Epidemiological survey of self-reported food allergy among university students in China

Hua Feng, PhD[a], Yong Liu, MD[b], Xiujuan Xiong, PhD[c], Qunying Xu, MD[b], Zhongwei Zhang, MD[b], Yongning Wu, PhD[d],* , Yuanan Lu, PhD[b,e],*

Abstract

The aim of this study was to investigate the prevalence of self-reported food allergy among university students in China.

A cluster-random sampling population-based cross-sectional study using self - administrated questionnaire was conducted with 2538 college students recruited from 6 universities in China. The questionnaire included data on age, sex, weight, height, FA, comorbid allergic diseases, family history, and understanding food allergy. Data were analyzed by SPSS 25.0 statistical software. Multivariate logistic regression analysis was performed to analyze the risk factors related to self-reported food allergy and estimate the odds ratio.

A total of 2538 questionnaires were distributed to the undergraduate students and 2313 completely effective questionnaires were collected, the effective response rate was 91.1%. 834 males and 1479 females were recruited, and their age ranged from 18 to 25 years old. The prevalence of self-reported food allergy was 15.7%, and the rate of doctor-diagnosed food allergy was 8.4%. The leading food allergens included shrimp, shellfish, milk, egg, peach, mango, beef, and peanut, and the prevalence of shrimp allergy was the highest (5.8%). The main clinical manifestation included skin mucous membrane and respiratory symptoms. The prevalence of food allergy were statistically significant difference ($P < .05$) between different age groups, family history, sun exposure times, smoking, and antibiotic use. Over 45% college students know little about food allergy.

The prevalence of self-reported food allergy among Chinese college students was high (15.7%). Shrimp was the main allergenic food, followed by shellfish, milk, egg, peach, and mango. Family history, sun exposure, obesity, and using antibiotics may be the influencing factors of food allergy. The Chinese undergraduates lacked the knowledge about food allergy. Thus, it is necessary to strengthen the health education program on food allergy for college students in China and other middle high-income nations.

Abbreviations: FA = food allergy.

Keywords: food allergy, university students, questionnaire survey, adult, China.

1. Introduction

Food allergy (FA) is an adverse food reaction mediated by immune system to certain food or components of food that affects all age groups across the world. There are extensive data to suggest that FA is common.[1]

The prevalence of FA is estimated to 8% of children and 5% of adults,[2,3] Over the past few decades, converging evidence indicates that the prevalence of FA has increased both in pediatric and adult populations.[3–5] The number of foods that can cause allergic reactions is growing, and the number of serious allergic reactions is also increasing.[6] A recent nationwide survey have indicated that over 1 in 10 US adults may be food-allergic, which was higher than the estimate of 1 in 13 reported for the US pediatric population by the same survey.[4]

Exposure to very small amounts of food allergen can trigger clinical symptoms and may affect multiple organs and systems such as gastrointestinal disorders, urticaria, and airway inflammation. The severity of food allergy ranges from mild to life-threatening. FA impacts to concern patient not only on physical health, but also psychosocial health, it has been associated with impaired quality of life and economic implications.[2,4,7]

Food allergy has become an increasingly important food safety and public health problem in the world.[6,8]

The prevalence of FA varies considerably with genetic background, living environment, dietary habits and age.[9] China is an emerging economies country, the lifestyle is shifting from tradition to westernization, but few studies on FA have been done in China, especially data on the epidemiology of FA among young adult are very limited.

Since allergen testing are not available in most cases, and oral food challenge requires more strict conditions which can be very expensive and time-consuming, so self-reported prevalence is frequently used in population-based studies.[3] The prevalence of self-reported FA may be exaggerated; however, the consensus is that when auxiliary tests are not available, then self-reported prevalence of FA can be an appropriate tool to evaluate the prevalence in a population-based study.[2] This survey-based study was designed to obtain the actual status of self-reported FA among college students and provide baseline data for further study to improve the prevention and management of FA in China.

2. Materials and Methods

2.1. Study population

There are 27 universities distributed in 6 districts in Nanchang city located south of China. A multistage cluster-random sampling was used in this population-based cross-sectional study. We selected 1 university from each district, so 6 universities were included, Then Class as a unit, students was recruited by random cluster sampling in each university. The sample number for each university was decided according to the total number of their students and a total of 2538 college students were recruited from 6 universities located in different regions of Jiangxi Province. Figure 1 described sampling framework.

2.2. Questionnaire survey

A population-based, cross-sectional survey was conducted from May to October of 2019. Self-administered questionnaires were distributed to 2538 college students to obtain information about demographic characteristic, FA, allergenic foods commonly reported or potentially importance for FA as frequent consumption in China, possible risk factors, co-morbid atopic disorders, family history, and FA knowledge. Investigators explained the purpose of the survey and the form-filling instruction, asked the participants to recall individual condition as accurate as possible before completing the questionnaire truly. Two trained proctors were available to answer any questions the subjects might have during the survey time.

Approval to conduct this study was granted by the Ethics Committee of China National Center for Food Safety Risk Assessment of China, Informed-written consents were obtained from all subjects.

2.3. Determination of FA

Food allergy was defined as suffering from allergenic foods in the subjects' life time, participants who had self-reported FA were defined FA cases. The question "Do you have or have you ever had a FA?", students who answered "yes" to this question were included as self-reported FA. On this basis, an additional question was asked as "whether you received a doctor-diagnosed or specialist-diagnosed for FA, those who answered "yes" to this question were defined as doctor-diagnosed FA.

2.4. Statistical analysis

Data were entered and verified by 2 individuals (double data entry), analyzed using SPSS 25.0 statistical software,

The descriptive statistics for categorical variables were summarized as frequencies and percentages, continuous data were expressed as means ± SD. Chi-squared tests were used to compare the prevalence of self-reported FA between subgroups including demographic characteristics including family history, other atopic disorders, and environmental exposure factors. Multivariate logistic regression analysis was performed to estimate the risk factors related to FA and the odds ratio (OR). All tests were 2-sided with a significance level of $P < .05$.

3. Results

3.1. Participation rate and demographic characteristics

A total of 2538 questionnaires were distributed and 2313 complete questionnaires were collected from college students of the 6 universities, with an effective response rate of 91.1%. The respondents included 834 males and 1479 females, ranged from freshman to junior students with the mean age of 20.5 ± 1.7 years (18 to 25 years old).

3.2. Food allergen

Figure 2A and 2B showed the prevalence rate and constituent ratio of food allergen, respectively. The main allergenic foods are shrimp, milk, shellfish, peaches, mango, eggs, beef, and peanuts, the prevalence of shrimp allergy is the highest (5.8%), accounting for 37.2% proportion. As for allergic foods, animal foods were more common (57.9%) than plant foods (25.6%). The source of food allergens are summarized in table 1, Supplemental Digital Content, http://links.lww.com/MD/G937. There were 45 (1.95%) college students reported they were allergic to 2 types of food allergens. Spectrum and prevalence of
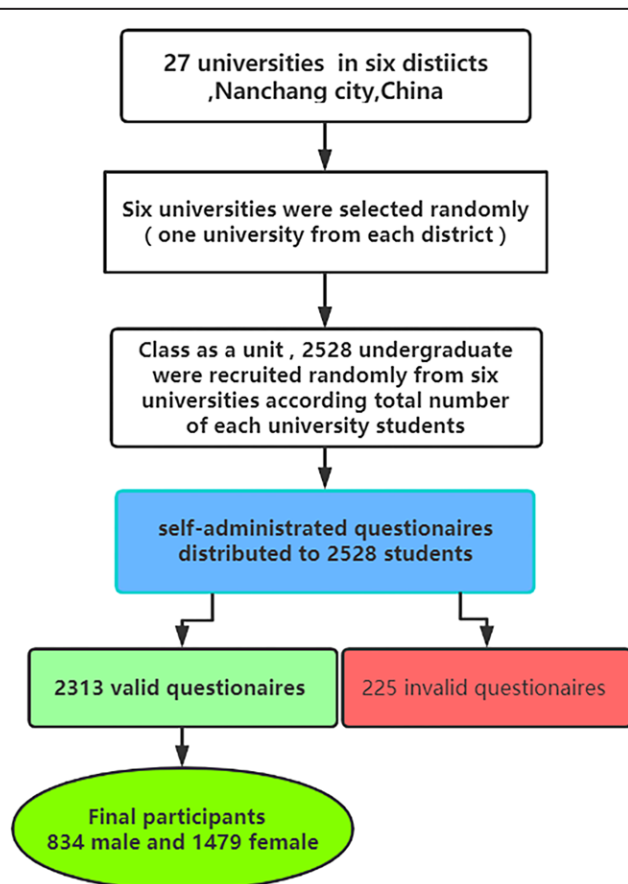

Figure 1. Flowchart of the study design of a population-based survey.
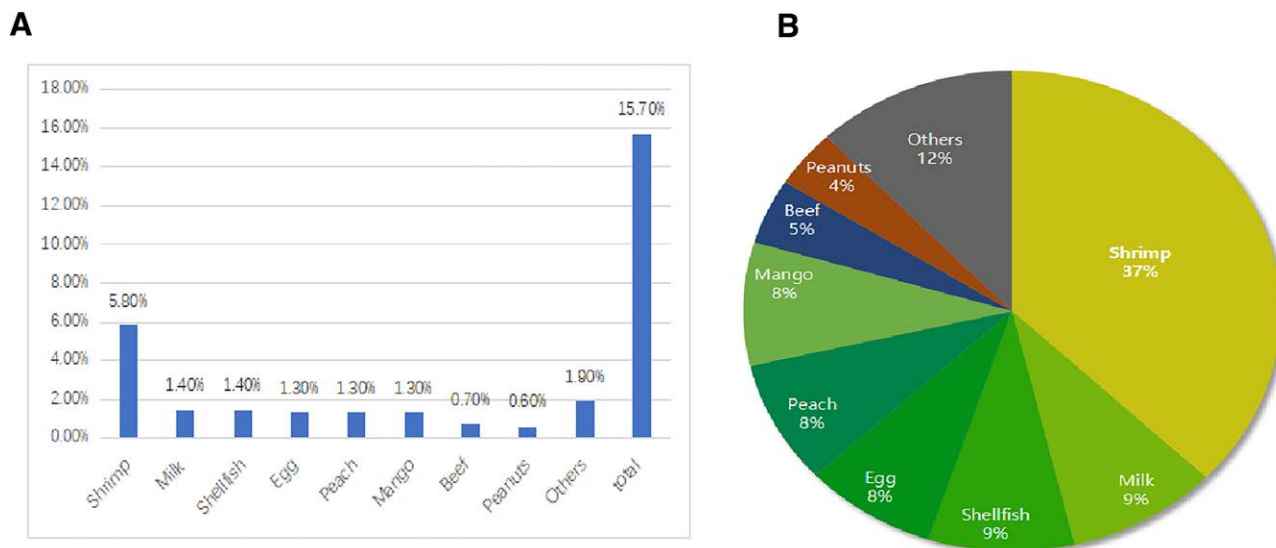
A

B

Figure 2. (A) Food allergen and prevalence rate of FA. (B) Distribution of the causative allergen.

allergies to 2 foods were shown in table 2, Supplemental Digital Content, http://links.lww.com/MD/G937.

3.3. Clinical symptoms of FA

Among 363 self-reported FA students, skin reactions were the most common symptom, such as itching, redness and urticaria. Others allergic symptoms include oral irritation (such as eyelid edema, redness and swelling around the mouth), circulatory system manifestation (restlessness, clammy skin, and pale face), gastrointestinal reactions (abdominal pain, diarrhea, and vomiting), and respiratory symptoms, which includes cough, runny nose, shortness of breath. The detail results are shown in Table 1.

In total, 59.1% reported symptoms within 2 hours after digesting the triggered food. Most of the undergraduates with shrimp allergy and egg allergy reported symptoms occurred within 2 hours. For those allergic to milk, symptoms commonly appeared after 2 hours. Allergic reactions to fruit (mangoes, peaches and oranges) developed symptoms within minutes after eating the causative foods.

3.4. Prevalence and influencing factors of FA

A total of 363 college students reported FA in this survey. The prevalence of self-reported FA was 15.7%, and of which, 53.7% (195 cases) were confirmed by the clinical diagnosis by doctors or allergy experts. The prevalence of doctor-diagnosed FA was 8.4%, and 168 FA cases were only self-reported, accounting for 46.3% of self-reported allergies.

3.5. Single-factor analysis

Table 2 shows the single-factor analysis result of the association between FA and possible influence factors that include sunlight exposure, smoking (including active and passive smoking), family history, exercise, obesity, concomitant allergic diseases, antibiotic use, and other conditions. There was statistically significant association between FA and exercise, sunlight exposure, smoking, antibiotics use, obesity, family history, and concomitant allergic diseases ($P < .05$). Life style also had some influence on FA, showing significantly lower prevalence of FA detected among people with relaxed life state, There was no statistically significant difference ($P = .06$) between FA and gender or age.

3.6. Multivariate logistic regression analysis

Variables that were statistically significant in the single factor analysis were further analyzed by logistic regression with forward stepwise (conditional). Multi-factor analysis showed that self-reported FA was associated with 5 independent influence factors, include sunlight exposure (OR:0.37), antibiotics use (OR:2.03), obesity (OR:2.04), other allergic disease (OR:2.86) and family history (OR:2.38). The details of multivariate logistic regression analysis were summarized in Table 3.

3.7. University students' knowledge of FA

Approximately 45% college showed their understanding to FA as "I just have heard of FA, but I don't know it more." Among the students with FA, only 34.7% chose to seek medical treatment immediately when suffering FA, 33.0% did not take any measures, and others chose to seek medical treatment after taking their own mitigation measures. Only 22.7% of the respondents paid attention to food labels when buying food, and 41.3% of college students with FA paid attention to food labels.

4. Discussion

Present studies have clearly indicated that the FA prevalence is increasing.[1,5,10] The most common epidemiological research method of FA is questionnaire survey, and the FA prevalence from the questionnaire surveys ranges from 13.7 to 33.7%.[11,12] Regional variations have been demonstrated for the prevalence

Table 1

Symptoms of food allergy.

Symptoms of food allergy	Frequency, n	Proportion, %
Abdominal pain, diarrhea, vomiting	153	15.1
Itchy, swollen, urticaria on skin	363	35.9
Redness and swelling of the eyelids or around the mouth	195	19.3
Cough, runny nose, tachypnea	135	13.3
Restlessness and clammy	165	16.3

Table 2

Prevalence and single-factor analysis of food allergy.

Variables		Food allergy, n	No food allergy, n	Total	Prevalence	χ² value	P value
Total		363	1950	2313	15.7%		
Gender	Male	138	696	834	16.5%	0.239	0.625
	Female	225	1254	1479	15.2%		
Age (yr)	18–19	105	303	408	25.7%		
	20–21	60	513	573	10.5%	4.191	0.242
	22–23	183	951	1134	16.1%		
	24–25	15	183	198	7.6%		
Life status*	Tired	78	315	393	19.8%	5.565	0.062
	Normal	270	1425	1695	15.9%		
	Easy	15	210	225	6.7%		
Exercise†	Usual	63	213	276	22.8%	6.679	0.035
	Sometimes	210	1242	1452	14.5%		
	Never	90	495	585	15.4%		
Sunlight exposure‡	Usual	105	975	1080	9.7%	27.303	0.000
	Sometimes	213	900	1113	19.1%		
	Never	45	75	120	37.5%		
Using antibiotic§	Usual	75	120	195	38.5%	33.603	0.000
	Sometimes	243	1299	1542	15.8%		
	Never	45	531	576	7.8%		
Smoking‖	Yes	183	708	891	20.5%	8.202	0.004
	No	180	1242	1422	12.7%		
Obesity	Yes	93	270	363	25.6%	10.165	0.001
	No	270	1680	1950	13.8%		
Family history	Yes	120	261	381	31.5%	31.494	0.000
	No	243	1689	1932	12.6%		
Other allergic disease	Yes	336	708	1044	32.2%	126.583	0.000
	No	30	1239	1269	23.6%		

*Life status is defined as self-perception subjective state, include tired, general and relax.

†Exercise: Usually is defined as exercise at least 5 times a week, every exercise for at least 30 minutes. Sometime is defined as s exercise 1 to 4 times a week, every exercise for at least 30 minutes. Never is defined as never exercise deliberately.

‡Sunlight exposure: Usually is defined as half an hour to more Sunlight exposure per day in average. Sometimes is defined as average daily sunlight exposure is less than half an hour. Never is defined as always intent to avoid sunlight, never deliberately expose to sunlight.

§Using antibiotic: Usually is defined as on average, it is used once or more per year. Sometimes is defined as on average, it is used less than once a year. Never is defined as never used.

‖Smoking include active or passive smoking. Passive smoking is defined as smoking by other people living indoors together, at least 1 cigarette a day on average, for 6 months or more.

Table 3

Multivariate logistic regression analysis.

Factors	B	S.E.	Wald	df	Sig.	OR	95% CI for OR Lower	Upper
							1.807	4.518
Sunlight exposure	−0.987	.184	28.936	1	.000	0.373	0.260	0.534
Frequency of using antibiotic	0.705	.205	11.856	1	.001	2.025	1.355	3.025
Obesity	0.716	.257	7.775	1	.005	2.047	1.237	3.387
Family history	0.868	.246	12.450	1	.000	2.383	1.471	3.859
Constant	−1.396	.562	6.168	1	.013	.248		

CI = confidence interval, OR = odds ratio.

of FA. Nwaru et al. conducted a study for a lifetime prevalence of self-reported FA and showed self-reported prevalence of FA was 6%.[13] In our study, the total self-reported prevalence of FA was 15.7%, which was higher than that reported FA affected between 2–10% of the American population and the prevalence of 6.6% self-reported FA recently in Canada.[3,13,14] FA prevalence in adult was estimated to be 13% in the US and about 5.2% in Japan (college students).[9] Chafen and his colleagues[15] conducted a meta-analysis of the FA epidemiology and concluded the prevalence of FA ranged from 1 to 10%, depending on the survey design and diagnostic criteria.

Current research findings suggest that many adults may not outgrow FA beginning in their childhood and/or have developed new FA during adulthood.[4] Due to the different environments, dietary patterns and customs and genetic background, the main allergic foods and related prevalence can be varied in different countries or regions. Peanut is a common

food allergen in the United States, United Kingdom, and Switzerland. The EuroPrevall concluded that the first priority of allergy foods include egg, cow's milk, codfish, shrimp, peanut, hazelnut, apple, peach, and celery root. The Food and Drug Administration in US recognizes peanut, soybean, cow's milk, egg, fish, crustacean shellfish, wheat, and tree nuts as the 8 most common food allergens, which are known to be responsible for more than 90% of FA reactions.[16] Peanut, nut, shellfish and fish are the most common causative foods in adult, the prevalence of allergy to shellfish, peanut allergy and nut allergy are 3.3%, 0.6%, and 0.1%, respectively.[17] The most commonly reported allergenic foods were milk, egg, and nuts among Japanese college students. The spectrum of allergen foods in this study is different and our study showed that the first food allergen is shrimp (5.8%), which is accounting for 37.2% of the total FA, followed by milk, shellfish, peaches, mango, eggs, beef, and peanuts.

The typical symptoms of FA include allergenic reactions to the skin, respiratory tract and gastrointestinal tract, and as well as cardiovascular aberrations. Anaphylaxis, immediate severe hypersensitivity to food, can involve several organ systems and induce life-threatening consequences, such as hypovolemic shock and respiratory compromise.[5] This study indicated that clinical manifestations of FA occurred commonly in skin, such as pruritus, redness, and swelling, followed by redness, swelling and tingling around the mouth, circulatory system, gastrointestinal and respiratory system symptoms, which are basically consistent with the reports in the literature.[1]

A study based on clinical food challenge test in the United States[18] analyzed 6377 subjects and found that men were more likely to have FA than women. Europrevall survey on prevalence of FA among primary school children in Vilnius, Lithuania showed boys had FA more frequently than girls.[19] Both FA study among adults in Portuguese and college students in Japan found that women reported a higher percentage of self-reported FA than men. However, this study revealed no significant association between FA and gender. These inconsistent results may be due to the influence from study population and methods used.

Age difference is the most important feature in the distribution of FA prevalence, FA is more prevalent in young children whose digestive and immune systems are underdeveloped. Perhaps due to small age gap in university students no significant variation about the prevalence of FA was demonstrated between age groups in our study.

Smoking was closely related to FA and smoking students had the FA prevalence of 20.5%. High tobacco consumption and excessive exposure to tobacco are associated with a significant increase in the prevalence of FA. Current studies have shown that both active and passive smoking are the risk factors of allergic diseases, smoking can regulate Th1/Th2 migration by affecting the expression of Th2-specific transcription factor GATA23.[20] There is relatively limited data on the smoking impact on FA. Therefore, more studies are needed to confirm the association between smoking and FA.

Human genetics plays an important role in the occurrence and development of FA. Of the children whose both parents are having food allergic diseases, 40–50% are likely to develop allergic diseases.[21] The incidence of FA in children with family history of allergy is significantly higher than those families with no allergic history.[22] Other allergic diseases, such as atopy rhinitis and drug allergy, had correlation with FA. Relevant results from this study were consistent with the previous research reports.[23–26]

A previous study showed that exposure to sunlight could promote vitamin D synthesis in skin, which improved immunologic tolerance through several mechanisms, including improving the T regulatory cell function and the induction of tolerogenic dendritic cells.[27] MF Vassallo[28] investigated 3792 FA cases in all ages in Boston, and concluded that people with FA were more commonly born in autumn and winter than in spring and summer, Food allergy prevalence was higher in children who were in insufficiency or the lack of vitamin D. RJ Mullins et al.[29] studied the IgE-mediated peanut allergy in children no more than 6 years old and concluded lack of vitamin D would increase the risk of FA. Our result also showed the relationship between exposure to sunlight and FA, with the highest prevalence of self-reported FA among college students who reported no sunlight exposure at all.

Maryam Hussain et al.[30] disclosed obese mice are more likely to develop FA. Similarly, Visness et al[31] elucidated the level of IgE was higher in obese and overweight children aged 2–19 years than the children of normal weight, and the probability of allergic reaction increased in obese children compared with children of normal weight. Our study showed the same association between obesity and FA. We also found the association between antibiotic use and FA, Antibiotic use usually may increase prevalence of FA, this outcome is consistent with the classic hygiene hypothesis on FA.

Dietary, environmental, exposing to antibiotics through overuse them in agriculture and medically prescribed antibiotics have altered the gut commensal microbiota, microbes interact closely with the immune system in the gut, in a way that is possibly harmful to the immune system and triggers FA.[32]

The college students with self-reported FA paid more attention to allergen label. The reason may be that they had FA; so they paid more attention to allergen in order to avoid the reoccurrence of FA. Therefore, it is necessary to constantly strengthen the management of food labels and popularize knowledge about FA. This can be approachable through using various social media so that consumers can avoid the certain foods containing allergens during consumption and through proper food selection.

In universities, many kinds of foods are provided, but there is no regulation on classification and management of FA specially for college students, there are 2 national standards related to food allergen labeling in China, one is GB 7718 General Standard for the Labelling of Prepackaged Foods,[33] the other is GB/T 23779 Allergenic Ingredients in Prepackaged Foods,[34] labeling allergenic food is a voluntary behavior of the food enterprises. Big-8, follows Codex recommendations, lacks supporting from epidemiological data on FA in the Chinese population at present.

Finding of this study showed that college students had little knowledge about FA, which suggests the essential need to strengthen the publicity and health education program in future through various effective approaches.

This study has several limitations. Self-reported diagnosis of FA might overestimate the overall prevalence of FA; recall bias might exist in the cross-sectional study. This study was particularly unique with very high participation rate, we evaluated FA prevalence in the general population of college students, which was deficient in China. Further studies will be conducted through clinical evaluation, serological analysis, oral food challenge on FA to obtain more accurate epidemiological data about FA in China, which can provide more reliable information for improving food allergy diagnosis, management, and treatment.

5. Conclusions

Our finding demonstrated a high self-reported FA of 15.7% among the college students in China, and the main food allergens were identified to be shrimp, shellfish, milk, egg, peach, mango, and beef and peanut. Family history, obesity, lack of sunlight exposure, excessive use of antibiotics, smoking may be modifiable risk factors for FA. Majority of college students are short of knowledge about FA, which needs to be improved through strengthening current health education program including FA in colleges and universities. Food allergy is increasing today becoming a prominent issue for Chinese food safety and public health, more works are urgent to undergo for improving the preventive and treatment of FA.

Acknowledgments

Author contributions

HF was the guarantor and designed the study; QX, ZZ, and YL participated in the acquisition, analysis, and interpretation of the data. HF drafted the initial manuscript; YW, YL revised the article critically for important intellectual content. All authors reviewed the results and approved the final version of the manuscript.

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