**Original Research Article**

**Prevalence, severity and risk factors of food allergy and food addiction among the people of Tangail district, Bangladesh**

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**ABSTRACT**

**Background:** Food allergy is an abnormal response of some particular foods triggered by the body’s immune system. Food addiction which generally shares a similar neurobiological and behavioral framework with substance addiction like foods. The aim of this study was to evaluate common food items responsible for food allergy along with food addiction among Bangladeshi people.

**Methods:** A cross-sectional study among 699 participants in the Tangail district of Bangladesh was done to record the presence of food allergy and food addiction patterns. Chi-square tests and logistic regression analysis were performed to assess the association between different factors with food allergy and food addiction.

**Results:** It was found that brinjal was the most frequent food item responsible for 28.3% of people’s food allergy. The main symptoms due to the food allergy were about 28.5% itching and 22.7% rash on the skin. According to this study, 50.4% of allergic patients took medicine and most of the allergic patients didn’t seek medical advice. A maximum of 72.8% of allergic patients also had an addiction to food. Street foods like jhalmuri, fried foods were the general food addicted items covering 34.9%. Food-addicted participants with food allergies reported significantly more problems with foods, where obesity and heart disease are recognized as clinical effects due to having higher amounts of fat and sugar to these foods.

**Conclusions:** The study revealed some important determinants of food allergic and food addiction that will help to increase our knowledge for the greater interest of our health and further research.

**Keywords:** Bangladesh, Food allergy, Food addiction, Hypersensitivity, Immune system, Knowledge

**INTRODUCTION**

Food is an integral part of life, even though some foods are responsible for allergies and some may even lead to fatality. Over 2000 years ago, Hippocrates has first recognized the adverse reactions to food who often addressed as the “Father of Medicine”. Food allergy is an adverse immune response reaction to food, especially proteins. This immunologic adverse reaction not to toxic contaminants or pharmacologic characteristics of the food; it may be due to metabolic disorders of the host or idiosyncratic responses, such as lactase deficiency. Due to the immature immune system in childhood and/or the inappropriate food introductory practices, children are more likely to develop food allergies than adults. A current study revealed that about 20% of the adult population of developed countries and 40-50% of school-going children are suffered by different allergic problems.

Food allergy expresses different kinds of symptoms on the skin including itching, urticaria, eczema,
angioedema, dermatitis, as well as in the gastrointestinal tract including vomiting, abdominal cramping, nausea, diarrhea and in the respiratory tract disorder including rhinitis, asthma, laryngeal edema. Anaphylactic shock is the most frightening symptom which is induced by a particular food that is acute in onset, occurring within minutes or hours, and without proper treatment, it may lead to death badly. Much other allergic disorder has been found in different organ systems that increase the risk of other allergic condition due to consuming allergic food items. These conditions could be minimized if proper strategies are taken followed by its early identification. About 49% perceive diet plays an important part in the control of their asthma was investigated by Melbourne Hospital.

The most common allergenic foods are beef, cow’s milk and dairy products, brinjal, hen’s egg, prawn, peanuts, gluten-containing cereals (e.g., wheat, rye, barley), mustard sesame, soybeans, fish, nuts crustaceans, and shellfish. Cow’s milk and eggs are recognized as the most common food allergens in the United States, while fruits and eggs in Europe and Middle East countries respectively. By changing the environmental lifestyle and adopting a westernized lifestyle increased the frequency of food allergy, as the western populations documenting the highest prevalence. Different genetic factors are also responsible for allergic reactions to food as having two or more family members with a history of allergy was more strongly predictive of food allergy in the child.

Food addiction could act in a similar way to other substance addictions, may have addictive potential and that some types of obesity and disordered eating may be the result of an addictive response to these foods. Yale food addiction scale (YFAS) is generally used to define and measure food addiction in humans by modifying the seven symptoms of substance dependence using the DSM-IV diagnostic criteria (The Diagnostic and Statistical Manual of Mental Disorders). The seven symptoms assessed in the scale were (i) tolerance (consuming more to achieve desired effects), (ii) withdrawal symptoms (agitation, anxiety, or other physical symptoms experienced after cutting down on certain foods), (iii) larger amounts consumed than intended, (iv) persistent desire or unsuccessful attempts to cut down, (v) much time spent using or recovering from substance, (vi) continual use despite knowledge of consequences, (vii) activities are given up due to use of substance.

The food addicted person chronically consumes more food than they need to maintain health. Food addiction is often associated with some adverse clinical characteristics like increased body weight, depression, anxiety, and substance abuse. The purpose of this study was to determine the most common food allergens in children and adults with various allergic symptoms and digestive problems along with food addiction in Tangail, Bangladesh.

METHODS

Study area and data collection

A descriptive, cross-sectional study was conducted by using a structured questionnaire developed from literature review and consultations with faculty members. This cross-sectional study was done on August 2019-January 2020. This comprised of the rural and urban parts of the Tangail district in Bangladesh. The approval for conducting this study was obtained from the Institution of Mawlana Bhashani Science and Technology University under the Department of Biotechnology and Genetic Engineering.

Sampling technique

The minimum sample size was estimated at 600 participants. However, a total of 699 participants were enrolled during the study period. These participants were chosen from households and educational institutions by systematic random sampling method. The questionnaire consisted of three main sections: (1) socio-demography (2) food allergy-related (24 items) and (3) food addiction-related (11 items). The questionnaire was translated from English to Bengali language when anyone fails to understand. Participants were asked about the presence or absence of food allergy symptoms. Then we provided the questionnaire to allergic patients, and they filled the questionnaire according to their allergic condition.

Statistical analysis

The data collected from the survey were analyzed by IBM SPSS version 20. Descriptive statistical analysis was used to provide estimates of population proportions with their respective 95% confidence intervals. Cross tabulations were performed with Chi-square tests to assess the statistical significance (p<0.05). Logistic regression analysis was done to examine the association between different factors with food allergy and food addiction. Microsoft Excel version 2016 was used to draw graphs wherever appropriate.

RESULTS

Demographic factors

A total of 699 respondents were interviewed for this study and the obtained data was used for the primary analysis. Out of which 51.2% were, males and 49.8% were females and most of them (51.8%) were lived in the village. The mean age of the participants was 29.35±13.46 years. Around half (49.6%) of the participants were students, out of 382 (54.6%) had at least one family member with allergic problems (Table 1).
Table 1: Socio-economic characteristics of the participants.

| Variables                  | N (%)        |
|----------------------------|--------------|
| Gender                     |              |
| Male                       | 358 (51.2)   |
| Female                     | 341 (48.8)   |
| Age in years (Mean±SD)     | 29.3±13.46   |
| Living place               |              |
| Village                    | 362 (51.8)   |
| Semi town                  | 171 (24.5)   |
| Town                       | 166 (23.7)   |
| Literacy status            |              |
| No formal schooling        | 59 (8.4)     |
| Primary                    | 208 (29.8)   |
| Secondary                  | 116 (16.6)   |
| H.S.C.                     | 273 (39.1)   |
| Graduate                   | 37 (5.3)     |
| Post graduate              | 6 (0.9)      |
| Employment status          |              |
| Farmer                     | 44 (6.3)     |
| Laborer                    | 32 (4.6)     |
| Business                   | 51 (7.3)     |
| Govt. job                  | 42 (6.0)     |
| Non govt. job              | 36 (5.2)     |
| Housewife                  | 139 (19.9)   |
| Student                    | 347 (49.6)   |
| Unemployed                 | 8 (1.1)      |
| Socio economic status      |              |
| Lower                      | 84 (12)      |
| Lower middle               | 231 (33)     |
| Middle                     | 340 (48.6)   |
| Upper middle               | 43 (6.2)     |
| Higher                     | 1 (0.1)      |
| Have family members with allergic problems | | |
| Yes                        | 382 (54.6)   |
| No                         | 317 (45.4)   |

Allergy symptoms and its caused foods

Of the 699 respondents, a total of 561 (80.3%) had heard about food allergy though all the participants had the symptoms of food allergy. When the participants were asked about the food allergens, most of them answered they were positive to more than one allergen. Under all studied patients, the most common foods responsible for food allergy was brinjal (28.3%) following hilsa fish (19%) and beef (17%). Most of the patients showed more than one symptom. Skin reactions, including itching (28.5%), rash (22.7%) are the most common symptoms among food allergy patients. Some participants also reported, facial itching (9.3%), throat swelling (2.4%) while 5.3% and 4.3% reported itching on the eyes and vomiting. In this study the allergic condition of the participants was not threatened at all; it could be potentially fatal in a minor group. Around two-thirds (63.4%) of the participants had a mild allergic condition (Table 2).

Table 2: Prevalence of self-reported food allergy, symptoms and allergic condition towards food allergy.

| Variables                  | N (%)        |
|----------------------------|--------------|
| Heard about food allergy   |              |
| Yes                        | 561 (80.3)   |
| No                         | 138 (19.7)   |
| Foods responsible for allergy|          |
| Beef                       | 119 (17)     |
| Hilsa fish                 | 132 (18.9)   |
| Milk                       | 25 (3.6)     |
| Egg                        | 12 (1.7)     |
| Brinjal                    | 198 (28.3)   |
| Prawn                      | 66 (9.4)     |
| Poultry chicken            | 18 (2.6)     |
| Arum                       | 47 (6.7)     |
| Malabar spinach            | 65 (9.3)     |
| Okra                       | 17 (2.4)     |
| Symptoms                   |              |
| Itching of the mouth       | 55 (7.9)     |
| Hives                      | 41 (5.9)     |
| Lip or tongue swelling     | 21 (3)       |
| Dyspnoea                   | 29 (4.1)     |
| Diarrhea                   | 9 (1.3)      |
| Swelling of the throat     | 17 (2.4)     |
| Difficulty swallowing     | 13 (1.9)     |
| Abdominal pain             | 23 (3.3)     |
| Rash in skin               | 159 (22.7)   |
| Itching on skin            | 199 (28.5)   |
| Vomiting tendency          | 30 (4.3)     |
| Anaphylaxis                | 1 (0.1)      |
| Itching on the eyes        | 37 (5.3)     |
| Allergic condition         |              |
| Acute                      | 120 (17.2)   |
| Chronic                    | 102 (14.6)   |
| Severe                     | 34 (4.9)     |
| Mild                       | 443 (63.4)   |

Table 3: Regression analysis on demographic factors associated with knowledge of food allergy.

| Variable                  | B   | OR   | 95% CI          | P value |
|---------------------------|-----|------|-----------------|---------|
| Age                       | 0.011 | 1.011 | 0.988-1.035 | 0.338 |
| Gender                    | -0.236 | 0.790 | 0.483-1.290 | 0.346 |
| Education                 | -0.598 | 0.550 | 0.436-0.695 | <0.001*** |
| Occupation                | 0.096 | 1.100 | 0.943-1.284 | 0.224 |
| Marital status            | 0.976 | 2.653 | 1.191-5.910 | 0.017** |
| Living place              | -0.305 | 0.737 | 0.531-1.023 | 0.068 |
| Socioeconomic status      | -0.511 | 0.600 | 0.450-0.800 | <0.001*** |

*CI=confidence interval *OR=odd ratios, *p<0.05, **p<0.01, ***p<0.001.

A significant association was found between the degree of knowledge and level of education among respondents (p<0.001; OR=0.550, 95% CI=0.436-0.695). There was no significant association between age, gender, and living place with the level of knowledge. There was also a
positive association between the knowledge level with socio-economic status (p<0.001; OR=0.600, 95% CI=0.450-0.800) (Table 3).

**Long-term effects**

Sometimes, the long-term effects of food allergy might be life-threatening like anaphylaxis. When asked about the long-term effects, 42.3% (296) had no effect followed by 15.3% (107) rash and 26.9% itching (Figure 1).

![Figure 1: Long-term effects of food allergy.](image)

**Practice related to food allergy prevention**

The extent of attitude and preventive practices regarding food allergy were summarized in Table 4. The majority of the participants only avoid allergic food when they suffered from allergy and only 25% of participants tried to avoid the foods responsible for allergy. Half of the food allergy sufferers took medicine to relief from this problem where only 38% sought medical advice from doctors. Although most participants did not participate in a diagnostic test, the most (19.6%) common diagnostic tool was a blood test (specific IgE) followed by skin prink test (4.9%) and oral food challenge (1.9%). Chi-square test was used to determine the association between allergic conditions and the participant’s attitude to get rid of allergy. Avoiding allergic food, taking medicine, sought medical advice from doctors all of the three factors were significantly associated with the allergic condition (p<0.001) (Table 5).

![Table 4: Attitude and preventive measures of food allergy.](image)

| Variables                      | N (%)          |
|-------------------------------|----------------|
| Try to avoid allergic foods   |                |
| Yes                           | 178 (25.5)     |
| No                            | 250 (35.8)     |
| Sometimes                     | 271 (38.8)     |
| Problem faced after avoiding allergic foods |          |
| Yes                           | 121 (17.3)     |
| No                            | 578 (82.7)     |
| Taking medicine               |                |
| Yes                           | 352 (50.4)     |
| No                            | 347 (49.6)     |
| Consult with doctor           |                |
| Yes                           | 267 (38.2)     |
| No                            | 432 (61.8)     |
| Diagnosis                     |                |
| Skin prink test               | 34 (4.9)       |
| Blood test                    | 137 (19.6)     |
| Patch test                    | 2 (0.3)        |
| Oral food challenge           | 13 (1.9)       |
| Never                         | 513 (73.4)     |

| Table 5: Association of preventing practices of food allergy with the allergic condition. |
|-----------------------------------------------|----------------|
| Variable                        | Allergic condition | Chi-square | P-value |
| Try to avoid allergic foods       |                  |            |         |
| Yes                             | Acute 36 (30%) | Chronic 21 (20.6%) | Severe 13 (38.2%) | Mild 108 (24.4%) | 24.387 | <0.001*** |
| No                              | 31 (25.8%) | 54 (52.9%) | 6 (17.6%) | 159 (35.9%) |            |         |
| Sometimes                       | 53 (44.2%) | 27 (26.5%) | 15 (44.1%) | 176 (39.7%) |            |         |
| Taking medicine                 |                  |            |         |
| Regularly                       | 24 (20%) | 15 (14.7%) | 2 (5.9%) | 24 (5.4%) | 92.646 | <0.001*** |
| Sometimes                       | 26 (21.7%) | 55 (53.9%) | 10 (29.4%) | 103 (23.3%) |            |         |
| Only when feeling uncomforted   | 64 (53.3%) | 23 (22.5%) | 17 (50%) | 215 (48.5%) |            |         |
| Never                           | 6 (5%) | 9 (8.8%) | 5 (14.7%) | 101 (22.8%) |            |         |
| Consult with doctor             |                  |            |         |
| Yes                             | 69 (57.5%) | 37 (36.3%) | 16 (47.1%) | 145 (32.7%) | 25.837 | <0.001*** |
| No                              | 51 (42.5%) | 65 (63.7%) | 18 (52.9%) | 298 (67.3%) |            |         |

**Addiction to food**

While all participants in this study suffered from food allergies, most participants also reported their addicted behavior to food when they were asked about their food addiction. Around 72% (95% CI=1.24-1.30) reported having an addiction to different food items.
Prevalence of food addicted items

Addictive food items usually act like drugs such as high salt and sugary fast food, street foods. Among the respondents, most of the students were more addicted to street food like jhalmuri, fried foods than the other participants. A total of 34.9% (244) respondents were addicted to jhalmuri, fried foods and 27.2% didn’t have any comment (Figure 3).

Knowledge, attitude and practice (KAP) level

Half of the respondents (49.5%; 346/699) ate large quantities of foods at one time, and 47% of the respondents had the tendency to eat addicted food items even though they were not hungry. Although most participants (78%) were aware of the clinical effects of food addiction, only 28% tried to avoid eating these foods excessively (Table 6).

Table 6: Knowledge, attitude and practice towards food addiction.

| Characteristics                        | N (%)     |
|----------------------------------------|-----------|
| Eating large quantities of foods at one time |          |
| Yes                                    | 346 (49.5) |
| No                                     | 353 (50.5) |
| Ever hidden food                       |           |
| Yes                                    | 187 (26.8) |
| No                                     | 512 (73.2) |
| Eat even if you were not hungry        |           |
| Yes                                    | 330 (47.2) |
| No                                     | 369 (52.8) |
| Eating in secret                       |           |
| Yes                                    | 152 (21.7) |
| No                                     | 547 (78.3) |
| Clinical effects of food addiction     |           |
| Yes                                    | 548 (78.4) |
| No                                     | 151 (21.6) |
| Try to avoid eating large quantities of food |      |
| Yes                                    | 195 (27.9) |
| No                                     | 504 (72.1) |

In the binary logistic regression analysis of the associations between having addiction on food and the participant’s attitude of the study group (Table 7), we found increased odds of having the attitudes among the participants about food addiction if the participants ate large quantities of foods at one time (OR: 11.528; 95% CI: 6.522-20.377) or ate even if they are not hungry (OR: 2.509; 95% CI: 1.528-4.118) or eating in secret (OR: 2.639; 95% CI: 1.259-5.528). No significant association was found for preventive practices.

Education has an impact on knowledge about the clinical effects of food addiction. A significant association was found between the degree of knowledge and level of education among respondents. Participants with a qualification of post-graduation (100%) were more than two times more knowledgeable as compared to the illiterate (50.8%). While persons with qualifications of intermediate (H.S.C) were 1.7 times more knowledgeable than illiterates (Table 8).

Table 7: Regression analysis on different characteristics associated with food addiction behaviour.

| Variables                                      | B     | OR    | 95% CI       | P value |
|------------------------------------------------|-------|-------|--------------|---------|
| Eating large quantities of foods at one time   | 2.445 | 11.528| 6.522-20.377 | <0.001***|
| Ever hidden food                               | 0.565 | 1.759 | 0.968-3.195  | 0.064   |
| Eat even if you are not hungry                 | 0.920 | 2.509 | 1.528-4.118  | <0.001***|
| Eat in secret                                  | 0.970 | 2.639 | 1.259-5.528  | 0.010** |
| Try to avoid eating large quantities of food   | -0.186| 0.830 | 0.480-1.437  | 0.506   |
| Searching foods when unavailable at home      | 0.225 | 1.252 | 0.764-2.051  | 0.373   |
In the past 2 decades, food allergy has emerged as a ‘second wave’ of the allergy epidemic after the rise in asthma and rhinitis.\textsuperscript{21,31} Peanut, soybean, cow’s milk, egg, fish, crustacean shellfish, wheat, and tree nuts as the eight most common food allergens were recognized by the US Food and Drug Administration.\textsuperscript{32} Besides these 8 foods, beef in China, rice in Thailand, sesame in Singapore, pork, seafood, and peaches in Korea, bananas in Saudi Arabia and Egypt, apples, tomatoes, and crab in Zimbabwe, peanuts and pineapples in Ghana, shrimp and oranges in Mexico, and corn in Brazil are important food items that were responsible for causing the allergy.\textsuperscript{33} The variance of allergy-causing food items varies in different countries depends on the food habits, genetic factors, and culture of the inhabitants.\textsuperscript{34} The Bangladeshi population has distinctive food habit that is different from other countries.

There was no established data on food allergy among the people of Bangladesh. This study set out to compare self-reported food allergy knowledge, the available food responsible for food allergy, symptoms, family background, and different correlations based on food allergy.\textsuperscript{35} Some aspects of food allergy management (e.g. educating patients about food avoidance, recognizing signs and symptoms, understanding definitions) were well rated to avoid food allergy.\textsuperscript{36} In this study, we found that almost 55% of the participants had a family history of allergy. A previous population-based study in Kolkata, 63.18% of patients had a family history of allergy.\textsuperscript{33}

The survey result showed that brinjal was found to be the most allergenic food item (28.3%), followed by beef and hilsa fish, about 17% and 18.9%, respectively, for food allergy. In a previous study in Kolkata, India, about 33.3% were sensitive to prawn, 43.42% to brinjal, and 20.6% to beef among 16 to 40 years aged patients.\textsuperscript{34} A recent study done in Lebanon showed that the most common food allergens were strawberry (16%) followed by eggs (19%) and nuts (16%).\textsuperscript{1} In a study in the United Arab Emirates, seafood and nuts were the most common food allergens.\textsuperscript{37} In this study, the most common symptoms of food allergic reactions were skin manifestations. About 28.5% and 22.7% of people were suffering from itching and rash on the skin as a symptom of food allergy. Skin manifestations were also the most frequently stated symptoms in similar studies conducted in Taiwan, Korea.\textsuperscript{38} Other symptoms also being noticed among the respondents were itching on the throat about 7.9%, vomiting tendency 4.3%, hives 5.9% and dyspnoea 4.1%. A study conducted in Lebanon, 86% of the food allergy sufferers suffered from skin reactions, including hives, itching, and redness and 30% reported facial swelling.\textsuperscript{1} Diarrhea, difficulty swallowing, abdominal pain, and anaphylaxis also being observed in allergic patients. About 63% of the allergic patients experienced a mild allergic condition. In a study in Kuwait, similar findings were also reported among the students with probable food allergy.\textsuperscript{39} Although there was no permanent solution to get relief from food allergy except avoiding these foods, only 25% of participants tried to avoid the foods responsible for allergy.

In this study, among the patients of food allergy, we tried to find out whether they were food addicted or not and find out the general addicted food items. However, the majority (72%) of the respondents reported that they had an addiction to different food items. Different previous studies indicated that the most common symptom of food addiction was “the persistent desire or unsuccessful attempts to cut down foods.”\textsuperscript{25} Among 47% population had the same symptom found in this study. Food addiction-like overeating tendency has been linked to overweight and obesity with their adverse health consequences, including insulin resistance and diabetes mellitus.
hypertension, and cardiac disease. Despite the fact that 78% of participants were aware of these effects, only 26% tried to avoid these foods.

This study suggested meaningful outcomes in that additional allergenic foods should be designated to ensure safe food service for the family especially children should advocate for a better allergy labelling system to inform and protect people. Future studies could use information about the prevalence and types of food allergy among another region of Bangladesh to develop effective educational programs and implement preventive measures on food-related allergies.

Limitation of the study was that due to a lack of knowledge, most people do not have proper knowledge about food allergy and food addiction as well as their harmful effects on health. Based on self-reported symptoms, the food allergy was diagnosed and not by laboratory investigations. Further research is needed to identify the role of genetic factors regarding food allergy.

CONCLUSION

Food allergies are recognized as a growing problem in the western world as well as in developing countries nowadays. This survey will be increasingly important to understand and assess the interplay between food allergy and food addiction in order to protect and identify appropriate sources of foods for sensitized sub-populations. Brinjal was recognized as the most frequent allergic food item responsible for various allergic conditions like skin reactions. This study also concluded the general symptoms and other qualitative and quantitative analyses that help to reduce the rate of allergic conditions and ensure a better food menu for the family. In addition, the study revealed, human food addiction behaviour, identification of common items of addictive food, physiological effects, and attitudes of concern with food addiction. This study can be helpful for people to avoid addicted food and enjoying a better life.

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