Heliyon 9 (2023) e15831

Contents lists available at ScienceDirect

Heliyon

journal homepage: www.cell.com/heliyon

Research article

Food neophobia and its association with sociodemographic factors and food preferences among Bangladeshi university students: Evidence from a cross-sectional study

Sumaia Sahrin [a], Md. Hasan Al Banna [b,c,*], M. A. Rifat [d,**], Justice Kanor Tetteh [e], Tasnu Ara [f], Mohammad Hamiduzzaman [g], Charles Spence [h], Satyajit Kundu [i,b], Mohammad Tazrian Abid [b], M.M. Mehedi Hasan [a], Nargees Akter [j], Ashish Biswas [k], Dilruba Easmin Jharna [l]

[a] *Department of Human Nutrition and Dietetics, Faculty of Nutrition and Food Science, Patuakhali Science and Technology University, Patuakhali 8602, Bangladesh*
[b] *Faculty of Nutrition and Food Science, Patuakhali Science and Technology University, Patuakhali 8602, Bangladesh*
[c] *Nutrition Initiative, Khustia, Bangladesh*
[d] *Department of Global Public Health, Karolinska Institutet, Stockholm, Sweden*
[e] *Department of Population and Health, University of Cape Coast, University Post Office, Cape Coast, Ghana*
[f] *Department of Food and Nutrition, College of Home Economics, Dhaka 1205, Bangladesh*
[g] *Faculty of Health, Southern Cross University, Gold Coast Campus, QLD, 4225, Australia*
[h] *Department of Experimental Psychology, University of Oxford, Oxford OX2 6BW, UK*
[i] *Global Health Institute, North South University, Dhaka 1229, Bangladesh*
[j] *Department of Geography and Environmental Studies, University of Chittagong, Chittagong 4331, Bangladesh*
[k] *Faculty of Agriculture, Patuakhali Science and Technology University, Patuakhali 8602, Bangladesh*
[l] *Department of Biochemistry and Food Analysis, Faculty of Nutrition and Food Science, Patuakhali Science and Technology University, Patuakhali 8602, Bangladesh*

ARTICLE INFO

Keywords:
Food neophobia
Food preferences
Demographics
University students
Bangladesh

ABSTRACT

Food neophobia, described as a reluctance to eat and or avoid new food, is a personality trait that affects food choice. Despite its potential influence on an individual's food intake, food neophobia has been poorly investigated in Bangladesh. This cross-sectional study was designed to evaluate food neophobia and its association with sociodemographic factors and food preferences in a sample of Bangladeshi university students. Five hundred students from five public universities completed the structured surveys. Food neophobia was assessed by a 10-item validated food neophobia scale with some minor modifications based on study settings. A multiple linear regression model was used to observe the factors associated with food neophobia. The mean food neophobia score among study participants was 37.45 (SD: 13.39, Range: 13–67). According to the adjusted statistical model, being female (regression coefficient, $\beta = 2.73$), having higher monthly family income ($\beta = -6.64$), being underweight ($\beta = 4.68$), being overweight ($\beta = -4.63$), having any food allergy ($\beta = 9.09$), and a history of sickness after eating a new food item ($\beta = 5.16$) were significantly associated with food neophobia amongst the participants. The participants' liking of various food items such as vegetables were significantly correlated with food neophobia scores.

* Corresponding author. Faculty of Nutrition and Food Science, Patuakhali Science and Technology University, Patuakhali, Bangladesh.
** Corresponding author.
E-mail addresses: banna.nfs.pstu@gmail.com (Md.H.A. Banna), m.a.rifat@stud.ki.se, rifatahmed011@gmail.com (M.A. Rifat).

https://doi.org/10.1016/j.heliyon.2023.e15831
Received 20 January 2023; Received in revised form 21 April 2023; Accepted 24 April 2023
Available online 28 April 2023

Nutrition education policies and programs are of importance to address the students' food neophobia during their tertiary education so that they maintain lifelong healthy dietary habits and consume a variety of foods to improve their physical health and well-being.

1. Introduction

An individual's food choices are determined by a wide range of factors, including intrinsic properties of the foods themselves, hunger and satiety levels, personality traits, food behavior, and food availability/accessibility [1–5]. Cognitive and motivational factors have also been found to influence an individual's acceptance or resistance of certain foods [6]. Food neophobia has been defined as the resistance, or reluctance, to try those foods that are novel or unknown [7]. From the evolutionary and adaptive points of view, food neophobia is genetically ingrained in human behavior to protect people from consuming potentially harmful and poisonous substances. This behavior, therefore, reduces people's propensity to try new or unknown foods, even though they might be nutritious [8]. Food neophobia has been shown to be associated with individual, familial, and cultural factors, including age, sex, gender, ethnicity, food preference, maternal age and education, and geographical location [9–12]. However, the intensity of food neophobia is not the same throughout an individual's lifetime. For example, it is the highest during early childhood, tends to reduce from early adulthood to adulthood, and gradually increases while aging [13–15].

Young adults (i.e., 18–25 years of age) such as university students become more independent and stay apart from their families; hence this period could be a critical time for developing eating disorders, unhealthy dietary habits, and non-communicable diseases, and nutritional imbalance, including becoming overweight or obese [16–18]. In Bangladesh, exposure to new food and cuisines is likely for university students when they start living away from the family environment. Furthermore, this transition requires various coping strategies to adjust to the new environment, including a likely somewhat different food system. For example, the research shows that poor food quality and substandard cuisines in public university premises were issues that students struggled to cope with in the new environment [19,20]. Earlier studies found the prevalence of eating disorders to range from 23% to 38%, among Bangladeshi university students [21,22]. Given the fact that nutritious and diversified food is highly important for the psychological and physical well-being of university students (as well as for others), previous studies have focused on food quality in the university premises and eating disorders among Bangladeshi university students; however, food neophobia has not been researched in this group.

1.1. Bangladeshi food culture and cuisines

In Bangladesh, agriculture is the main sector of domestic production and employs the highest proportion of workforce. A variety of crops, vegetables, fruits, and fishery items are produced throughout the year. For example, 142 varieties of vegetables, 72 varieties of fruits, and 251 freshwater and 475 marine fish species are available in Bangladesh [20,23], with production varying from one region to another. In southern/coastal Bangladesh, there tends to be a high availability of seafood such as marine fish, crabs, and a variety of dry fish [24]. On the other hand, there is a greater availability and popularity of freshwater fish in northern Bangladesh. Furthermore, cuisines also vary from one region to another. Some divisional and district-level cities/towns have their own traditional cuisines and food items. For example, a special meat curry called *Mezban* is popular in Chattogram, dried fish is popular in southern Bangladesh, a semi-fermented fish item called *Sidol* is available in northeastern areas, different types of *Biryani* (an item made of rice, meat, and spices) are popular in Dhaka, a number of ethnic cuisines are available in the Chattogram Hill Tracts, and sweet food items namely *Kachagolla*, *Balish mishti*, and *Chomchom* are popular, respectively, in Natore, Jamalpur, and Tangail district [25–28]. Therefore, it is likely that people experience new foods and cuisines when they move from one area to another. Given that sociocultural and individual factors influence food choice, people are therefore likely to show resistance to some of these new food and cuisines [29,30]. These facts support the assumption that food neophobia might exist among Bangladeshi university students who experience new foods and cuisines, mostly for the first time in their lives, when they move from their home to the university premises surrounded by new food system.

1.2. Objective of the study

In recent years, investigating students' food neophobia has increased due to their higher vulnerability to maintaining healthy dietary habits. Several studies have been conducted on food neophobia among students in different countries such as southern India [31], China [32], Lebanon and the United States [33], Malaysia [34], and southern Chile [35]. However, in Bangladesh, no previous research has been conducted to observe the rates of food neophobia amongst university students. Therefore, the objective of the present study was to assess food neophobia amongst university students in Bangladesh and its association with sociodemographic characteristics and food preferences in order to help fill the knowledge gap. The findings could be useful to help understand the distribution of food neophobia amongst university students and to consider possible preventive measures.

2. Methods

2.1. Study settings

Five public universities from three divisions of Bangladesh - Dhaka, Chattogram, and Barishal - were chosen as the key data-gathering locations for this study. In these three divisions, there are 25 public universities. Out of 25, five universities were purposefully approached to take part in the study; two were from Dhaka, one was in Chattogram, and two were in Barishal, respectively. The purposive selection was based on the feasibility of data collection, availability of study resources, and compliance from the university authority. The high student numbers, the sociodemographic and cultural diversity of students (i.e., low to high-income families), the availability of diverse food items locally, and students' enrollment from different areas of the country provided a good rationale for selecting the universities as study settings.

2.2. Study design, sample size calculation and sampling

A cross-sectional study design was used. Participants were from both undergraduate and graduate courses of the universities. The study was conducted from July 2022 to October 2022. The following eligibility criteria were considered when recruiting the participants: (i) being an adult (age ≥18 years), (ii) being Bangladeshi by birth, and (iii) being a current student. Students with any severe physical health conditions and psychiatric disorders were informed not to participate in the study. The sample size was calculated using the following formula:

Minimum sample size

$$n = \frac{z^2 \times p \times (1-p)}{d^2} \quad (1)$$

Here, the following features were considered: (i) since there is no any comparable research on food neophobia in Bangladesh, a 50% predicted prevalence was chosen (p = 0.5). Likewise, 50% was taken as the anticipated prevalence in several previous studies [36–40]. (ii) 95% level of confidence (Z = 1.96) and (iii) 5% margin of error (d = 0.05). Thus, a minimum required sample of 384 participants was calculated by putting the values into equation (1). Additionally, an optimal sample size of 422 was estimated by considering a 10% non-response rate. To increase the external validity and generalizability of the study, we aimed to include more participants than the calculated sample size [41]. Finally, a total of 500 participants were included in the study.

A simple random sampling procedure was used to recruit the participants. Since there are no restrictions on entry to public university campuses in Bangladesh, the study team went to various locations on the campuses (such as places where students congregate and enjoy their free time like playgrounds, canteen, etc.) to recruit study subjects. Thus, the study team randomly approached students on the campuses, explained the purposes of the study, and invited them to take part. Samples were equally drawn from each of the five universities (i.e., 100 participants from each university).

2.3. Study variables and measures

The questionnaire consisted of 24 variables which were divided into three parts: (i) socio-demographic information (nine variables), (ii) liking of various foods (five variables), and (iii) assessment of food neophobia (10 variables) (Supplementary file: Annex 1).

2.3.1. Assessment of outcome (food neophobia)

Food neophobia was assessed by a 10-item Food Neophobia Scale (FNS) with some minor changes to contextualize it with the study settings [7]. The phrasing of certain items (specifically, items: 3, 4, 5, and 6) was modified without altering the original meaning. For instance, the original item "I liked foods from different countries" was changed to "I liked foods from different cultures/districts" in item number 4 ("countries" replaced by "cultures/districts"). All adjustments were made in light of a previous study that had been carried out among university students in China [32]. Participants respond on a 7-point Likert scale, ranging from "strongly disagree" (1 point) to "strongly agree" (7 points). The total score was calculated by summing individual's scores for each item, with reverse-scoring for items: 1, 4, 6, 9 and 10. The overall score ranges from 10 to 70, with a higher score denoting a higher level of food neophobia.

2.3.2. Independent variables

Independent variables consisted of sociodemographic and disease-related information, such as gender (male vs. female), age, study level (1st year or 2nd year or 3rd year or 4th year or Masters), family size (<5 members vs. ≥ 5 members), residence (city or sub urban or rural), family income, self-perceived body mass index (BMI; underweight or normal weight or overweight), food allergy (yes or no), and history of illness after consuming a new food (yes or no). Participants' age and monthly family income were gathered as a continuous measure and subsequently categorized these variables for the ease of data analysis (e.g., income was dichotomized based on the median income value). Food allergies, BMI, and food sickness (to new foods) were used as a predictor in the previous studies [33,42]. Moreover, the extent to which respondents liked various food items were assessed by a six-point Likert scale ("do not like at all'' to "like very much'') following the method of Siegrist et al. (2013) [43]. Respondents' preferences for various foods were assessed using the question, "How much do you like the following foods?" Vegetables, fruits, whole grain bread, chocolate and candies, as well as chips, nuts, and snacks were all considered as food items for this assessment section.

2.4. Questionnaire validity and reliability

The content validity and reliability of the questionnaire were checked by a translation back-translation approach, pilot testing, and measuring internal consistency, respectively. The English version of the FNS was retrieved from the previous literature [7,32] and translated into Bengali (i.e., the national language of Bangladesh) by a registered translator (Bengali, English), which was cross-checked by the investigators of this study. Any disagreements with the meanings of the words was discussed with an independent Bengali literature expert to confirm the usability and applicability of the words. The degree to which the measures of food neophobia are consistent and stable (i.e., questionnaire reliability) was determined using a pilot survey of the questionnaire. Perneger et al. (2015) [44] recommended a default sample size of 30 participants for pre-testing the questionnaire to obtain a reasonable power to detect fairly common problems. So, a pilot survey among 30 university students was carried out in order to observe the usability and consistency of the questionnaire. However, the responses of the pilot survey were excluded from the final analysis. The internal consistency of the questionnaire was measured using Cronbach's alpha (α), and an excellent level of internal consistency was found for the food neophobia section (Cronbach's $\alpha = 0.903$). Reliability statistics of the scale are shown in Supplementary Table 1.

2.5. Interviews and data gathering procedures

Data from the respondents were gathered through face-to-face interviews by trained data collectors (interviewers) with a printed version of the questionnaire. The principal investigator (PI) organized a training program via an online platform (i.e., Zoom meeting) to instruct data collectors on interview scheduling, interview techniques, and eligibility of the participants. Four data collectors visited the selected universities ($n = 5$) and conducted data collection. The length of each interview was approximately 12 to 15 min.

2.6. Statistical approach

Data analysis was conducted using STATA (BE version 17.0, StataCorp, College Station, TX, USA) and SPSS (IBM version 23.0, Armonk, NY, USA). Descriptive statistics, including frequency, percentage, mean and standard deviation (SD) were computed for the variables of interest. A Shapiro-Wilk test was conducted, and it was found that the distribution of food neophobia scores departed

Table 1
Socio-demographic characteristics of study participants (N = 500).

Variables	Frequency′	Percentage (%)
Gender		
Male	219	43.8
Female	281	56.2
Age (in years)		
18–20	65	13.0
21–24	333	66.6
≥25	102	20.4
Study level		
1st	137	27.4
2nd	104	20.8
3rd	103	20.6
4th	102	20.4
Masters	54	10.8
Family size		
<5 members	280	56.0
≥5 members	220	44.0
Residence		
City	313	62.6
Sub urban	13	2.6
Rural	174	34.8
Family income (monthly, BDT)†		
≤35, 000	267	53.4
>35,000	233	46.6
Self-perceived BMI		
Underweight	77	15.4
Normal weight	312	62.4
Overweight	111	22.2
Allergic to any specific food		
Yes	214	42.8
No	286	57.2
History of sickness after eating a new food item		
Yes	325	65.0
No	175	35.0

Note: †BDT = Bangladeshi Taka (currency) and 1 USD = 94.52 BDT as of Jul 22, 11:08 a.m. UTC.
BMI = Body mass index.

significantly from normality (W = 0.972, p < 0.001); therefore, a non-parametric test was used. A Kruskal-Wallis test and Wilcoxon rank-sum tests were performed to compare food neophobia scores across the different explanatory variables. Finally, a multiple linear model was fitted to identify the factors associated with food neophobia. All assumptions were checked regarding linear regression after fitting the model. Regression coefficients (β) with 95% confidence interval (CI) and standard errors (SE) were used to quantify associations. Moreover, a Spearman's rank correlation was used to assess the association between food neophobia and the liking of various foods. In all analyses, a p-value of <0.05 was considered statistically significant.

2.7. Ethics

The study was conducted in accordance with the World Medical Association Declaration of Helsinki 2001 and the project protocol and ethics documents were reviewed and approved by the Institutional Ethical Committee (IEC) of Patuakhali Science and Technology University, Bangladesh (ethical approval reference number: PSTU/IEC/2022/35). The participation in this study was self-nominated and signed informed consent was taken from all participants. Anonymity and confidentiality of their personal and de-identifying information were strictly maintained.

3. Results

The demographic, socio-economic, body weight and disease-related information of the study participants are shown in Table 1. Five hundred participants with a mean age of 22.86 (SD: 2.01) years were included in this study. Slightly more than half of the respondents were female (56.2%), and the majority were undergraduates (89.2%) (see Table 1).

Participants' responses of assessing food neophobia are summarized in Supplementary Table 2. The mean food neophobia score was 37.45 on a scale of 10 to 70 (SD: 13.39, Range: 13–67). As shown in Table 2, the mean food neophobia score differed significantly as a function of the participant's age (p = 0.013), study level (p = 0.004), family income (p < 0.001), self-reported BMI status (p < 0.001), food allergy (p < 0.001), and history of sickness after having a new food item (p < 0.001).

Table 3 represents the factors associated with food neophobia among the participants using a multiple linear regression model.

Table 2
Differences in food neophobia score as a function of participants' socio-demographic characteristics (N = 500).

Variables	Food Neophobia Score		P value	
	Mean	SD	Kruskal–Wallis Test	Wilcoxon Rank Sum Test.
Gender				0.052
Male	36.02	11.70		
Female	38.57	14.49		
Age (in years)			***.013***	
18–20	35.83	15.25		
21–24	38.63	12.52		
≥25	34.65	14.50		
Study level			***.004***	
1st	37.69	14.00		
2nd	41.15	13.11		
3rd	37.41	13.02		
4th	35.76	11.45		
Masters	33.02	14.91		
Family size				.096
<5 members	38.34	13.79		
≥5 members	36.32	12.81		
Residence			.810	
City	37.54	15.93		
Sub urban	38.00	5.35		
Rural	37.26	7.57		
Family income (monthly, BDT) †				***< .001***
≤35, 000	42.37	12.21		
>35,000	31.82	12.45		
Self-perceived BMI			***< .001***	
Underweight	46.92	13.56		
Normal weight	37.84	12.06		
Overweight	29.81	12.36		
Allergic to any specific food				***< .001***
Yes	45.50	11.65		
No	31.43	11.29		
History of sickness after eating a new food item				***< .001***
Yes	33.43	11.73		
No	44.93	13.10		

Note: †BDT = Bangladeshi Taka (currency) and 1 USD = 94.52 BDT, BMI = Body mass index. Bolded and italic values indicate statistically significant (p < 0.05).

Table 3
Multiple linear regression analysis showing the factors associated with food neophobia among study participants (N = 500).

Variables	Unadjusted Model				Adjusted Model†			
	β	SE	95% CI	P value	β	SE	95% CI	P value
Gender								
Male	Reference				Reference			
Female	2.55	1.20	0.18, 4.90	***0.035***	2.73	0.99	0.78, 4.68	***0.006***
Age (in years)								
18–20	Reference				Reference			
21–24	2.79	1.80	−0.75, 6.35	0.121	3.26	1.74	−0.16, 6.60	0.062
≥25	−1.18	2.11	−5.34, 2.97	0.575	4.68	2.49	−0.22, 9.58	0.061
Study level								
1st	Reference				Reference			
2nd	3.47	1.72	0.09, 6.85	***0.044***	0.42	1.57	−2.68, 3.51	0.791
3rd	−0.28	1.73	−3.67, 3.11	0.872	−0.94	1.56	−3.99, 2.11	0.545
4th	−1.92	1.73	−5.32, 1.48	0.267	−1.54	1.77	−5.02, 1.93	0.383
Masters	−4.67	2.13	−8.85,-0.49	0.029	−4.55	2.51	−9.50, 0.30	0.071
Family size								
<5 members	Reference				Reference			
≥5 members	−2.02	1.20	−4.39, 0.35	0.094	−1.77	0.91	−3.56, 0.02	0.053
Residence								
City	0.27	1.27	−2.22, 2.76	0.830	0.67	1.09	−1.49, 2.83	0.544
Sub urban	0.74	3.86	−6.84, 8.31	0.849	1.08	2.92	−4.65, 6.81	0.712
Rural	Reference				Reference			
Family income (monthly, BDT)								
≤35, 000	Reference				Reference			
>35,000	−10.54	1.10	−12.71,-0.37	***<0.001***	−6.64	0.95	−8.50, −4.77	***<0.001***
Self-perceived BMI								
Underweight	9.09	1.57	5.99, 12.18	***<0.001***	4.68	1.32	2.09, 7.27	***<0.001***
Normal weight	Reference				Reference			
Overweight	−8.03	1.37	−10.71,-5.34	***<0.001***	−4.63	1.16	−6.91, −2.34	***<0.001***
Allergic to any specific food								
Yes	14.07	1.03	12.04, 16.11	***<0.001***	9.09	1.05	7.04, 11.15	***<0.001***
No	Reference				Reference			
History of sickness after eating a new food item								
Yes	11.50	1.15	9.25, 13.76	***<0.001***	5.16	1.06	3.07, 7.25	***<0.001***
No	Reference				Reference			

Note: †BDT = Bangladeshi Taka (currency) and 1 USD = 94.52 BDT, BMI = Body mass index.
β = Regression coefficient, SE = Standard error, CI = Confidence Interval.
Bolded and italic values indicate statistically significant ($p < 0.05$).
† The adjusted model was statistically significant [$F(15, 484) = 27.61$, $p < 0.001$]. The R^2 for adjusted model was 0.4611.

Adjusted linear regression analysis demonstrated that the female participants had a higher food neophobia score compared to the males (β = 2.73, 95% CI: 0.78 to 4.68, p = 0.006). The participants whose family income was >35,000 Bangladeshi taka (1 USD = 94.52 BDT as of Jul 22, 11:08 a.m. UTC) per month had a lower food neophobia score than their counterparts (β = −6.64, 95% CI: −8.50 to −4.77, p < 0.001). Participants who reported themselves as underweight (β = 4.68, 95% CI: 2.09 to 7.27, p < 0.001) were more likely to be neophobic to food, while those who identified themselves as being overweight (β = −4.63, 95% CI: −6.91 to −2.34, p < 0.001) were less likely to be food neophobic than those who classified themselves as having a normal body weight. Participants who had a food allergy (β = 9.09, 95% CI: 7.04 to 11.15, p < 0.001) and a history of sickness after a new food intake (β = 5.16, 95% CI: 3.07, 7.25, p < 0.001) were more food neophobic compared to their counterparts (see Table 3).

Table 4 shows the association between food neophobia and the liking of various foods among study participants. The results revealed that food neophobia influences the preferences for foods from various food categories. Food neophobia was significantly negatively correlated with the liking of vegetables (Spearman's rank correlation coefficient, $r_s = -0.253$, p = 0.012), chocolate and candies ($r_s = -0.332$, p < 0.001) and chips, nuts, and snacks ($r_s = -0.167$, p < 0.001) (see Table 4).

Table 4
Correlation between food neophobia score and liking of various foods among study participants (N = 500).

Variables	Spearman's rank correlation coefficient, r_s	P value
Vegetables	−0.253	***0.012***
Fruits	−0.054	0.226
Whole grain bread	0.045	0.318
Chocolate and candies	−0.332	***<0.001***
Chips, nuts, and snacks	−0.167	***<0.001***

Note: Bolded and italic values indicate statistically significant ($p < 0.05$).

4. Discussion

The focus of this cross-sectional study was to assess food neophobia among Bangladeshi university students and the association between their food neophobia with sociodemographic factors and food preferences. In line with previous studies, some sociodemographic factors were examined [8,45]. The factors like gender, family income, BMI, and food allergy were found to influence the students' food neophobia (see Fig. 1). The study also found how food neophobia significantly correlated with the students' food preferences such as for vegetables, chocolate and candies, chips, nuts, and snacks.

Even though it can be difficult to generalize and statistically compare the food neophobia scores across different countries, doing so can aid academics in better understanding the levels of food neophobia globally. In this study, the food neophobia score among university students was 37.45 (SD: 13.39), which was comparable to a study undertaken among female college students in Southern India [31]. Our study observed a higher food neophobia score among the participants than that reported in previous studies conducted among Chinese university students (mean score: 36.27) [32], college students in the USA (mean score: 29.80) and in Lebanon (mean score: 36.4) [33] and Koreans aged 20–40 years (mean score: 33.50) [10]. Moreover, in our study, more than half of the participants (52.6%) had a food neophobia score that was higher than the average value. This may be an indication of the predominant existence of food neophobia among university students in Bangladesh.

With regard to gender, some studies report contrasting findings regarding its association with food neophobia. In line with findings from this study, gender is reported to be a significant predictor of food neophobia and food preferences [46,47]. The female students who took part in this study were almost three times more likely to be food neophobic as compared to their male counterparts. As reasoned in the literature, women focus more on the nutritional value of food and prioritize healthy food intake such as avoiding sweet foods and high-fat foods as compared to men [46,48]. Another study conducted amongst Brazilian children reported that boys were more food neophobic than girls (de Almeida et al., 2022). Contrary to such findings, there are studies that have found no significant association between gender and food neophobia [32,43,45]. Perhaps, the disparities in findings could be situated into the debate of "nature vs. nurture", thus food neophobia can be both inherited and environmentally conditioned [42]. The differences in findings could also be attributed to socio-cultural aspects present in each study setting.

Congruent with the results of other studies [49–51], family income was found to significantly influence food neophobia among Bangladeshi university students. Parents with a high income often have fewer restrictions for weight and food control strategies for their children, who often enjoy the liberty and resources to explore and be exposed to different varieties of food [49]. Perhaps, this explains why it is that Bangladeshi university students from homes with family incomes greater than 35,000 BDT per month had a lower food neophobia score as compared to their counterparts.

There are conflicting reports in the literature with regard to the association between BMI and food neophobia. Consistent with findings from other studies [42,45,52], this study found a significant association between food neophobia and the self-perceived BMI status of Bangladeshi university students. Those participants who classified themselves as underweight were more food neophobic while those who were overweight were less food neophobic compared to those having a normal body weight. Participants who classified themselves as overweight were more open to try new foods including junk foods. Eating disorders and unhealthy dietary intake which are commonly associated with student life on university campuses and could predispose them to non-communicable diseases like overweight and obesity [16–18]. However, many studies have also reported no significant association between BMI and food neophobia [53–55]. The disparities in findings could plausibly reflect the differences in the sociodemographic characteristics of the study participants in each study or else differences in how BMI was measured in each study; considering that this study used a self-reported measure.

Food neophobia is often worsened by the elimination of dietary options due to food allergy [56]. The distressing effect, the fear of unknown food ingredients and food composition with respect to how their bodies will react, and the lack of variety in meal preparation for people with food allergies often exacerbate the situation. It is therefore not surprising that in the present study, Bangladeshi university students who reported having a food allergy and a history of sickness after eating a new food item were more food neophobic compared to their counterparts.

The finding concerning the association between food neophobia and liking of vegetables reported in the present study corroborates

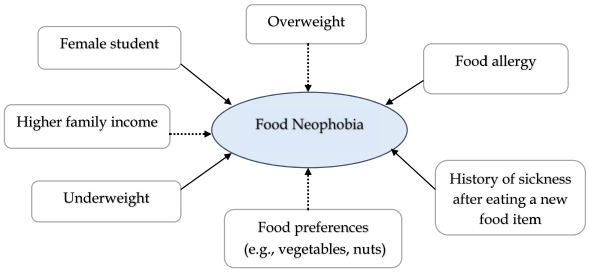

Fig. 1. The key determinants of food neophobia among university students in Bangladesh. This illustration is based on the output of an adjusted linear regression model and Spearman's rank correlation analysis. Variables with a solid-arrow showed a positive association (i.e., parameters were associated with high food neophobia score), whereas those variables with a dotted-arrow refer to a negative association (i.e., the parameters were associated with low food neophobia score instead).

the findings from another study conducted among Italian children [57]. In contrast to this finding, however, a randomized controlled trial in Norway has reported no significant association between food neophobia and vegetable liking/intake [58]. Though the association between food neophobia and vegetable intake is inconclusive in the literature, the findings from this study suggest that neophobic Bangladeshi university students exhibit some dislike towards vegetable intake. This could plausibly be as a result of some students having allergies. Once again, considering that more than half of this study's participants were females, who were also almost three times more likely to be food neophobic, and females are reported to be selective and often avoid sweets and fatty foods [46,48]; it is therefore not surprising that food neophobia in this study negatively correlated with the liking of chocolate, candies, chips, nuts and snacks.

4.1. Strengths and shortcomings of the research

This study has several shortcomings that should be considered while interpreting the outcomes. First, food neophobia and its association with socio-demographics and food choices were assessed by cross-sectional investigation; therefore, a causal relationship cannot be established. Second, since only five public universities from three divisions of Bangladesh (Dhaka, Barishal, and Chattogram) were included in the study, the findings cannot be extrapolated to other settings such as private universities or other age groups. Third, we only considered reliability analysis (i.e., Cronbach's alpha) and back-translation of the scale used for assessing the outcome of this study. Since the Bengali version of the food neophobia scale has not yet been validated, a statistics-based adaptation and validation study for the Bangladeshi population is highly recommended. Fourth, respondents' social desirability and reporting biases may exist due to the self-report nature of the assessment tool.

Despite these drawbacks, this study has a number of strengths. To the best of our knowledge, this is the first study in Bangladesh to have evaluated food neophobia and its associated factors among university students, and literally any population group. The outputs of this study offer preliminary data for designing and implementing interventions to reduce the students' food neophobia. Moreover, this study has rigorous methodological and statistical techniques with thorough and reproducible procedures for future investigation in other similar contexts. The large sample size represents another strength of this study.

4.2. Implications for practice

Although the university-age period, also known as emerging adulthood, is a crucial time for both the adoption of healthy dietary practices as well as the development of eating disorders, there was no previous investigation on food neophobia among university students in Bangladesh. Therefore, the study is a contribution to the literature and its findings could be useful for further investigations. One of the key findings to emerge from this study is that body mass index, food allergy and food preferences are linked to food neophobia among university students. These findings can be taken to suggest that university authorities should arrange health and nutrition education programs so that students can maintain healthy dietary habits and consume a variety of foods.

5. Conclusions

The findings indicate a higher level of food neophobia among public university students in Bangladesh. Experimental and analytical studies could be conducted to better understand the factors related to food neophobia among university students in Bangladesh. Based on the findings reported here, it is suggested to policymakers for considering appropriate way forwards to address food neophobia among university students. Further research could be conducted to assess whether food neophobia exists among other population groups (such as children, adolescents, etc.) in Bangladesh.

Author contribution statement

Sumaia Sahrin: conceived and designed the experiments, wrote the paper. Md. Hasan Al Banna: conceived and designed the experiments, performed the experiments, analyzed and interpreted the data, contributed reagents, materials, analysis tools or data, wrote the paper. M. A. Rifat, Justice Kanor Tetteh, Tasnu Ara, Mohammad Hamiduzzaman, Charles Spence and Satyajit Kundu: performed the experiments, wrote the paper. Mohammad Tazrian Abid, M.M. Mehedi Hasan, Nargees Akter and Ashish Biswas: performed the experiments, contributed reagents, materials, analysis tools or data, wrote the paper. Dilruba Easmin Jharna: conceived and designed the experiments, wrote the paper.

Funding statement

This work was supported by the Research and Training Center (RTC) of Patuakhali Science and Technology University, Bangladesh (grant code: 5921-NFS-39). Moreover, the article publishing charge (APC) was supported by Karolinska Institutet, Sweden.

Data availability statement

Data will be made available on request.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.heliyon.2023.e15831.

References

[1] J. Albrecht, T. Schreder, A.M. Kieemann, V. Schopf, R. Kopietz, A. Anzinger, M. Demmel, J. Linn, B. Kettenmann, M. Wiesmann, Olfactory detection thresholds and pleasantness of a food-related and a non-food odour in hunger and satiety, Rhinology 47 (2009) 160–165.
[2] J.A. Desor, O. Maller, K. Andrews, Ingestive responses of human newborns to salty, sour, and bitter stimuli, J. Comp. Physiol. Psychol. 89 (1975) 966–970.
[3] P. Fernandez, M. Bensafi, C. Rouby, A. Giboreau, Does olfactory specific satiety take place in a natural setting? Appetite 60 (2013) 1–4.
[4] E.T. Rolls, Taste, olfactory and food texture reward processing in the brain and the control of appetite, Proc. Nutr. Soc. 71 (2012) 488–501.
[5] C. Spence, What is the link between personality and food behavior? Curr. Res. Food Sci. 5 (2022) 19–27.
[6] S. Assanand, J.P.J. Pinel, D.R. Lehman, Personal theories of hunger and eating 1, J. Appl. Soc. Psychol. 28 (1998) 998–1015.
[7] P. Pliner, K. Hobden, Development of a scale to measure the trait of food neophobia in humans, Appetite 19 (1992) 105–120.
[8] M.L. Dematte, I. Endrizzi, F. Gasperi, Food neophobia and its relation with olfaction, Front. Psychol. 5 (2014) 127.
[9] G.A. Bekker, H. Tobi, A.R.H. Fischer, Meet meat: an explorative study on meat and cultured meat as seen by Chinese, Ethiopians and Dutch, Appetite 114 (2017) 82–92.
[10] J.Y. Choe, M.S. Cho, Food neophobia and willingness to try non-traditional foods for Koreans, Food Qual. Prefer. 22 (2011) 671–677.
[11] C.A. Gómez-Luciano, L.K. de Aguiar, F. Vriesekoop, B. Urbano, Consumers' willingness to purchase three alternatives to meat proteins in the United Kingdom, Spain, Brazil and the Dominican Republic, Food Qual. Prefer. 78 (2019), 103732.
[12] M. Siegrist, C. Hartmann, Perceived naturalness, disgust, trust and food neophobia as predictors of cultured meat acceptance in ten countries, Appetite 155 (2020), 104814.
[13] V. Fernández-Ruiz, A. Claret, C. Chaya, Testing a Spanish-version of the food neophobia scale, Food Qual. Prefer. 28 (2013) 222–225.
[14] B. Schnettler, G. Crisóstomo, J. Sepúlveda, M. Mora, G. Lobos, H. Miranda, K.G. Grunert, Food neophobia, nanotechnology and satisfaction with life, Appetite 69 (2013) 71–79.
[15] H. Tuorila, L. Lähteenmäki, L. Pohjalainen, L. Lotti, Food neophobia among the Finns and related responses to familiar and unfamiliar foods, Food Qual. Prefer. 12 (2001) 29–37.
[16] M.H. Al Banna, K. Brazendale, M.S.I. Khan, A. Sayeed, M.T. Hasan, S. Kundu, Association of overweight and obesity with the risk of disordered eating attitudes and behaviors among Bangladeshi university students, Eat, Beyond Behav. 40 (2021), 101474.
[17] M.C. Nelson, M. Story, N.I. Larson, D. Neumark-Sztainer, L.A. Lytle, Emerging adulthood and college-aged youth: an overlooked age for weight-related behavior change, Obesity 16 (2008) 2205–2211.
[18] M.H. Al Banna, K. Brazendale, M. Hasan, M.S.I. Khan, A. Sayeed, S. Kundu, Factors associated with overweight and obesity among Bangladeshi university students: a case–control study, J. Am. Coll. Health 70 (2022) 2327–2333.
[19] S. Ali, M.F.H. Sarker, M.S. Islam, M.K. Islam, R. Al Mahmud, Pursuing higher education: adaptation challenges and coping strategies of rural students at urban universities in Bangladesh, Tert. Educ. Manag. 27 (2021) 91–106.
[20] F. Haque, M.H.K. Talukder, K.K. Alam, S.J. Khan, M.R. Karim, Difficulties faced by the undergraduate medical students in relation to institution and hostel campus: views of selected medical colleges of Bangladesh, Bangladesh, J. Med. Educ. 10 (2019) 23–25.
[21] S. Pengpid, K. Peltzer, G.U. Ahsan, Risk of eating disorders among university students in Bangladesh, Int. J. Adolesc. Med. Health 27 (2015) 93–100.
[22] M.H. Al Banna, M.F. Dewan, M.R. Tariq, A. Sayeed, S. Kundu, T.R. Disu, S. Akter, S. Sahrin, M.S.I. Khan, Prevalence and determinants of eating disorder risk among Bangladeshi public university students: a cross-sectional study, Heal. Psychol. Res. 9 (2021), 24837.
[23] R. Ahmad. Veg Output Grows Fast, 2017. https://www.thedailystar.net/frontpage/veg-output-grows-fast-1343068 (Accessed 2 September 2022).
[24] M.H. Al Banna, A. Al Zaber, N. Rahman, M.A.M. Siddique, M.A.B. Siddique, J.E. Hagan Jr., M.A. Rifat, C.N.A. Nsiah-Asamoah, A.-A. Seidu, B.O. Ahinkorah, Nutritional value of dry fish in Bangladesh and its potential contribution to addressing malnutrition: a narrative review, Fishes 7 (2022) 240.
[25] A. Mahmud, Shutki Popular Food in Ctg, Earns Foreign Currency, 2013. https://www.thedailystar.net/news/shutki-popular-food-in-ctg-earns-foreign-currency.
[26] Salina Parvin, Old Dhaka Recipes, 2016. https://www.thedailystar.net/lifestyle/deshi-mix/old-dhaka-recipes-1281043.
[27] Fayeka Zabeen Siddiqua, Majestic Mezban. https://www.thedailystar.net/news/majestic-mezban, 2013.
[28] M. Hossain, Y. Kabir, Ethnic Fermented Foods and Beverages of Bangladesh, Ethn. Fermented Foods Alcohol, Beverages Asia, 2016, pp. 73–89.
[29] A. Veeck, Encounters with extreme foods: neophilic/neophobic tendencies and novel foods, J. Food Prod. Market. 16 (2010) 246–260.
[30] E.C. Monterrosa, E.A. Frongillo, A. Drewnowski, S. de Pee, S. Vandevijvere, Sociocultural influences on food choices and implications for sustainable healthy diets, Food Nutr. Bull. 41 (2020) 59S–73S.
[31] U. Chitra, K. Adhikari, M.S. Radhika, N. Balakrishna, Neophobic tendencies and dietary behavior in a cohort of female college students from Southern India, J. Sensory Stud. 31 (2016) 70–77.
[32] H. Tian, J. Chen, Food neophobia and intervention of university students in China, Food Sci. Nutr. 9 (2021) 6224–6231.
[33] A. Olabi, N.E.O. Najm, O.K. Baghdadi, J.M. Morton, Food neophobia levels of Lebanese and American college students, Food Qual. Prefer. 20 (2009) 353–362.
[34] R. Muhammad, K.M. Abdullah, M.S.M. Zahari, M.S.M. Sharif, Revealing the scenario of food neophobia among higher learning institution students from Klang Valley, Malaysia, Procedia-Social Behav, Science 170 (2015) 292–299.
[35] B. Schnettler, Y. Höger, L. Orellana, H. Miranda, G. Lobos, J. Sepúlveda, M. Sanchez, E. Miranda-Zapata, M. Denegri, K.G. Grunert, Food neophobia, life satisfaction and family eating habits in university students, Cad. Saúde Pública 33 (2017), e00165615.
[36] M.H. Al Banna, S. Kundu, K. Brazendale, B.O. Ahinkorah, T.R. Disu, A.-A. Seidu, J. Okyere, M.S.I. Khan, Knowledge and awareness about food safety, foodborne diseases, and microbial hazards: a cross-sectional study among Bangladeshi consumers of street-vended foods, Food Control 134 (2022), 108718.
[37] M. Al Banna, T.R. Disu, S. Kundu, B.O. Ahinkorah, K. Brazendale, A.-A. Seidu, J. Okyere, N. Rahman, S. Mondal, B. Matubber, Factors associated with food safety knowledge and practices among meat handlers in Bangladesh: a cross-sectional study, Environ. Health Prev. Med. 26 (2021) 1–12.
[38] M.T. Abid, M.H. Al Banna, M. Hamiduzzaman, A. Seidu, S. Kundu, H. Rezyona, T.R. Disu, N. Akter, M. Khaleduzzaman, B.O. Ahinkorah, Assessment of food safety knowledge, attitudes and practices of street food vendors in Chattogram city, Bangladesh: a cross-sectional study, Public Heal. Challenges. 1 (2022) e16.
[39] M.H. Al Banna, M. Hamiduzzaman, S. Kundu, T. Ara, M.T. Abid, K. Brazendale, A.-A. Seidu, T.R. Disu, N.H.M.R. Mozumder, J.B. Frimpong, The association between Bangladeshi adults' demographics, personal beliefs, and nutrition literacy: evidence from a cross-sectional survey, Front. Nutr. 9 (2022), 867926.
[40] M.H. Al Banna, M.S.I. Khan, H. Rezyona, A.-A. Seidu, M.T. Abid, T. Ara, S. Kundu, B.O. Ahinkorah, J. Hagan John Elvis, M.A. Tareq, Assessment of food safety knowledge, attitudes and practices of food service staff in Bangladeshi hospitals: a cross-sectional study, Nutrients 14 (2022) 2540.

[41] R. Cavana, B. Delahaye, U. Sekeran, Applied Business Research: Qualitative and Quantitative Methods, John Wiley & Sons, 2001.
[42] A.J. Knaapila, M.A. Sandell, J. Vaarno, U. Hoppu, T. Puolimatka, A. Kaljonen, H. Lagström, Food neophobia associates with lower dietary quality and higher BMI in Finnish adults, Publ. Health Nutr. 18 (2015) 2161–2171.
[43] M. Siegrist, C. Hartmann, C. Keller, Antecedents of food neophobia and its association with eating behavior and food choices, Food Qual. Prefer. 30 (2013) 293–298.
[44] T. V Perneger, D.S. Courvoisier, P.M. Hudelson, A. Gayet-Ageron, Sample size for pre-tests of questionnaires, Qual. Life Res. 24 (2015) 147–151.
[45] M. Jezewska-Zychowicz, M. Plichta, M.E. Drywień, J. Hamulka, Food neophobia among adults: differences in dietary patterns, food choice motives, and food labels reading in poles, Nutrients 13 (2021) 1590.
[46] L. Bärebring, M. Palmqvist, A. Winkvist, H. Augustin, Gender differences in perceived food healthiness and food avoidance in a Swedish population-based survey: a cross sectional study, Nutr. J. 19 (2020) 1–8.
[47] V. Manippa, C. Padulo, L.N. Van der Laan, A. Brancucci, Gender differences in food choice: effects of superior temporal sulcus stimulation, Front. Hum. Neurosci. 11 (2017) 597.
[48] J. Wardle, A.M. Haase, A. Steptoe, M. Nillapun, K. Jonwutiwes, F. Bellisie, Gender differences in food choice: the contribution of health beliefs and dieting, Ann. Behav. Med. 27 (2004) 107–116.
[49] F. Ayoughi, M. Handley, J. Garza, S. Amin, R. Volpe, A. Lammert, Parental perspective and feeding practices effects on food neophobia in elementary school children in San Luis Obispo County, J. Sensory Stud. 37 (2022), e12717.
[50] S. Roßbach, K. Foterek, I. Schmidt, A. Hilbig, U. Alexy, Food neophobia in German adolescents: determinants and association with dietary habits, Appetite 101 (2016) 184–191.
[51] P. Tsimitri, A. Michailidis, E. Loizou, F.T. Mantzouridou, K. Gkatzionis, E. Mugampoza, Bioeconomy and the Production of Novel Food Products from Agro-Industrial Wastes and Residues under the Context of Food Neophobia, 2018.
[52] A. Knaapila, K. Silventoinen, U. Broms, R.J. Rose, M. Perola, J. Kaprio, H.M. Tuorila, Food neophobia in young adults: genetic architecture and relation to personality, pleasantness and use frequency of foods, and body mass index—a twin study, Behav. Genet. 41 (2011) 512–521.
[53] C.L. Brown, E.B. Vander Schaaf, G.M. Cohen, M.B. Irby, J.A. Skelton, Association of picky eating and food neophobia with weight: a systematic review, Child. Obes. 12 (2016) 247–262.
[54] E. Maiz, N. Balluerka, Nutritional status and Mediterranean diet quality among Spanish children and adolescents with food neophobia, Food Qual. Prefer. 52 (2016) 133–142.
[55] R.A. Perry, K.M. Mallan, J. Koo, C.E. Mauch, L.A. Daniels, A.M. Magarey, Food neophobia and its association with diet quality and weight in children aged 24 months: a cross sectional study, Int. J. Behav. Nutr. Phys. Activ. 12 (2015) 1–8.
[56] N. Rigal, F. Reiter, C. Morice, D. De Boissieu, C. Dupont, Food allergy in the child: an exploratory study on the impact of the elimination diet on food neophobia, Arch. Pédiatrie Organe off, La Sociéte Française Pédiatrie. 12 (2005) 1714–1720.
[57] M. Laureati, S. Bertoli, V. Bergamaschi, A. Leone, L. Lewandowski, B. Giussani, A. Battezzati, E. Pagliarini, Food neophobia and liking for fruits and vegetables are not related to Italian children's overweight, Food Qual. Prefer. 40 (2015) 125–131.
[58] E.A.M. Blomkvist, A.K. Wills, S.H. Helland, E.R. Hillesund, N.C. Øverby, Effectiveness of a kindergarten-based intervention to increase vegetable intake and reduce food neophobia amongst 1-year-old children: a cluster randomised controlled trial, Food Nutr. Res. 65 (2021).