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Prevalence and Effects of Food Allergies among Young Adults at a University Setting of Sri Lanka

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ABSTRACT

Food allergy is a growing global health concern, potentially life-threatening, and requiring prompt action. While studies in Sri Lanka have addressed food allergy prevalence in children and adolescents, there is limited information on the prevalence, severity, and associated factors among young adults. Hence, this serves as one of the first large-scale studies in Sri Lanka focusing on food allergy prevalence and its academic and social effects among young adults. This study aimed to estimate the prevalence, clinical manifestations, scope of allergens, socio-demographic variables, and high-risk behaviors related to food allergies in young adult students at the University of Peradeniya, Sri Lanka. A questionnaire was distributed to undergraduates via email and online platforms, resulting in 1169 valid responses. Statistical analysis using descriptive and inferential methods was performed on the data set ($p < 0.05$). The prevalence of self-reported food allergies was 17.5%, with significantly higher rates among females (20.3%) than males (10.6%) (χ^2, $p < 0.001$). Logistic regression analysis indicated that prior childhood diagnosis increased the likelihood of strict allergen avoidance ($p < 0.01$). In addition, history of previous hospitalization was also a significant predictor ($p < 0.05$). Socioeconomic status showed a modest association with the prevalence of food allergy ($p = 0.03$). These findings highlight the gender and early-life allergy history as key determinants of allergy management behaviors. These observations indicate that food allergies substantially impact young adults adversely affecting their quality of life. The present study highlights the need for appropriate confirmatory testing and treatment to avoid unnecessary dietary restrictions. Further research is required to explore the molecular basis of food allergens specific to Sri Lankan diets.

INTRODUCTION

Food allergy is a complex, immunologically mediated response to specific food antigens (Ali, 2017; Zaher, et al., 2023). In recent decades, food allergy has emerged as a significant global health concern, adversely affecting individuals' overall well-being (Zaher, et al., 2023). Research indicates that food allergy prevalence spans all age groups worldwide. In the United States, food allergy is notably prevalent among adults, with over 1 in 10 reporting allergies to various food types (Feng et al., 2022). European countries report adult lifetime food allergy prevalence ranging from 9.5% to 35% (Zaher, et al., 2023). Similarly, in the Kingdom of Saudi Arabia, 15% of adults and 6.4% of minors are diagnosed with food allergy. Population-based studies from the USA, UK, Australia, and Norway reveal that 5-10% of children under five years are affected by food allergy (Zaher, et al., 2023; Hassan et al., 2020).

Recent data suggests that food allergies affect individuals across all ages, genders, races, and socio-economic backgrounds (Feng et al., 2022). Understanding food allergy prevalence among young adults is particularly crucial due to behavioral and lifestyle changes during this period (Sorgi et al., 2015). Increased independence in food choices can lead to higher risks of severe allergic reactions (Hassan et al., 2020). Moreover, university students often lack supervision in managing food allergies and necessary medications. For instance, at Imam Abdulrahman Bin Faisal University, although 24.5% of students were prescribed a self-injectable epinephrine (SIE) device, only 4.7% consistently carried it with them (Hassan et al., 2020). Additionally, 13.5% of university students with moderate to severe food allergies had not been prescribed confirmatory testing despite reporting symptoms to a physician (Ali, 2017). A study in China highlighted the poor knowledge of food allergy among undergraduates, underscoring the need to address food allergy's impact on university students and establish supportive systems (Feng et al., 2022).

While extensive research has been conducted in developed countries due to higher prevalence rates, there is a paucity of published data on food allergy less prevalent occurrence in developing countries. A retrospective cohort study conducted at the Immunology Clinic, Department of Immunology, Medical Research Institute in Sri Lanka reviewed records of 1255 patients over 12 years and found that 27.5% were affected by food allergy, with cow's milk and red meat identified as major allergens (De Silva et al., 2022). Additionally, a descriptive cross-sectional study involving 449 adolescents aged 16-19 years reported that over 30% were burdened by food allergy, with 20% hypersensitive to specific foods (Wimalasiri et al., 2013). However, previous studies in Sri Lanka have primarily focused on children and adolescents, highlighting a need to expand research to older populations.

The present study aimed to fill the research gap by investigating the prevalence, clinical manifestations, and the scope of food allergens among young adult students at University of Peradeniya, Sri Lanka. The University of Peradeniya was chosen as the study setting, because it is Sri Lanka's largest and most diverse state university, comprising nine faculties. The student population represent all the provinces and socio-economic backgrounds, thereby providing a representative sample of the national young adult population. Additionally, the study examined the socio-demographic variables and high-risk behaviors associated with food allergies, as well as their social impacts. This comprehensive approach provides a deeper understanding of how food allergies affect young adults in Sri Lanka, informing targeted interventions and support mechanisms.

MATERIALS & METHODS

Study population and data collection

The target population for this cross-sectional study comprised Sri Lankan undergraduates aged 19 to 29 years, enrolled in the 1st to 4th academic years across all nine faculties of the University of Peradeniya, Sri Lanka. As

defined by the National Youth Policy (2014), individuals aged 15-29 years are classified as young adults. Therefore, undergraduates who did not fall within this age range or who were non-Sri Lankan students without at least one Sri Lankan parent were excluded from the study. Participant eligibility was verified by requesting their university admission number, which is a unique identifier assigned to all enrolled students. Ethical approval for the study was obtained from the Institutional Review Board of the Faculty of Agriculture, University of Peradeniya (Certificate no: ECC/2021/e/003), and informed consent was secured from all participants prior to data collection. Data collection was conducted over two months using a questionnaire distributed via the official email of each participant through their respective faculties.

Study design and sample size calculation

To ensure a representative sample of the university's population, a stratified random sampling method was utilized. This approach involved selecting random samples from each faculty, which were subsequently combined to create a final composite sample. This method facilitated adequate representation and ease of data collection from the diverse student body at the University of Peradeniya. According to the Lemeshow formula (S. Lemeshow, 1990), the estimated minimum sample size required for the study was 1,165 participants. This calculation was based on a reported allergy prevalence rate of 9% (Liyanage, 2017) and a non-response rate of 20% (Bozman, 2005). The study aimed for a prevalence estimate with an accuracy of ±1.8% (Pourhoseingholi, Vahedi and Rahimzadeh, 2013) at a 95% confidence level, leading to a target enrollment of 1,174 participants over a two-month period. The stratified random sampling was performed by the proportionate selection of emails from each faculty and then sending the Google Form link to those who were selected. All the participants meeting the inclusion criteria were enrolled, ensuring stratification. The representativeness was ensured from a total population of 10,190 undergraduates across the 1st to 4th academic years, enhancing the reliability and validity of the study findings. This was operationalized by including a proportionate number of participants from each faculty based on its student population across all nine faculties.

Survey development

The survey was developed using Google Forms to enhance convenience and accessibility for participants. A standardized questionnaire was created, drawing on previous surveys by Ali (2017) and Sicherer (2003), with modifications tailored to the specific needs of the Sri Lankan population. The questionnaire was made available in English, Sinhala, and Tamil to accommodate diverse linguistic backgrounds. To ensure clarity and comprehension, the survey underwent pilot testing with 100 undergraduates from the 1st to 4th academic years in the Faculty of Agriculture. This pilot test assessed the questionnaire's understandability and allowed for slight adjustments based on participant feedback. Additionally, it provided insights into the required time for survey completion, the non-response rate, and the preliminary prevalence rate of food allergens. To prevent duplicate responses, participants were restricted to one submission by managing the use of Google Forms' built-in settings: the 'limit to 1 response' option, which required participants to sign in with their official university email. This ensured only one submission per account, although they had the option to update or edit their responses if necessary. The Google Form comprised six sections, including an overview of the survey and a consent form, ensuring ethical conduct and participant awareness. Following the pilot phase, test–retest reliability was assessed by administering the questionnaire to the same group of participants twice, two weeks apart, and calculating the correlation between the two sets of responses to confirm stability.

Survey structure and content overview

The survey was designed to collect specific information across seven sections while ensuring participant clarity and consent, with a

strong emphasis on anonymity by not collecting any identifying information. The first section included a participant information sheet that outlined the survey's title, purpose, estimated completion time, confidentiality of responses, and instructions for participation. Participants were required to provide informed consent before proceeding. Those who consented by responding "yes" were directed to the next section on socio-demographic information, while those who declined were guided to section 8 to formally withdraw from the study. Section 2 focused on socio-demographic data, gathering details such as the participant's faculty, academic year, gender, age, ethnicity, place of birth, current residential district, living area, and monthly family income. In section 3, participants were asked about their observations related to food allergy symptoms. This included questions on the amount of food triggering symptoms, average onset time, duration, and severity. Additional inquiries included actions taken after the diagnosis and specific food allergen groups. Section 4 examined food allergy diagnosis criteria, prescriptions received, personal experiences with food allergies, and other non-food allergies observed. Section 5 investigated barriers to food consumption patterns due to the allergy, using both open-ended questions and multiple-choice questions. Finally, section 6 included a form acknowledging participants' involvement in the study to reinforce the ethical considerations of the research. To enhance clarity, all study variables and their measurement scales are summarized in Table 1.

Table 1. Study variables and measurement scales

Category	Variable	Type	Measurement/Scale
Socio-demographic	Gender	Categorical	Male / Female
	Age	Continuous	Years
	Ethnicity	Categorical	Sinhala / Tamil / Muslim / Other
	Faculty	Categorical	Nine faculties
	Residential area	Categorical	Urban / Semi-urban / Rural
	Family monthly Income	Ordinal	Low / Middle / High
Clinical	Food allergy status	Categorical	Yes / No
	Type of allergen	Categorical	Crustaceans, Fruits, Meat, Fish, etc.
	Severity of symptoms	Ordinal	Mild / Moderate / Severe
	Age of onset	Ordinal	<5, 6–10, 11–15, 16–19, 19–29 years
	Diagnosis method	Categorical	Self-diagnosis / Healthcare professional / Confirmatory tests
	Symptoms	Categorical	Skin, Gastrointestinal, Respiratory, Anaphylaxis
Behavioral /Social	Allergen avoidance behavior	Ordinal	Always / Sometimes / Rarely / Never
	Social restrictions	Ordinal	Never / Rarely / Sometimes / Most of the time

Statistical analysis

Data analysis and graphical presentations were conducted using the Statistical Package for Social Sciences (SPSS version 26.0; IBM Corp, Armonk, NY, USA). Descriptive statistics for categorical variables were reported as frequencies and percentages, while continuous variables, including age, were summarized as means ± standard deviation (SD) along with their range. The Chi-square test was employed to compare categorical variables. Chi-square tests to examine associations between categorical variables (e.g., gender and allergy

prevalence) and logistic regression models to identify predictors of strict allergen avoidance and food allergy prevalence were used in the analysis. Statistical significance was determined at a significance level of α=0.05. All continuous variables included in the dataset were assessed for normality prior to analysis using both graphical methods (histograms and Q–Q plots) and the Shapiro–Wilk test. As the majority of these variables did not meet the assumptions of normal distribution, non-parametric statistical approaches were applied where relevant.

RESULTS

Participation rate

A total of 10,190 undergraduates were invited to participate in the online survey, of whom 1,174 (11.5%) completed it. After reviewing the data, five responses were excluded, leaving a total sample of 1169 (N=1169). Accordingly, the targeted final sample size of 1165 was able to be achieved. Three of them were beyond the age range considered, and two of them had participated in the survey twice (duplicate responses were identified by matching official university email addresses). All of them were considered as the outliers of the survey and excluded resulting in a 99.6% valid response rate. The results were summarized before statistical analysis.

General characteristics of the study participants and the prevalence of food allergies

The study included 821 female and 348 male participants, representing 70.23%, and 29.77% of the study population, respectively. Participants were recruited from various faculties within the university, including the Faculty of Agriculture, Science, Engineering, Arts, Management, Allied Health Sciences, Medicine, Dental and Veterinary Sciences.

Among the 1,169 participants, food allergies were reported by 204 respondents, resulting in a prevalence rate of 17.5%. Of these, 128 participants (62.7%) had their food allergies diagnosed with a healthcare professional, while the remaining 76 respondents (37.3%) were identified as having food allergies based on specific criteria, despite lacking a formal medical diagnosis. These criteria included the onset of symptoms within less than 2 hours after consuming the particular food, recurrence of symptoms upon consuming the same food, and symptoms triggered by a small quantity of the food (National Institute of Allergy and Infectious Diseases, 2011).

Table 1 depicts the general characteristics of the participants diagnosed with food allergies. In terms of gender, the prevalence of food allergies was significantly higher in females (20.3%) compared to males (10.6%), with a p-value of 0.00009 ($p<0.05$). This significant difference indicates that food allergies are more common among female undergraduates at the University of Peradeniya.

However, no statistically significant difference in food allergy prevalence was observed among ethnicities ($p=0.76$) or types of residential areas ($p=0.62$). In contrast, a significant difference was found regarding monthly income ($p=0.03$). The prevalence of food allergies was highest among students from lower-income families (≤ Rs. 30,000) at 20.8%, followed by higher-income families (≥ Rs. 60,000) at 19.5%. The lowest prevalence was observed in the middle-income group (Rs. 30,000-60,000) at 14.1%. These findings suggest that socioeconomic factors may influence food allergy prevalence, with students from both lower and higher-income families reporting higher rates compared to those from middle-income families.

Types of food allergens

Participants reported the occurrence of food allergies across various food categories, with 145 respondents out of 204 (70.1%) experiencing allergies to multiple foods (shown in Figure 1). Table 2 outlines the signs and symptoms associated with different allergen food categories and specific food types as reported by the participants. Food allergy occurrences were reported across categories identified using the European Union major

Table 2. Association between general characteristics of the total population and prevalence of food allergy

Variable		Total respondents	Food allergy respondents	p-value (α = 0.05)
Gender	Male	348	37	<0.001
	Female	821	167	
Ethnicity	Sinhala	1060	188	0.760
	Tamil	71	11	
	Muslim	34	4	
	Other	4	1	
Residential area	Urban	197	31	0.619
	Semi-urban	601	103	
	Rural	371	70	
Family monthly income group	Low	259	54	0.028
	Middle	504	71	
	High	406	79	

**Significance determined at α = 0.05*

allergen list and prior studies (European Academy of Allergy & Clinical Immunology, 2014).

Seafood allergies

As illustrated in Figure 1, the highest number of respondents reported allergies to crustaceans, with 68 individuals (5.82%). In this study, seafood such as crab, prawns, shrimps, baby shrimp, cuttlefish, and squid were commonly observed food allergies among young adults. Among the shellfish types of allergens, crustaceans were common, unlike mollusks. The only specified molluscan shellfish on the list was squid.

Fruit allergies

Similar to the prevalence of crustacean allergies, 5.82% of young adults reported allergies to fruits (Figure 1). Among these, pineapple was the most cited allergen, consistent with previous research findings (Wimalasiri et al., 2013). This study also highlighted allergies to several tropical fruits that are less frequently reported in previous studies (Table 2). These include banana (sour plantain and Anamalu banana), rose apple (Jambu), Rambutan (*Nephelium lappaceum L.*), Lovi (*Flacourtia inermis*), citrus limon, tree sorrel (Bilin), Durian (*Durio zibethinus* L.), mangosteen (*Garcinia mangostana*), and soursop (katu anoda - *Annona muricata*).

Meat and fish allergies

A significant proportion of respondents reported reactions to meat and fish, with 32.4% and 22.5%, respectively. Among university students, common meat-related allergies included beef, pork, mutton, and venison, while common fish-related allergies involved tuna, canned fish, and herrings.

Vegetable allergies

The reported allergy prevalence for vegetables is 22.1%, with the most commonly reported allergies being to tomato, breadfruit (*Artocarpus altilis*), and jackfruit (*Artocarpus heterophyllus*), consistent with previous literature (Wimalasiri *et al*., 2013; Iddagoda *et al*., 2022). Notably, three respondents reported

experiencing itching in the mouth and redness of the skin and lips after consuming *Sesbania grandiflora* (Kathurumurunga flowers), Lasia (*Lasia spinosa*) tender leaves (Kohila Dalu), and *Colocasia* species (Wel Ala Kola), which has not been reported in previous findings. These observations revealed potential novel allergenic foods unique to Sri Lankan diets underscoring the importance of region-specific allergen profiling.

Milk and dairy allergies

A total of 11.3% of university students reported having allergies to milk and dairy products, including ice cream, cheese, curd, and yogurt. Cow's milk allergy, involving caseins and whey proteins, was identified as the most common childhood food allergy within the Sri Lankan population (De Silva et al., 2022). Interestingly, a few individuals reported allergies to coconut milk, including curries.

Other allergens

Among tree nuts, legumes, and oil crops, 4% of participants reported allergies to peanuts, while 1.5% reported allergies to cashews, almonds, and hazelnut products.

Primary wheat allergy is less common among Sri Lankan population compared to Western countries. This study reported a 7.4% allergy rate towards wheat-based processed foods. However, some participants are allergic not only to wheat but also to spicy foods, which causes them to refrain from Sri Lankan spicy foods like "*Koththu*". There are a variety of spices that are staples in the Sri Lankan diet, including red chili, coriander, cumin, mustard seed, fenugreek, ginger, turmeric, and curry leaves, some of which have been recognized for causing spice allergies in the literature (Arakali, Green, and Dinakar, 2017). Moreover, some young adults in this study reported allergic reactions after consuming gelatin-based sweets, aligning with previous findings (De Silva et al., 2022). Among university students with multiple food allergies, there is a notable sensitivity to certain brands of soft drinks, particularly those containing artificial colors and carbonated beverages.

Patterns and diagnostic approaches of food allergies among young adults

Table 2 provides an overview of the types of signs and symptoms associated with various food categories among allergic young adults at the University of Peradeniya, based on the information obtained. Most of the undergraduates with food allergies reported symptoms that occurred within 1-2 hours. For those allergic to crustaceans and fish, symptoms commonly appeared within a few minutes.

Figure 2 illustrates the distribution of symptoms among young adult respondents, categorized as mild, moderate, and severe based on their severity (European Academy of Allergy & Clinical Immunology, 2014). Severity was categorized based on clinical manifestations defined for allergic reactions by the European Academy of Allergy & Clinical Immunology in 2014 (e.g., mild: localized skin symptoms; moderate: gastrointestinal or respiratory symptoms without systemic involvement; severe: anaphylaxis requiring hospitalization). The majority of respondents reported experiencing moderate to mild symptoms, which were typically managed with Western medications or, in some cases, without any treatment. Severe, life-threatening anaphylactic reactions that required hospitalization were observed in only 5% of the participants.

The methods used to diagnose food allergies among participants varied, with a significant number of individuals relying on self-diagnosis.

According to the data, 74 out of 204 young allergy respondents (approximatel 36.3%) diagnosed with the support medical practitioner, food allergies without undergoing any biochemical tests. This reliance on self-diagnosis may reflect the limited access to diagnostic services, cost barriers, and or a strong trust in experiential knowledge among students.

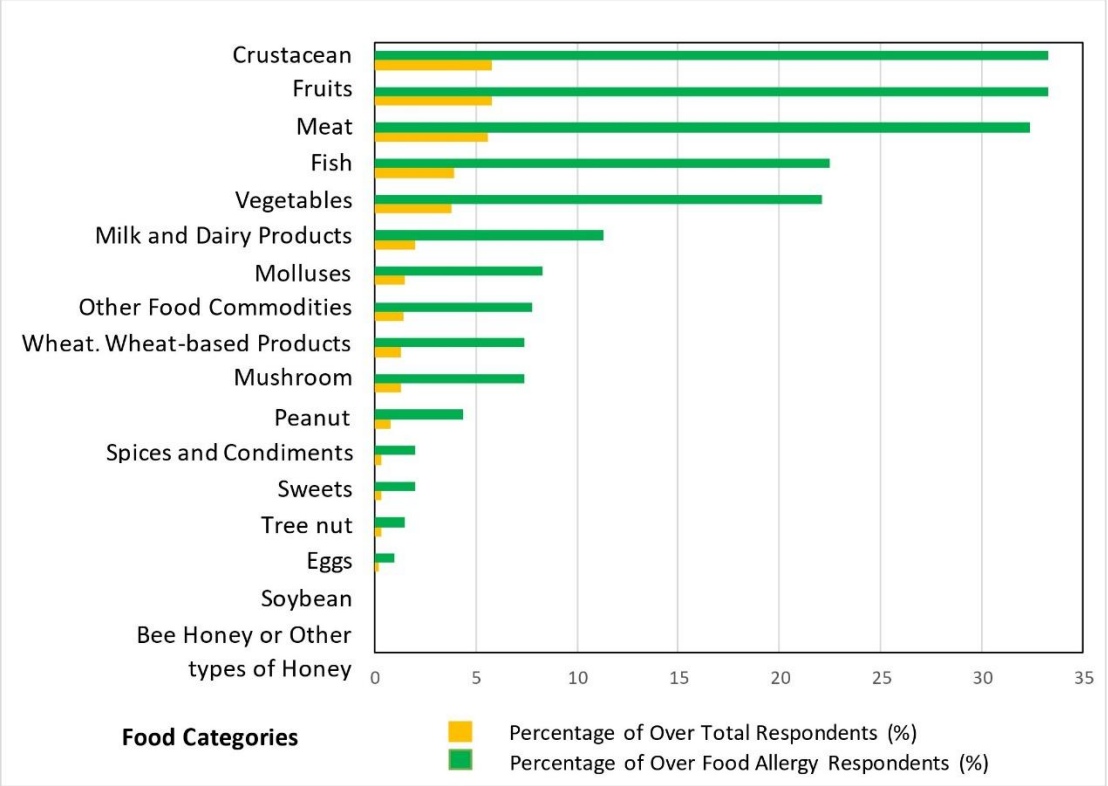

Figure 1. Prevalence of food allergy among the young adult population according to the type of food category

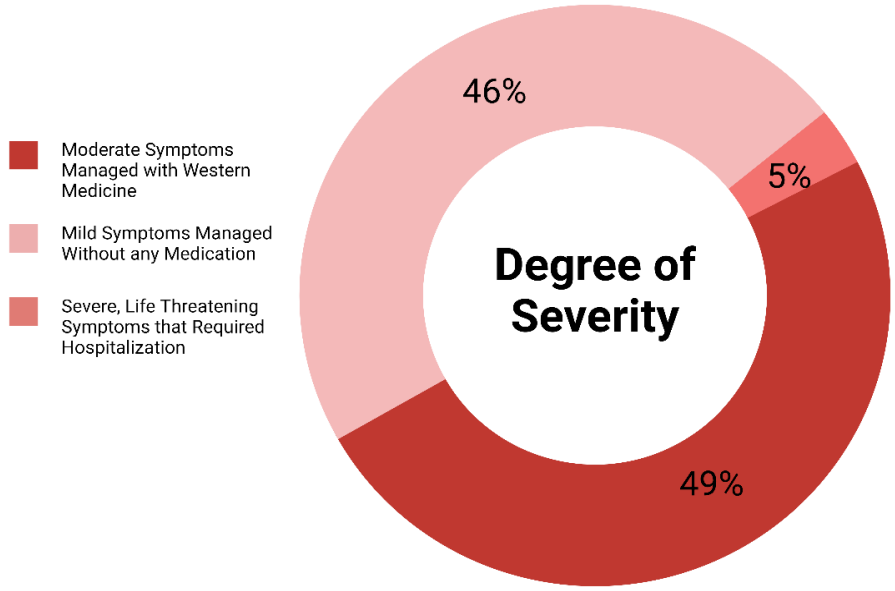

Figure 2. Severity of food allergy signs and symptoms

Table 3. Signs and symptoms associated with different allergenic food categories and specific food types among young adults

Food Category	Reported Signs and Symptoms	Specific Foods Causing Allergy
Crustacean	• Skin reactions: Hives, eczema and rashes • Gastrointestinal reactions: Nausea, vomiting, stomach pain • Angioedema: Deep swelling of tissues, often affecting the face, lips, or throat. • Anaphylaxis: Difficulty breathing, swelling of the throat • Others: Headache, itchy mouth or ear canal	Crab, Prawns, Shrimps, Baby Shrimp ("*Koonisso*"), Cuttlefish
Fruits	• Skin reactions: Hives, eczema and Rashes • Gastrointestinal reactions: Nausea, vomiting, stomach pain, odd taste in mouth • Others: Headache, itchy mouth or ear canal	Pineapple, Mango, Papaya, Durian, Apple, Oranges, Banana (including Sour olantain and "*Anamalu"* Banana), Rose Apple ("*Jambu"*), "*Rambutan"* (*Nephelium lappaceum* L.), "*Lovi"* (*Flacourtia inermis*), *Citrus Limon*, *Tree Sorrel* ("*Bilin"*), Mangosteen (*Garcinia mangostana*), Soursop ("*Katu anoda"* - *Annona muricata*)
Meat	• Skin reactions: Hives, eczema and rashes • Gastrointestinal reactions: Nausea, vomiting, stomach pain, diarrhea • Angioedema: Deep swelling of tissues, often affecting the face, lips, or throat. • Anaphylaxis: Difficulty breathing, swelling of the throat • Respiratory reactions: Sneezing • Others: Headache, redness of the skin or around the eyes	Beef, Pork, Mutton, Venison, Sausages, Bacon

Table 3. Cont.

Food Category	Reported Signs and Symptoms	Specific Foods Causing Allergy
Fish	• Skin reactions: Hives, eczema and rashes • Gastrointestinal reactions: Nausea, vomiting, stomach pain, diarrhea • Cardiovascular reactions: Rapid heartbeat, low blood pressure, heartburn • Respiratory reactions: Wheezing • Others: Headache, redness of the skin or around the eyes • Anaphylaxis: Difficulty breathing, swelling of the throat	Tuna, Canned fish, Herrings, Dried fish, Dried sprats
Vegetables	• Skin reactions: Hives, eczema and rashes • Gastrointestinal reactions: Stomach pain • Others: Headache, redness of the skin or around the eyes, itchy mouth and ear • Cardiovascular reactions: Heartburn	Tomato, Brinjal, Moringa, Cabbage, Breadfruit, Bitter Gourd, *Sesbania Grandiflora* (*Kathurumurunga flowers*), Colocasia species (*Wel Ala Kola*), Jackfruit (*Artocarpus heterophyllus*), Lasia (*Lasia spinosa*) tender leaves (*Kohila Dalu*)
Milk and related products	• Skin reactions: Hives, eczema and rashes • Gastrointestinal reactions: Nausea, vomiting, stomach pain, diarrhea, odd taste in mouth • Anaphylaxis: Difficulty in breathing, swelling of the throat • Cardiovascular reactions: Low blood pressure, heartburn • Respiratory reactions: Wheezing • Others: Headache, irritability or nervousness, erythematous lesions on face	Cow Milk, Goat Milk, Coconut Milk, Cheese, Ice Cream, Fermented Dairy Products (Yogurt, Curd), Milk Powder containing products (Chocolates)
Molluscs	• Skin reactions: Hives, eczema and rashes • Gastrointestinal reactions: Nausea, vomiting, stomach pain, diarrhea • Cardiovascular reactions: Heartburn • Angioedema: Deep swelling of tissues, often affecting the face, lips, or throat. • Respiratory reactions: Nasal congestion or runny nose, sneezing • Anaphylaxis: Difficulty breathing, swelling of the throat • Others: Headache	squid

Table 3. Cont.

Food Category	Reported Signs and Symptoms	Specific Foods Causing Allergy
Legumes	• Skin Reactions: Eczema • Gastrointestinal reactions: Nausea, Vomiting, stomach pain, diarrhea • Others: Metallic taste or unusual taste in the mouth.	Peanuts, Peanut butter, Chickpea
Cereals	• Gastrointestinal reactions: Nausea, Vomiting, stomach pain, diarrhea • Respiratory reactions: Shortness of breath • Others: Itching or irritating of the mouth	Wheat flour-based foods (Sri Lankan short-eats and sweets, Kotthu, Dosa)
Mushroom	• Gastrointestinal reactions: Nausea, vomiting, stomach pain, diarrhea • Others: Increased body temperature and fatigue	Commercially available and homegrown wild edible mushroom (i.e. straw mushroom)
Spices	• Skin reactions: Eczema and rashes • Others: Headache, irritability or nervousness, redness and itching of the skin	Pepper, Chili Sambol, Mustard, Spicy fried rice
Eggs	• Gastrointestinal reactions: Nausea, Vomiting, stomach pain, diarrhea • Others: Loss of consciousness	Chicken eggs
Tree nuts	• Gastrointestinal reactions: Nausea, vomiting, stomach pain, diarrhea • Angioedema: Deep swelling of tissues, often affecting the face, lips, or throat. • Anaphylaxis: Difficulty breathing, swelling of the throat and difficulty in swallowing • Others: Itching of the mouth, throat, eyes, skin or any other area.	Cashew, Almonds, Chocolates containing Hazelnuts, Almonds and Cashew
Beverages	• Angioedema: Deep swelling of tissues, often affecting the face, lips, or throat. • Respiratory reactions: Shortness of breath, sore throat, sneezing • Others: Itchy mouth and ear, red bumps on skin	Soft drinks with artificial colors, Carbonated beverages
Gelatin desserts	• Skin reactions: Hives, eczema and rashes	Gelly desserts, Marshmallows and confections such as gummy bears, fruit snacks, and candy lollipop

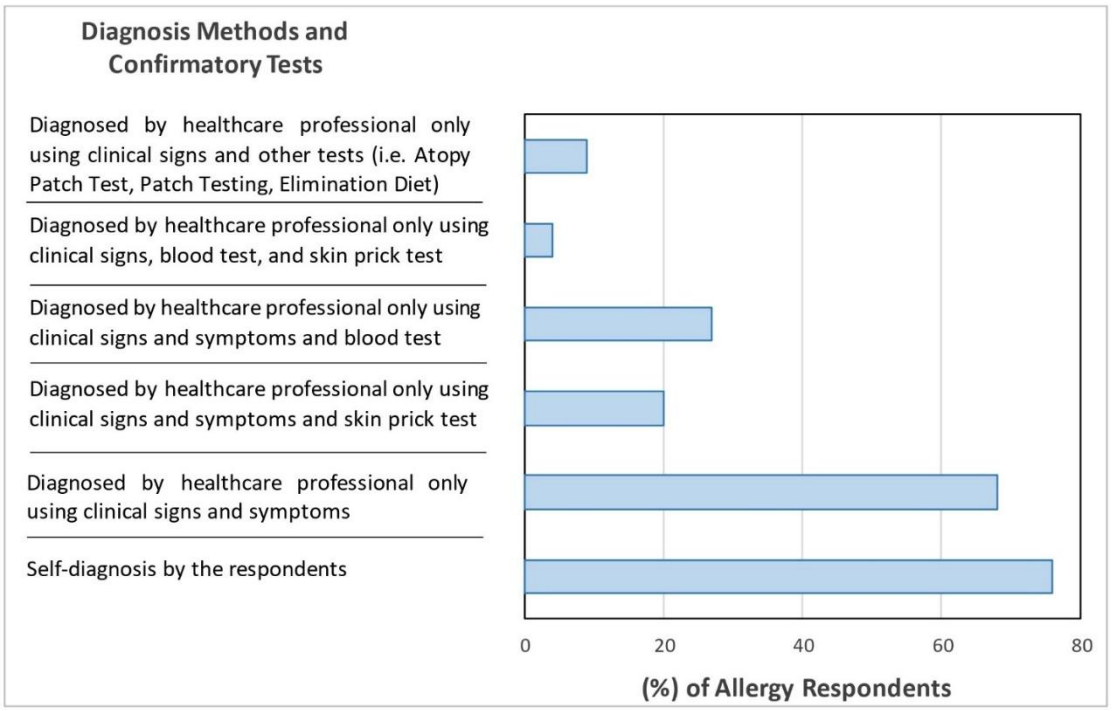

Figure 3. Methods of diagnosis and confirmatory tests for food allergy

However, self-reported data introduces the possibility of misclassification of food intolerance as allergy, particularly among those who self-diagnosed without confirmatory testing. This limitation should be considered when interpreting the findings. Among the 128 respondents (62.7%) who were diagnosed by a healthcare professional, 68 individuals (33.3% of the total respondents) did not confirm their diagnosis with a biochemical test. Figure 3 summarizes the various methods and confirmatory tests used to diagnose food allergies among the respondents.

Figure 4 shows the age distribution of initial food allergy reactions. The highest proportion (28.9%) occurred between 16–19 years, followed by 11–15 years (27%) and 6–10 years (22.5%). Early childhood (<5 years) accounted for 12.3%, while 9.3% reported onset during young adulthood (19–29 years).

Social impact of food allergies on university students

About 32.8% of participants consistently avoid allergens, indicating a high level of adherence to allergen management. Furthermore, participants who were hospitalized and/or were diagnosed with food allergies during childhood were more likely to report strict avoidance of the allergens. In contrast, 29.9% of respondents practice avoidance only sometimes, suggesting a more intermittent approach to allergy management. Additionally, 17.5% rarely avoid allergens, which could imply occasional lapses or less strict management. Interestingly, 19.4% of respondents reported never avoiding allergens, indicating a lack of adherence to avoidance strategies.

The impact of food allergies on social restrictions among respondents varies notably (Figure 5). Approximately 5.9% of participants reported experiencing social restrictions most of the time due to their food allergies, highlighting significant challenges in their social interactions. This restriction was reported more frequently by female participants than by male participants.

In contrast, 24% of respondents experience these restrictions sometimes, suggesting that food allergies occasionally affect their social life, though it is not a constant issue.

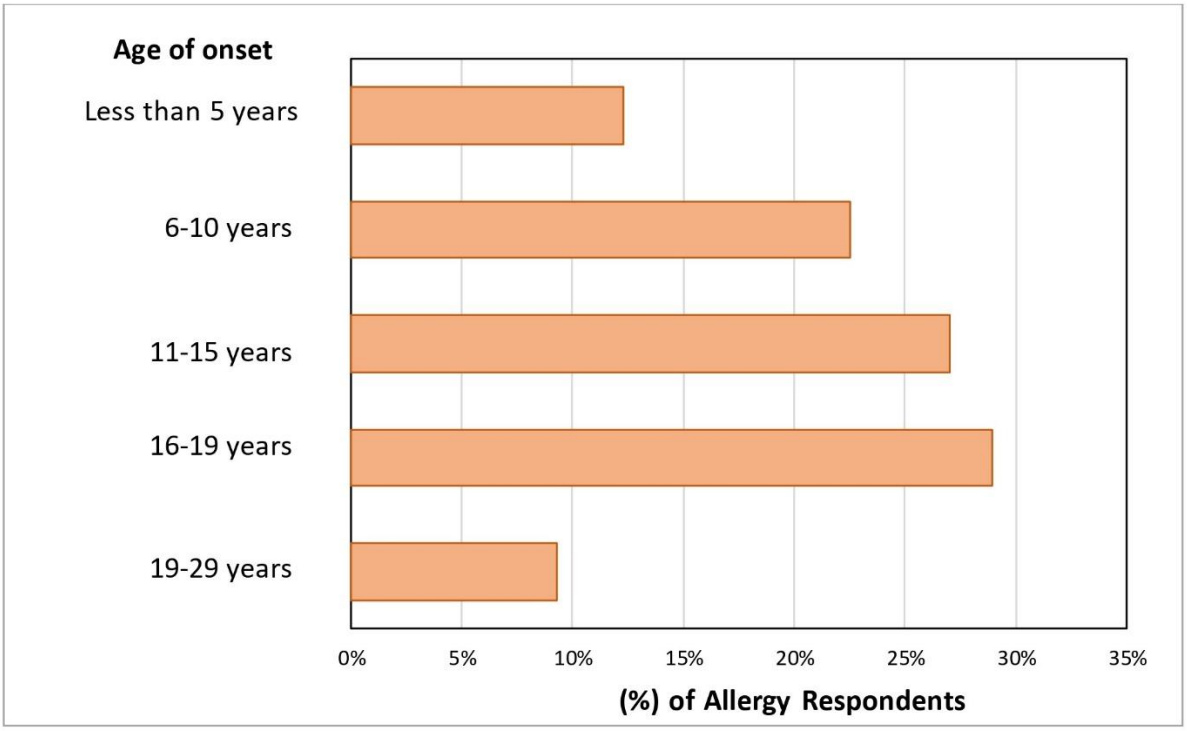

Figure 4. Age group distribution of initial food allergy reactions among university students

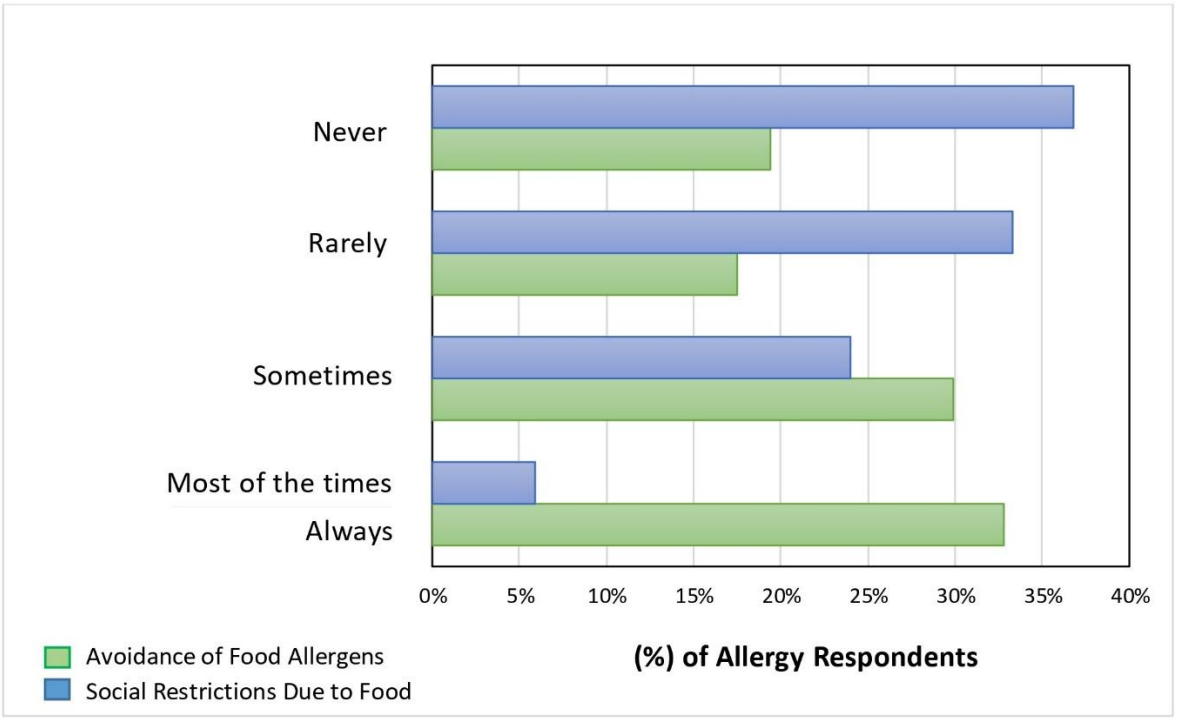

Figure 5. Food allergen avoidance and social restrictions among allergy respondents

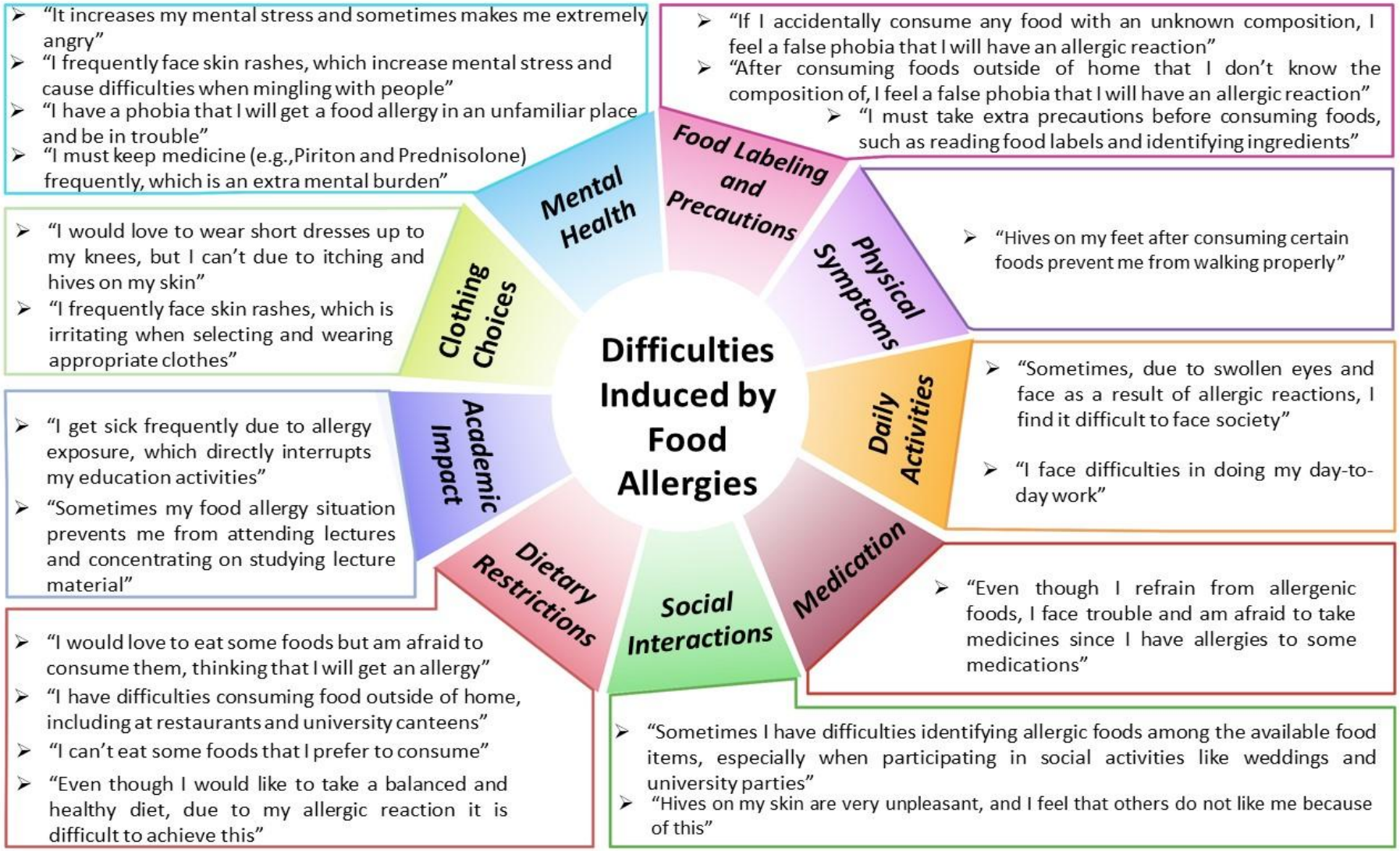

Figure 6. Various challenges reported by university students with food allergies in response to the open-ended question, "How troublesome do you find it because of your food allergy?"

A larger group, 33.3%, reported experiencing social restrictions rarely, indicating that food allergies infrequently limit their social activities. Finally, 36.8% of respondents stated they have never faced a social restriction due to their food allergies, suggesting that food allergies have a minimal impact on their social engagements.

As depicted in Figure 6, various challenges reported by university students with food allergies in response to the open-ended question, "How troublesome do you find it because of your food allergy?" The responses highlighted the significant impact of food allergies on their daily lives, both physically and mentally.

DISCUSSION

In this study, food allergies were found to be significantly more prevalent among female undergraduates at the University of Peradeniya. In contrast, a previous study on food allergies among students at Imam Abdulrahman Bin Faisal University found no statistically significant difference in the prevalence of food allergies based on gender (Hassan et al., 2020). However, other research findings have highlighted gender-specific differences in food intolerance and allergies. According to Kelly and Venu (2009), gender-specific differences become evident in food intolerance and allergies, particularly after puberty. Females tend to suffer more frequently from food-related symptoms compared to males. Several factors may explain this observation, including hormonal effects, gender-specific behaviors, risk perception, and medication intake (Afify and Pali-Schöll, 2017). Therefore, these findings highlight the need for further research to understand the role of sex in the pathogenesis of food allergies.

As potential reasons for socioeconomic factors influence on food allergy occurrence could include differences in diet, access to healthcare, environmental exposures, and awareness about food allergies. Further research is necessary to explore the underlying causes of these disparities and their implications for public health interventions. The discussion about each the food allergies is presented section wise.

Seafood allergies

Among the mollusk, Gastropods and bivalves such as abalones and oysters are not generally consumed as cephalopods. Previous studies have indicated that adults over 18 years old in Sri Lanka have allergy rates to crustaceans and mollusks of 11% and 4%, respectively (De Silva et al., 2022). A possible reason for low prevalence could be less exposure to varieties of mollusks by Sri Lankan. Tropomyosin is identified as the major allergen in many shellfish, including crustaceans (crayfish, lobster, crab, prawns) and mollusks (oyster, mussel, clam, scallop, octopus, squid, edible snails) (Prester, 2016).

Fruit and vegetable allergies

The broader range of allergenic fruits reflects the unique dietary patterns of the Sri Lankan population and underscores the need for localized studies on food allergies. Iddagoda (2023) revealed novel IgE-sensitive proteins in rose apple (*Syzygium jambos* L.) and jackfruit (*Artocarpus heterophyllus*), which belong to the same family as breadfruit. Hence, robust studies are needed to investigate the molecular basis of these endemic food items in the Sri Lankan diet.

Meat and fish allergies

The findings of this study are consistent with previous research regarding meat and fish allergies (De Silva et al., 2022; Wimalasiri et al., 2013). Canned mackerel salted fish is one of the most popular food types in Sri Lanka, and among fish-allergic university students, 87.0% reported allergies to canned fish. Major fish allergens, including parvalbumin, are heat stable and can withstand extensive cooking processes and canning (Taki et al., 2023). Thus, the management of fish allergy generally relies on complete avoidance. Moreover, patients with red meat allergies have developed allergic

reactions, including anaphylaxis to vaccines containing bovine or porcine components, such as the measles, mumps, and rubella vaccine and the live Japanese encephalitis vaccine (De Silva et al., 2022). The current study did not collect information regarding this association, which merits further investigation.

Interestingly, this study highlighted that only a few individuals exhibited itching and rashes after consuming dried fish and dried sprats, suggesting that although many Sri Lankans consume dried fish, these specific fish products may have a lower allergenic potential compared to other types. Compared to meat and fish, reported allergies to eggs are very low (1%) among university students. Previous literature also highlights that the prevalence of egg allergy in Asia is lower than in developed Western countries (De Silva et al., 2022; Arakali, Green, and Dinakar, 2017).

Milk, dairy allergies, and other allergens

Iddagoda et al. (2022) highlighted that coconut allergies are not rare in Sri Lanka despite its popularity among Asians. This study also emphasized that patients with a history of immediate IgE hypersensitivity to coconut milk are advised to avoid fresh or boiled coconut milk.

It is believed that the early introduction of peanuts reduces the risk of peanut allergy (Du Toit., 2015). In Sri Lanka, the introduction of peanuts after 8-12 months is recommended, which may explain the low incidence of peanut allergy in this study population (Jayatissa et al., 2012). De Silva et al. (2017) reported that adults in Sri Lanka show allergies to sesame, which was not observed in this study. Furthermore, although university students frequently consume soy meat, like textured vegetable protein, the study population did not report any allergies to soy products. This aligns with previous findings (Wimalasiri et al., 2013).

Although food additives generally do not pose issues for most individuals, a subset of people with specific allergies may react adversely to certain additives, such as artificial colors and sulfites (Bahna and Burkhardt, 2018). This observation highlights the need for further investigation into the prevalence and impact of these food additives in the Sri Lankan population. Another interesting finding is that 7.4% of participants reported allergies to both commercially available and wild mushrooms, which has also been documented in previous literature (Arakali, Green, and Dinakar, 2017). In addition, honey products contain a variety of allergens from bees and the substances they collect (pollens, nectar, propolis) and produce (honey, royal jelly) (Kumar Gupta and Stangaciu, 2014). Despite being tested in this study, no allergies were reported for honey.

In contrast to the findings of the present study, previous findings suggest that allergic reactions to certain foods such as sea foods and fruits (mangoes, peaches and oranges) developed symptoms within minutes after eating the causative foods (Feng et al., 2022). Studies have explained that the delayed presentations of symptoms are often associated with the difficulty in determining the exact type of food responsible for allergic responses (Zukiewicz-Sobczak et al., 2013). With that regard, further studies involving medical investigations may assist in better defining patterns of food allergy among young adults.

According to the present survey, reported severe reactions were primarily associated with meat, dairy, and seafood, necessitating immediate medical attention. In contrast, mild and moderate symptoms were more commonly linked to fruits and vegetables. Among the respondents who reported food allergies, twelve individuals indicated that they always carry allergy management drugs to address reactions promptly. Licari et al. (2019) highlighted several promising practices for food allergy management, such as allergen-specific immunotherapy, anti-cytokine therapy, toll-like receptor (TLR) therapy, gene therapy, and probiotic treatments. These approaches warrant further investigation, particularly within the Sri Lankan population.

In this survey, university students with food allergies reported that blood tests and skin-prick tests are commonly used as rapid diagnostic methods after consultation with healthcare professionals. However, the accuracy of these tests can vary (Jacob and Sicherer, 2017). The oral food challenge is considered the gold standard for food allergy diagnosis (Calvani et al., 2019). This method involves the supervised consumption of the suspected allergen in gradually increasing amounts, with medical professionals monitoring adverse reactions. Oral food challenges provide direct evidence of an allergic reaction, making them more accurate than skin prick tests and blood tests, which can yield false-positive or false-negative results. Despite their accuracy, practical considerations often limit the widespread use of oral food challenges.

Present survey suggests that new food allergies can develop in young adulthood, particularly due to exposure to new food products such as crustaceans and mollusks. Young adults in university, who have more financial independence, tend to eat at restaurants more often and are therefore more exposed to seafood. The variability in the reported age of onset could be influenced by the small sample size and recall bias, as participants might have difficulty in accurately remembering their first allergic reaction and may instead recall a more recent adverse reaction.

From a social impact perspective, previous studies reported that the risk of severe allergic reactions and the anxiety associated with the strict avoidance of food allergens have been shown to negatively impact on the quality of life of these patients (Warren et al., 2016).

As demonstrated by this survey, many students reported being unable to eat certain foods they preferred. Some mentioned a fear of consuming foods they would love to eat due to the risk of an allergic reaction. This often makes it difficult for them to maintain a balanced and healthy diet. The stress and anxiety associated with food allergies were common themes, with some students mentioning increased mental stress and episodes of extreme anger. Students frequently face difficulties performing day-to-day tasks, including eating out at restaurants and university canteens. There is a persistent fear of having an allergic reaction in unfamiliar places, leading to significant anxiety. Participating in social activities like weddings and university parties can be challenging due to difficulties in identifying allergenic foods. Swollen eyes, face, and frequent skin rashes caused by allergic reactions affect their confidence and social interactions. The necessity of keeping and taking medications adds a significant mental burden, especially for those who also have allergies to certain medicines.

Food allergies often interrupt educational activities. Some students reported missing lectures and having difficulty in concentrating on their studies due to frequent illnesses and allergic reactions. Extra precautions, such as reading food labels and identifying ingredients, are necessary before consuming food. The fear of accidental exposure to allergens leads to anxiety after eating unknown foods. Skin rashes and hives affect clothing choices, with some students unable to wear short dresses due to itching and hives. Frequent skin rashes, itching, and hives are not only physically uncomfortable but also lead to increased mental stress. Hives on the feet can even prevent proper walking. The responses underscore the need for comprehensive support systems for university students with food allergies to manage their condition effectively and reduce the associated physical and psychological burdens. Further research and targeted interventions are necessary to improve the quality of life for individuals living with food allergies.

CONCLUSIONS

Food allergies are a growing public health issue that significantly affects individuals' quality of life. This study found a self-reported prevalence of 17.5% for food allergies among young adults in Sri Lanka in a selected setting,

with notable associations with gender and family income. The primary allergens identified included crustaceans, fruits, meat, fish, and vegetables. Most participants experienced moderate symptoms that could be managed with Western medication, although many had not consulted healthcare professionals for diagnosis. This underscores the need for effective interventional strategies to manage severe reactions and enhance the quality of life for university students with food allergies. While confirmatory testing and appropriate treatment are essential, it is important to avoid unnecessary dietary restrictions. Educational and social support programs can provide individuals with valuable information about dietary modifications and potential allergens, thereby improving their overall well-being. The study's limitations include its reliance on self-reported data and lack of objective allergy testing. Future research involving formal medical investigations is needed to accurately assess the prevalence and patterns of food allergies among university students.

DATA AVAILABILITY STATEMENT

The datasets generated and/or analyzed during the current study are not publicly available due to protecting individual privacy, but de-identified portions of the data are available from the corresponding author on reasonable request.

STATEMENT OF ETHICS

Ethical approval for this study was obtained from the Institutional Review Board at the Ethical Clearance Committee (ECC), Faculty of Agriculture, University of Peradeniya (Certificate Number: ECC/2021/e/003). Participation in the research was entirely voluntary, with no coercion or incentives offered to potential participants.

CONFLICT OF INTEREST

The authors have no conflicts of interest to declare.

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