidence of a difference in peanut allergy risk, depending on whether the Asian-born parent was the mother or father of the child. Moreover, the difference in peanut allergy prevalence was not completely explained by differences in modifiable lifestyle factors, such as infant feeding, pet exposures, or having older siblings. Of the measured environmental factors, lower rates of dog ownership among East Asian parents appeared to contribute the most to an increase in peanut allergy.

This study was significant in that it had a large sample size and used standardized objective food allergy testing to define food allergy. The increase in the prevalence of peanut allergy in Australian infants of Asian-born parents appears to have occurred in a single generation. Interestingly, the Asian-born parents themselves had lower rates of allergic disease than did the Australian-born parents. This finding suggests a potential environmentally related mechanism driving the development of food allergies.

Another recent survey study, by Panjari et al,²⁵ examines the possible association between parental migration and the development of food allergy. The study intended to investigate the risk factors for nut allergy in Asian children and in children born in Australia via a health entrance questionnaire to all 5-year-old children in Victoria, Australia. The study defined Asia as “East Asia plus India.” Patient-reported nut allergy prevalence was 3.1% among the cohort of 60,000 children. The prevalence of peanut allergy and tree nut allergy was 2.7% and 1.7%, respectively. Asian children were twice as likely to have nut allergy as were non-Asian children, with a statistically significant adjusted odds ratio of 2.67. Children born in Asia who subsequently migrated to Australia had a decreased risk of having nut allergy (adjusted odds ratio, 0.1). Peanut-only allergic children born to Asian mothers were less likely to have another nut allergy if they were also born in Asia. Similarly, peanut allergic children born in Australia were more likely to have a tree nut allergy than those children born in Asia (adjusted odds ratio, 1.35). As is common with survey-based studies, a key limitation of this study was the overestimation of food allergy reported by parents. However, the study, just like the prior one above, revealed that parental migration from Asia to Australia may be an important risk factor in the development of nut allergy in the subsequent generation.

Kamdar et al²⁶ recently investigated a similar migration effect in the United States, evaluating for any difference in the patterns of food allergy between Asian Indian children and white children in the first large-scale survey of food allergic reactions of Asian Indian children in the United States. The parents of 114 Asian Indian children with food allergies responded to the survey. The mean age at the time of food allergy diagnosis was 3.3 years, and 66.7% of the children were boys. Approximately 67% of the allergies were reported to be diagnosed by a physician, 70% were diagnosed by serum or skin tests, and approximately 30% were revealed through an oral food challenge. Tree nut was the most common food allergy in this population and was reported in 59% of the children. This finding was not expected because it is not the most common food

allergy in the general US population. Other food allergies noted were to chickpea flour, capsicum (variant of green pepper), and Indian lentils. Despite the small sample size, a large variety of food allergens that are typically not seen in the general population were reported, including foods such as avocado, banana, beef, bulgur wheat, coconut, corn, eggplant, food dye, garlic, ginger, green peas, jalapeño peppers, kiwi, melon, rice, and tomato. In addition, 11% of the parents self-reported that they had a food allergy. This study is still ongoing; however, the preliminary findings are important because they reveal that individuals of Indian descent living in the United States tend to be allergic to foods that are frequently not thought of as common food allergens.

Types of Food Allergens in South Asia

A wide array of food allergens have been reported in South Asia/Indian subcontinent. The preponderance of these publications are in the form of case reports or anecdotal descriptions. Published case reports from India during the past 20 years highlight unique food allergen triggers specific to the ethnic cuisine. In 1997, Patil et al²⁷ described 2 cases of acute allergic reactions to fenugreek, one of them occurring via inhalation, and the other via topical application of fenugreek seed powder. Fenugreek is a plant in the family Fabaceae and is used both as an herb and in seed-form in Indian cooking.²⁸ It is widely considered a traditional remedy for diabetes, to stimulate appetite, and to enhance milk production in breastfeeding women. Fenugreek seeds are also often ground up into a paste and applied topically for various skin ailments. In the case reported by Patil et al,²⁷ inhalation of fenugreek resulted in rhinorrhea, wheezing, and transient loss of consciousness. In the second case, application of fenugreek to the scalp resulted in numbness to scalp, facial edema, and wheezing. Allergy testing was performed on both patients and on 3 nonallergic controls to fenugreek and other members of the Leguminosae family. Both patients were found to be sensitized to fenugreek and chickpea and reacted on double-blind, placebo-controlled food challenges. Negative outcomes to all modalities of testing were seen in the control group. This report highlights the first documented case of fenugreek allergy in the South Asian region.

There also appear to be regional and ethnic differences in the most common triggers of food allergic reactions, possibly related to varying dietary patterns. The typical South Asian diet includes various types of grains and legumes, such as pigeon pea (Hindi word: toor/*Cajanus cajan*), black gram (Hindi word: urad/*Vigna mungo*), and mung bean (Hindi word: moong/*Vigna radiata*), that are not commonly consumed in the United States, Western Europe, or Australia.⁸ A few years after his findings on fenugreek allergy, Patil et al²⁹ conducted a double-blind, double placebo-controlled study of 1,400 patients from allergy clinics in Mumbai, India. The purpose of this study was to formally diagnose patients with clinical histories suggestive of chickpea allergy using in vivo and in vitro evaluation. Chickpea (Hindi word: chana/*Cicer arietinum*) is a staple food in the Indian diet and is also commonly used topically for cosmetic purposes, such as in facial and body masks. Before this study, there had been no formal evaluation of allergy testing in patients who had a history suggestive of chickpea allergy. In this study, both the patient and control underwent a screening questionnaire, followed by skin prick test to chickpea, and finally double-blind, placebo-controlled food challenges. Taking into account each person's skin prick test result and specific IgE level, the investigators determined that the skin prick test had a 100% sensitivity and serum testing had a 64% specificity of diagnosing a chickpea allergy. The authors reported that skin prick testing and serum specific IgE measurement to chickpea via enzyme-linked

immunosorbent assay together could reliably diagnose chickpea allergy in individuals with suggestive symptoms.

One of the earliest reports of food allergy to mango in India was published by Hedge et al.³⁰ in 2007. The authors presented a case of a 43-year-old woman with recurrent oropharyngeal pruritus and facial edema after eating ripe mangoes. Skin prick testing was performed, and serum specific IgE to mango was obtained from the patient and 10 nonallergic controls. Skin prick test results were positive in the patient to both mango extract and mango juice and negative in the controls. The level of specific IgE to mango extract in the patient was double that seen in the control group, and the level of specific IgE to mango juice in the patient was more than 9 times that of the control group. The results of the skin prick test and serum IgE measurements provided support that the patient sustained an IgE-mediated food allergy to mango.

The same investigators also reported what they believe to be the first known case of cultivated mushroom allergy in India in 2009. Hedge et al.³¹ described a case of a 32-year-old woman living in Mysore, India, who developed facial edema and generalized urticarial within minutes of eating mushroom curry.³¹ The results of skin prick tests to the mushroom extract and to the cooked mushroom extract were strongly positive, suggesting a heat-stable allergen. The mushroom allergen was later identified as *Agaricus bisporus*.

There have been only few case reports of allergy to eggplant reported in the allergy literature. The study by Babu et al.³² was one of the first studies to reveal a sex predominance of sensitization and allergy to eggplant. The investigators conducted a cross-sectional study of 741 randomly chosen individuals and found a sensitization prevalence of 9.2% determined by skin prick testing and specific IgE levels. Fifteen percent of the sensitized population developed an immediate adverse reaction within 2 hours of an oral challenge, which account for 1.4% of the total population. A total of 85% experienced a reaction after 4 hours, to which the investigators suggested a non-IgE-mediated hypersensitivity, resulting in a delayed reaction. In addition, there was a 2:1 female-to-male dominance of overall eggplant allergy. Cutaneous reactions (urticaria, pruritus) were the most common allergic reactions, affecting nearly 60% of the participants who reacted, followed by wheezing and rhinorrhea, which affected 30% of the participants.

In 2013, Kasera et al.³³ reported the first known case of anaphylaxis to amaranth grain in India. Amaranth grains, commonly known as rajgira in India, are actually minuscule buds that make up the flowers of the *Amaranthus* plant. It is considered to be a pseudo-cereal and includes an impressive array of nutrients, including protein, minerals, and fiber. In this case, a 60-year-old woman development oropharyngeal pruritus, conjunctival erythema, and generalized edema 5 minutes after consuming the rajgira for the first time. She had reportedly eaten roasted rajgira grains several years before this incident and had developed anaphylaxis at that time as well. The patient underwent formal allergy testing via skin prick test, serum specific IgE testing for raw rajgira and roasted rajgira, followed by a graded oral food challenge. She developed a large positive response on the skin prick test and elevated IgE levels to raw rajgira and roasted rajgira. She also developed oropharyngeal pruritus after consuming 1,000 mg of the flour. This case and the ones above serve as examples of the fact that food allergic triggers are local and can vary based on the dietary patterns of a particular region.

Because many of the foods commonly consumed in South Asia are also a part of the typical diet in other countries, a PubMed search was conducted to determine if such foods have been found to result in food allergies in other parts of the world. A brief literature search revealed that lentil allergy has been reported in several countries, including Turkey,³⁵ Spain,³⁶ and Italy.³⁷ Mushroom allergy has also been documented in a few case reports

worldwide, including in Japan,³⁸ Spain,^{39,40} and Turkey.⁴¹ Mustard seed has been reported in Spain,⁴² and cumin has been reported once in the United States.⁴³ There are also a few reports of legume allergy, specifically fenugreek and chickpea, that have been noted in Norway,⁴⁴ Belgium,⁴⁵ France,⁴⁶ and Spain.^{35,47} The presence of these studies reveal that individuals from other regions of the world who commonly consume certain foods, which are also a part of the South Asian diet, have also developed more uncommon food allergies.

The increasing prevalence and recognition of food allergy in developing countries are a peculiar phenomenon, with studies revealing an increase in more westernized regions.^{3–5,7,23,24,48} Interestingly, during the last decade, reports have also revealed an increase in non-food allergic diseases, such as asthma, in countries that have transitioned to a more westernized lifestyle.^{49–52} In the United States, Western Europe, and Australia, the increasing evidence of the atopic march first gained recognition more than 50 years ago, primarily referring to atopic dermatitis, aeroallergen sensitization, and asthma.^{52–54} Food allergy incidence during that period was uncommon but has gained recognition as the second wave of allergic disease, with an increasing prevalence in the past 15 to 20 years.⁵² The apparent increase in the prevalence of food allergy in Asia has occurred much more rapidly than its counterpart in the West and possibly reflects the rapid westernization of society. There is much evidence of the influence of decreasing microbial exposure on increasing global atopy, especially on respiratory disease and allergic rhinitis.^{55–59} Other studied factors include increased inflammatory diet and increased inhaled pollutants.⁵² These factors may also underlie the increase in food allergy; however, other lifestyle factors, such as changing cooking practices and increased use of processed foods, should also be investigated.

Conclusion

Overall, recent studies reveal that there may be a low prevalence of food allergy in South Asian residents, however higher than in the past. However, interestingly, there is an increased prevalence of certain food allergies among individuals of Asian origin who emigrate to some westernized countries. In addition, there is evidence that both native and emigrant Asian populations tend to have unusual food allergens that are not commonly seen in populations in westernized countries. A significant limitation of the studies reviewed here is the lack of a rigorously conducted investigation. In conclusion, there remains a need to explore the fascinating association between the incidence of food allergy and the westernization of society, especially in the South Asian region.

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