

Research Paper

Food Allergies: Knowledge and Practice among Food Service Workers Operating in Western Romania

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ABSTRACT

The purpose of our study was to determine the knowledge and practices regarding food allergies among food service workers operating in western Romania (Timiș, Arad, and Caraș-Severin counties). A self-administered, multiple-choice questionnaire was completed by 121 Romanian food service workers from 23 food service units from July to September 2016. The food service workers interviewed had a moderate level of knowledge and practices regarding food allergies. The results highlight knowledge gaps in the areas of cross-contact and control of anaphylaxis emergencies, indicating the need to retrain food service workers. Our study revealed positive results according to education level, better practices used by more experienced staff, and differences between job positions and eating places. Higher knowledge levels of trained employees coexisted with better practices reported by employees who attended specific courses on allergens. All of these findings (significant at the 5% level) support the hypothesis that training programs must be adapted to the participants' needs and characteristics (professional experience, field of activity, and food service education level) to be easily accessible and to lower costs.

Key words: Food allergies; Food service workers; Knowledge; Practices; Romania

Food allergies are reactions caused by a food or its ingredients (allergens) (3). More than 170 foods can cause food allergies, but 90% of severe allergies result from milk, eggs, peanuts and other nuts, shellfish, gluten-containing cereals, soybeans, celery, mustard, sesame, lupin, mollusks, and products thereof (6). The symptoms of food allergies range from mild to severe; severe allergic reactions can progress to anaphylactic shock, which could eventually lead to death (32). Food allergy is a growing public health concern that affects more than 17 million people in Europe; 3.5 million of these people are younger than 25 years, and the sharpest rise in food allergies has been observed in children and young adults (11). In Romania, which has been a European Union member country since 1 January 2007, official statistics do not provide information about the prevalence of food allergies; independent research projects are the only sources of data. Research suggests that the prevalence of food allergies is lower in Romania than in western European countries (9, 30). However, food allergies represent a hidden hazard to public health in Romania.

Because food allergies have no cure, sensitive individuals must manage their allergies through the avoidance of foods that contain allergens (35). To protect individuals with food allergies, the European Commission developed the

labelling directive, Directive 2000/13/EC (12), which mandates food manufacturers to label all ingredients of prepackaged foodstuffs sold in the European Union, with very few exceptions. The most important amendments of the labelling directive, referring to food allergens, are in Directive 2003/89/EC (13), which introduced the list of food allergens that must be labeled on foodstuffs (Annex IIIa) and subsequently was completed by Directive 2007/68/EC (14). Regulation (EC 1169/2011 (15) introduced, starting December 2014, the mandatory labeling of allergens in foods so that allergens are highlighted from the rest of the ingredients for packaged products sold in bulk or served in restaurants.

Even under conditions imposed by the new legislative requirements, avoiding the risks caused by food allergens is not always possible. Identification of allergenic ingredients is a difficult task even for the most well-informed food service workers. Various studies conducted in Brazil, England, New Zealand, Spain, and the United States have revealed that the level of knowledge and implementation of best practices regarding food allergies by food service workers and their managers must be improved (3, 4, 7, 23, 24, 31, 38). In most cases, the low level of knowledge and inadequate practices used are a result of the lack of training regarding food allergies.

In Romania, some of the food hygiene courses, which are compulsory for Romanian food handlers according to

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MS order 331/1999 (26), include a generic training on food allergies. The available data indicate that in Romania the number of training programs specifically addressing food allergies is limited, and participation in this training is voluntary.

The present study was conducted to (i) determine Romanian food service worker knowledge and practices regarding food allergens and (ii) identify opportunities to improve existing training programs to correct the observed deficits. To the best of our knowledge, this study is the first survey focused on the knowledge and practices regarding food allergies among Romanian food service workers.

MATERIALS AND METHODS

Questionnaire. A self-administered questionnaire was used for data collection. The questionnaire was based in part on information from previous studies (2–4, 7, 8) and the personal experience of the researchers. The 32 questions administered to the food service workers participating in the study were structured in three sections: demographic characteristics and the knowledge and practices regarding food allergens. The demographic characteristics included age, gender, education level, type of food establishment, professional experience, position at work, professional food service training, and the source of training in the field of food allergens. In the knowledge section, 11 questions (with five possible responses including “do not know” to reduce the possibility of randomly selecting the correct answer) covered subjects such as food allergy definition, food allergy symptoms, and safe food preparation practices. Another question was included for which participants had to choose the most common causative agents of food allergies. Practices in the field of food allergens were investigated with 12 questions using the 5-point Likert-type scale (never, rarely, sometimes, often, and always). The questionnaire was accompanied by simple instructions for completion, information concerning the purpose of the study, and assurance that participation was confidential.

Sampling technique. Thirty-five food service units, i.e., restaurants ($n = 10$), fast food premises ($n = 14$), catering premises ($n = 7$), and coffee shops ($n = 4$), in western Romania (Timiș, Arad, and Caraș-Severin counties) were invited to participate in the study. The authors had no legal right of entry into these food premises. Twenty-three units (ca. 65.71%) confirmed their participation in the study from July to September 2016. The research population included the managers and front- and back-of-the-house staffs (cooks, hosts, waiters, runners, etc.) operating in food service units in western Romania.

Data collection. The hazard analysis critical control point program team leaders from the companies that confirmed their participation in the study received the questionnaires (163 copies) by mail. These leaders distributed the questionnaires, monitored the evaluation process, and returned the completed questionnaires for analysis. Of the 128 questionnaires returned, 7 were eliminated from further analysis because they were incomplete, and the remaining 121 questionnaires (ca. 78.52%) were processed. The reliability of the questionnaire was verified in a pilot study with 20 questionnaires. Based on the collected comments, some questions in the final questionnaire were changed to improve clarity. These pilot study questionnaires were not included in the final study.

Statistical analysis. The data were analyzed with SPSS version 21.0 (IBM, Armonk, NY). Two global scores for

knowledge and practices were computed. The score for knowledge was built by adding 1 point for each correct answer in the first 11 questions. Question 12, which had multiple choices, was coded as a fraction. Therefore, the maximum number of points that could be obtained for knowledge was 12, and the final score was computed as the percentage of points obtained by each respondent. The score for practices was computed as the mean number of the points for the Likert-type questions, ranging from 1 and 5. The median, the mean rank, and the mean and standard deviation of scores for knowledge and practice by the levels of the demographic variables are shown in Table 1. The Spearman rank correlation coefficient was used to determine the correlation between knowledge and practice scores. The obtained value of 0.414 (two-tailed, $P < 0.001$) indicated that the association between the two variables was moderately positive and significant.

In the preliminary analysis, the variance homogeneity between the groups of respondents (Levene test) and the normality assumption (Shapiro-Wilk test) were verified. After checking these assumptions, the decision was made to use a nonparametric test and, in some specific cases, both nonparametric and heteroskedasticity corrected tests. Because deviations from normality are generally present, the Kuskal-Wallis and Mann-Whitney omnibus tests were used in all cases. The same tests, with a Bonferroni correction, were applied in pairwise comparisons when the corresponding omnibus test result was significant. The Jonckheere-Terpstra test was also applied for variables with ordered levels (age, education, and experience) to test the hypothesis of no general tendency.

In some situations, in addition to nonnormality we found unequal variances between grouping levels. To deal with the heteroskedasticity problem in these cases, we extended our analyses by using the Welch test for the overall differences and the Games-Howell test for the pairwise comparisons. These tests were used for only specific situations.

As a general rule, the cutoff for significance was set at 5%; however, some comments and remarks are made regarding results at the 10% level.

RESULTS

Demographic characteristics of participants. The demographic characteristics of the participants in this study are presented in Table 1.

Food allergy knowledge of Romanian food service workers. The knowledge questionnaire revealed that only 40.5% ($n = 49$) of the responding food service workers knew what a food allergy is, and 43.8% ($n = 53$) of them knew how quickly the symptoms of a food allergy appear (Table 2). Many (61.16%, $n = 74$) of the food service workers knew the most common symptoms of a food allergy, and 67.77% ($n = 82$) knew the measures to be taken when a customer or consumer experiences an allergic reaction. Only 25.62% ($n = 31$) of workers knew that deep frying, freezing, or boiling cannot destroy allergens. The separate packing, labeling, and storage of allergens, proper sanitation and disinfection of equipment and utensils, and use of dedicated equipment for preparing food for customers with allergies were identified as effective methods for preventing cross-contact with allergens by 60.33% ($n = 73$) of respondents, and 65.29% ($n = 79$) of the workers considered service of allergen-containing foods and

TABLE 1. Demographic characteristics and comparative analysis of food allergy knowledge and practices of Romanian food service workers (N = 121)

Characteristic	Test ^a	n	Question group					
			Knowledge			Practice		
			Median	Mean rank ^b	Mean $\pm$ SD	Median	Mean rank	Mean $\pm$ SD
Gender	NS							
Female		71	5.66	56.72	6.29 $\pm$ 2.27	4.67	57.27	4.64 $\pm$ 0.24
Male		50	6.62	67.08	6.72 $\pm$ 1.91	4.75	66.29	4.7 $\pm$ 0.22
Age interval (yr)	NS							
21–30		35	5.66	57.74	6.27 $\pm$ 1.87	4.58	53.94	4.62 $\pm$ 0.24
31–40		28	6.62	67.11	6.59 $\pm$ 1.5	4.67	56.48	4.63 $\pm$ 0.23
41–50		44	6.50	57.22	6.39 $\pm$ 2.62	4.71	69.18	4.72 $\pm$ 0.22
≥ 51		14	7.08	68.82	6.95 $\pm$ 2.22	4.75	61.96	4.67 $\pm$ 0.23
Education level	KW, JT							
Primary school (4th grade)		2	5.16	46.75	5.17 $\pm$ 3.54	4.71	65.25	4.71 $\pm$ 0.06
Lower secondary school (8th grade)		17	4.66	46.79 A	5.56 $\pm$ 1.86	4.67	48.47 B	4.58 $\pm$ 0.22
High school (12th grade)		88	6.58	60.56	6.4 $\pm$ 1.86	4.67	59.60 A	4.66 $\pm$ 0.21
University		14	9.25	83.04 A	8.17 $\pm$ 3.02	4.92	84.43 AB	4.79 $\pm$ 0.32
Professional experience (yr)	JT							
<1		9	5.50	46.11	5.52 $\pm$ 1.04	4.67	47.00	4.52 $\pm$ 0.33
1–5		34	6.08	58.09	6.25 $\pm$ 1.91	4.67	53.51 A	4.63 $\pm$ 0.19
5–10		31	5.83	58.95	6.31 $\pm$ 1.96	4.67	58.56	4.64 $\pm$ 0.28
10–15		17	6.58	60.21	6.24 $\pm$ 1.96	4.75	62.50	4.69 $\pm$ 0.14
15–20		11	7.41	67.86	6.8 $\pm$ 2.19	4.67	64.82	4.7 $\pm$ 0.16
>20		19	7.58	73.34	7.59 $\pm$ 2.94	4.83	81.45 A	4.79 $\pm$ 0.21
Professional catering training ^c	MW							
Trained		44	6.79	73.24 A	6.99 $\pm$ 1.50	4.75	68.77	4.7 $\pm$ 0.26
Untrained		77	5.66	54.01 A	6.17 $\pm$ 2.38	4.67	56.56	4.65 $\pm$ 0.21
Source of training in food allergens	KW							
Specific course		10	6.79	79.05	7.35 $\pm$ 1.13	4.88	81.30 A	4.8 $\pm$ 0.20
Hygiene course		53	6.58	64.94	6.79 $\pm$ 2.42	4.75	67.12	4.7 $\pm$ 0.25
Course at the workplace		58	5.75	54.28	6.02 $\pm$ 1.89	4.67	51.91 A	4.61 $\pm$ 0.20
Job description	KW							
Manager		11	8.75	89.36 A	8.22 $\pm$ 2.15	4.83	68.59	4.68 $\pm$ 0.36
Cook		32	6.54	59.06	6.41 $\pm$ 2.19	4.75	70.36	4.73 $\pm$ 0.19
Waiter		44	6.04	58.86	6.23 $\pm$ 1.76	4.67	52.64	4.63 $\pm$ 0.20
Other ^d		34	6.58	56.41 A	6.25 $\pm$ 2.33	4.67	60.56	4.66 $\pm$ 0.25
Eating place	KW							
Restaurant		38	6.75	75.46 A	7.38 $\pm$ 2.18	4.75	72.42 A	4.74 $\pm$ 0.20
Fast food		44	5.45	49.27 A	5.81 $\pm$ 2.04	4.67	61.36	4.67 $\pm$ 0.21
Catering		26	5.66	53.83	5.93 $\pm$ 1.78	4.50	41.50 A	4.54 $\pm$ 0.22
Coffee shop		13	6.66	72.77	7.10 $\pm$ 1.98	4.67	65.38	4.67 $\pm$ 0.31

^a NS, variable was not significantly associated with knowledge and practices. Significant results ($P < 0.05$) for other variables were obtained with Kruskal-Wallis (KW), Mann-Whitney (MW), and Jonckheere-Terpstra (JT) tests.

^b Significant multiple comparisons test with Bonferroni correction. Ranks with the same letter are significantly different at $P < 0.05$.

^c In Romania, many courses are available for professional qualification of personnel in the catering industry, cooks, wait staff, etc.

^d Host, hostess, busser, runner, expeditor, pastry baker, barista, bartender, dishwasher, and fast food cashier.

non-allergen-containing foods on the same tray a source of cross-contact with food allergens (Table 2). Many (67.77%, $n = 82$) of the respondents knew that when an allergen comes into contact with a food product, this product should not be consumed by people suffering from allergies. Most respondents (74.38%, $n = 90$) knew that allergic persons cannot safely consume foods that cause allergies, even in trace amounts. Approximately 24% ($n = 29$) of food service workers knew that the frying process can be a source of

cross-contact with other food proteins when the oil was previously used to cook other foods.

Romanian food service worker knowledge about the most common causative agents of food allergies is summarized in Table 3. Almost unanimously, study participants identified eggs as food allergens (96.69%, $n = 117$). Peanuts and crustaceans and products thereof (76.86% of respondents, $n = 93$) and milk (70.25%, $n = 85$) ranked second as responsible for generating food allergies. The

TABLE 2. Food allergy knowledge of among Romanian food service workers (N = 121)

Question	No. (%) of answers
1. What is a food allergy?	
A. An adverse immune response to food proteins	49 (40.5) ^a
B. An adverse immune response to food carbohydrates	31 (25.62)
C. An adverse immune response to food lipids	36 (29.75)
D. Worsening of symptoms of food poisoning	5 (4.13)
E. Don't know	
2. Which of the following are the most common symptoms of a food allergy?	
A. Trouble breathing and swelling of lips, face, tongue, and throat	43 (35.54)
B. Skin rash and gastrointestinal disorders (vomiting, cramps, diarrhea)	3 (2.48)
C. Dizziness, lightheadedness, or fainting	1 (0.82)
D. All of the above	74 (61.16) ^a
E. Don't know	
3. What are the measures you need to take when a customer or consumer has an allergic reaction?	
A. We offer a glass of water to "dilute" the level of allergens and stop the reaction	14 (11.57)
B. We quickly investigate the causes of the allergy	18 (14.87)
C. We immediately provide medical assistance	82 (67.77) ^a
D. We offer the customer a discount on the bill	4 (3.31)
E. Don't know	3 (2.48)
4. How fast do the symptoms of a food allergy appear?	
A. Immediately or within a few hours after the food is consumed	53 (43.80) ^a
B. Within 12 h of ingesting the food	41 (33.88)
C. Within 24 h of ingesting the food	6 (4.95)
D. Within 2 days at most of ingesting the food	17 (14.05)
E. Don't know	4 (3.31)
5. Which of the following procedures can destroy allergens?	
A. Deep frying	33 (27.27)
B. Freezing	8 (6.61)
C. Boiling	47 (38.84)
D. None of the above	31 (25.62) ^a
E. Don't know	2 (1.65)
6. Which of the following is an effective method to prevent cross-contact with allergens?	
A. Packaging, labeling, and separate storage of allergens	9 (7.44)
B. Proper cleaning and disinfection of equipment and utensils	15 (12.39)
C. Use of dedicated equipment for preparing food for customers with allergies	18 (14.88)
D. All of the above	73 (60.33) ^a
E. Don't know	6 (4.95)
7. How should one act when an allergen (e.g., peanut or mustard seeds) falls into a ready-to-eat food destined for a customer who suffers from food allergies?	
A. Remove the allergen and inspect the food to be sure you've removed it completely	32 (26.44)
B. The product should not be consumed by allergic persons	82 (67.77) ^a
C. No precaution because it does not pose any risk to the consumer's safety	2 (1.65)
D. Remove the top layer of food that came into contact with the allergen, redecorate, and serve the product	2 (1.65)
E. Don't know	3 (2.48)
8. Can people with food allergies safely eat foods that cause allergies?	
A. Only if they consume a small amount	12 (9.91)
B. Only if they take an antihistamine as a preventative	4 (3.31)
C. They can never safely consume food that causes allergies	90 (74.38) ^a
D. Appropriate heat preparation of the food product eliminates any health risk	9 (7.44)
E. Don't know	6 (4.95)
9. Which of the following situations can cause cross-contact with food allergens?	
A. Transport and serving allergen-free products and other foods on the same tray	79 (65.29) ^a
B. Contact between raw and cooked foods	38 (31.4)
C. Contact between allergen-containing foods and raw meat	2 (1.65)
D. Contact between allergen-containing foods and dairy products	2 (1.65)
E. Don't know	

TABLE 2. *Continued*

Question	No. (%) of answers
10. Which of the following products is a hazard for consumers with food allergies?	
A. Fried foods	51 (42.15)
B. Foods served with various sauces	5 (4.13)
C. Complex food products with many ingredients	3 (2.48)
D. All of the above	62 (51.24) ^a
E. Don't know	
11. Why can fried foods be dangerous to consumers suffering from food allergies?	
A. Frying modifies the chemical structure of foods	5 (4.13)
B. Cross-contact with other food proteins that may be present because the oil was previously used to cook other foods	29 (23.97) ^a
C. Cross-contact with other food fats that may be present because the oil was previously used to cook other foods	57 (47.11)
D. The high fat content of fried foods aggravates allergic reactions	30 (24.79)
E. Don't know	

^a Correct response.

workers surveyed identified to a lesser extent sulfur dioxide (64.46%, $n = 78$) and nuts (29.75%, $n = 36$) as food allergens.

Differences in the global knowledge scores were noted by demographic group. Regarding gender, no significant difference between men and women was found to exist for this variable ($P = 0.109$) according to the Mann-Whitney test. Although respondents older than 50 years obtained higher scores, no significant tendency was detected for knowledge across the age groups according to the Jonckheere-Terpstra test ($P = 0.705$). For the education variable, completion of only primary school was removed from testing because of unacceptable low number of observations (Table 1). In pairwise comparisons, the Games-Howell test ($P = 0.027$) revealed significant differences between university and lower secondary school

graduates. The omnibus Jonckheere-Terpstra test ($P = 0.004$) supported the hypothesis of a significant tendency in knowledge with increasing education levels. Because the primary school level was removed, by tendency we mean an upward increase of the knowledge score from lower grades to the university level. A general increasing tendency was also noticed across the levels of professional experience for knowledge, but the Jonckheere-Terpstra did not validate this trend as significant ($P = 0.117$).

The professional training of respondents was associated with higher scores for knowledge (Table 1). The Welch test ($P = 0.021$) indicated a significant difference in knowledge between trained and untrained employees.

Concerning the type of training a specific type of course provided, the hygiene course was somewhere in the middle and the course at the workplace was the least useful option. This pattern was globally confirmed by the Welch test ($P = 0.013$) and in pairwise comparisons by the Games-Howell test, which revealed a significant difference ($P = 0.017$) between the specific course and the course at the workplace. However, according to the Kruskal-Wallis test the overall difference was not significant, making it difficult to draw a clear conclusion.

The overall Kruskal-Wallis test ($P = 0.045$) revealed that job position is significantly associated with differences in knowledge between employees. However, only the difference between managers and other positions was sufficiently large to maintain its significance ($P = 0.04$) after applying the Bonferroni correction in pairwise comparisons.

Employee knowledge differed significantly when the type of eating establishment was considered (Kruskal-Wallis test, $P = 0.003$). The pairwise Bonferroni corrected tests revealed a significant difference ($P = 0.004$) in knowledge between restaurant employees and those at fast-food premises.

Food allergy practices of food service workers. Many (73.55%, $n = 89$) of the food service workers reported

TABLE 3. *Knowledge among Romanian food service workers (N = 121) of the most common causative agents of food allergies*

Select which of the following are the most common causative agents of food allergies ^a	No. (%) of answers	
	Yes	No
Eggs ^b	117 (96.69)	4 (3.31)
Milk ^b	85 (70.25)	36 (29.75)
Citrus fruit	11 (9.09)	110 (90.91)
Sulfur dioxide (at a concn of >10 ppm) ^b	78 (64.46)	43 (35.54)
Strawberries	72 (59.50)	49 (40.50)
Nuts ^b	36 (29.75)	85 (70.25)
Crustaceans and products thereof ^b	93 (76.86)	28 (23.14)
Peanuts ^b	93 (76.86)	28 (23.14)
Lamb meat	75 (61.98)	46 (38.02)
Benzoic acid	68 (56.2)	53 (43.80)
Chocolate	57 (47.11)	64 (52.89)
Carrots	2 (1.65)	119 (98.35)

^a According to the Annex II of the European Union (EU) Regulation 1169/2011 (15) and Commission Delegated Regulation (EU) 78/2014 amending Annex II to Regulation 1169/2011.

^b Correct answer.

TABLE 4. Food allergy practices used by Romanian food service workers (N = 121)

Statement	No. (%) of answers				
	Never	Rarely	Sometimes	Often	Always
I check the raw materials and ingredients before processing allergen-free foods			2 (1.65)	30 (24.79)	89 (73.55) ^a
I wash, rinse, and disinfect utensils, equipment, and work surfaces before processing allergen-free foods				20 (16.53)	101 (83.47) ^a
I wash my hands with soap and water and change gloves before processing allergen-free foods				9 (7.44)	112 (92.56) ^a
I use separate or dedicated equipment and utensils to process allergen-free foods			4 (3.31)	29 (23.97)	88 (72.73) ^a
I use separate or dedicated equipment and utensils to process allergen-free meals concomitantly with allergen-containing foods	91 (75.21) ^a	27 (22.31)	2 (1.65)	1 (0.83)	
I fry allergen-free foods in the same oil that was previously used to cook allergen-containing foods	95 (78.51) ^a	25 (20.66)	1 (0.83)		
I clearly identify allergen-free meals immediately after preparation	1 (0.83)	1 (0.83)	8 (6.61)	55 (45.45)	56 (46.28) ^a
I pack, label, and store potentially allergenic ingredients separately			10 (8.26)	50 (41.32)	61 (50.41) ^a
When serving customers with food allergies, I take care that allergen-free meals do not come in contact with allergen-containing meals		1 (0.83)	7 (5.79)	44 (36.36)	69 (57.02) ^a
When there is suspicion of cross-contamination of an allergen-free meal with allergens, I do not serve it to clients with food allergies	7 (5.79)	1 (0.83)	4 (3.31)	31 (25.62)	78 (64.46) ^a
When I am unsure of the allergen potential of an ingredient in a meal on the menu, I do not recommend that product to people suffering from food allergies			2 (1.65)	20 (16.53)	99 (81.82) ^a
When a customer specifies that he or she is suffering from a food allergy, I provide detailed information about ingredients and preparation	1 (0.83)	1 (0.83)	14 (11.57)	105 (86.78)	

^a Correct answer.

that they always checked raw materials and ingredients before processing allergen-free foods. Regarding hand hygiene practices, almost all workers (92.56%, $n = 112$) reported that they always washed their hands with soap and water and changed gloves before processing allergen-free foods (Table 4). The majority of workers (83.47%, $n = 101$) reported that they always washed, rinsed, and disinfected utensils, equipment, and work surfaces before processing allergen-free foods. Many (72.73%, $n = 88$) respondents claimed that they always used separate or dedicated equipment and utensils to process allergen-free foods, but only 23.97% ($n = 29$) reported that they perform this operation often. The self-reported food allergy practices suggested that workers never processed allergen-free meals concomitantly with allergen-containing foods (75.21%, $n = 91$) and did not fry allergen-containing foods and non-allergen-containing foods in the same oil (78.51%, $n = 95$) (Table 4). Only 46.28% ($n = 56$) of those surveyed always clearly identified meals without allergens immediately after preparation, and 45.45% ($n = 55$) reported that they performed this operation often. Half of the respondents always packed, labeled, and stored potentially allergenic ingredients separately, and 41.32% ($n = 50$) claimed that they performed these operations often (Table 4). About half (57.02%, $n = 69$) of the food service workers reported that

they are always careful that allergen-free foods do not come in contact with allergen-containing foods when serving customers with food allergies, and 64.46% ($n = 78$) did not serve meals suspected of cross-contact with allergens to customers with food allergies. The majority of those questioned (81.82%, $n = 99$) claimed that when unsure of the allergen potential of an ingredient in a meal, they always did not recommend it to people with food allergies, and 86.78% ($n = 105$) of the workers reported that they often provided detailed information about the ingredients and preparation to clients with food allergies (Table 4).

The differences in the global practices score among the demographic groups also was analyzed. No significant differences were found between men and women, according to the Mann-Whitney test ($P = 0.161$), and no significant tendencies and differences were detected across age groups according to the Jonckheere-Terpstra ($P = 0.084$) and Kruskal-Wallis ($P = 0.226$) tests.

Regarding education level, we found an overall significant difference with the Kruskal-Wallis test ($P = 0.013$). In pairwise comparisons, a significant difference was found between university and lower secondary school groups ($P = 0.013$) and between university and high school groups ($P = 0.041$). The omnibus Jonckheere-Terpstra test ($P = 0.005$) also supported the hypothesis of a significant

tendency for best practices from workers with lower secondary school to those with university educations. As in the case of knowledge scores, the primary school education level was removed from the analysis. The perfect monotonic increase of the practices scores across the levels of professional experience (Table 1) was highly significant (Jonckheere-Terpstra test, $P = 0.003$). Significant differences in pairwise comparisons also were found between the intervals of 1 to 5 and >20 years (Kruskal-Wallis test, $P = 0.033$).

The professional training of respondents was associated with higher scores for practices (Table 1), but the Mann-Whitney test ($P = 0.063$) revealed a significant difference only at the 10% level. Concerning the type of training, the same pattern for knowledge scores was found (the specific course best suited was the hygiene course). These differences were globally confirmed by the Kruskal-Wallis test ($P = 0.011$). The results in pairwise comparisons indicated that scores after a specific course were significantly higher than scores after the course at the workplace ($P = 0.041$). Although cooks and managers obtained the highest scores, the Welch test ($P = 0.12$) indicated no significant differences in practices between job positions.

The eating place also was a significant factor for employee practices (Kruskal-Wallis test, $P = 0.006$). With the pairwise Bonferroni corrected tests, a highly significant difference ($P = 0.003$) was found between restaurant and catering employees.

DISCUSSION

The results of this study provide information about food allergy knowledge and practices among food service workers in western Romania. The majority of those workers surveyed correctly identified the most common causative agents of food allergies: eggs, peanuts, crustaceans and products thereof, and milk. These findings suggest that respondents should be able to inform their customers about allergens in products, as prescribed in Regulation 1169/2011 (15). These results are similar to those previously reported by other researchers (2, 3, 16, 20, 31, 34).

However, the results also revealed important gaps in knowledge of food allergies. Less than half (40.5%) of the study participants knew what a food allergy is in contrast with findings in previous studies (7, 34). A similar level of knowledge (43.8%) also was found among respondents when asked how quickly symptoms of a food allergy may occur. A lower percentage of correct responses for the same question was reported by Shafie and Azman (34), whereas Choi and Rajagopal (7) and Radke et al. (31) reported a higher percentage of correct responses. These findings suggest that the respondents in the present survey are undertrained and underinformed about anaphylaxis emergencies. The lack of knowledge about these emergencies limits the ability of these food service workers to respond properly to food allergy emergencies in their establishments. These knowledge gaps must be eliminated.

Another troubling finding was that only 25.62% of respondents knew that deep frying, freezing, and boiling cannot destroy allergens, in contrast with findings in

previous studies (2, 3, 5, 10, 23, 38). Approximately one-quarter (24%) of the respondents knew that using the same oil in frying operations can be a source of cross-contact from other food proteins. Shafie and Azman (34) reported a similar level of knowledge regarding cross-contact. These results are of great concern because a lack of understanding of the risk posed by cross-contact with other food proteins might result in serious harm to food-allergic customers.

The respondents also used inadequate food allergy practices related to cross-contact. These results are in contrast with those of previous studies (2, 7). A possible explanation for our findings is the confusion of the terms “cross-contact” and “cross-contamination” as used previously in several studies (1, 2, 37). Cross-contact represents “the transfer of an allergen from a food containing an allergen to a food that does not contain the allergen,” whereas cross-contamination “occurs when microorganisms are transferred from one food or surface to another” (33). Cross-contact generally occurs through the transfer of allergenic proteins during processing or handling, especially when multiple foods or ingredients are produced in the same facility or on the same processing line, such as nonallergenic foods or foods containing other allergenic proteins (17). To prevent cross-contact with food allergens, food service establishments should clearly define in their good manufacturing practices such operations as separate packing, labeling, and storage of allergen-containing foods, proper sanitation and disinfection of equipment and utensils, use of dedicated equipment for preparing food for customers with allergies, use of color coding for quick identification, and verifying orders and/or delivering them separately.

Even when these best practices are implemented and maintained in food service premises, the employees remain an essential factor in prevention and management of allergic reactions. Lack of a communication system from serving staff to kitchen and lack of knowledge and awareness among food service workers were also identified as primary factors that lead to allergic reactions (28). Front-of-house staff must communicate with customers about allergens on the menu, make recommendations about allergen-free options, share information with kitchen staff, and prevent cross-contact during food delivery. Back-of-the-house staff must be cautious and avoid cross-contact during food preparation (21). Food service workers will follow these safe food handling practices when they receive adequate and consistent managerial support. The managers must provide food allergy training for staff, including food allergy awareness, and must provide an environment (gloves, hand washing sinks, tongs, standard operating procedures, and active managerial control) that encourages employees to follow best food safety practices (7, 31).

The study results revealed that several demographic characteristics of the respondents were significantly associated with knowledge and practices related to food allergies. Because the knowledge and practices scores were only moderately correlated, many individual differences were found in the association with the demographic variables. Level of education had a highly significant effect on both food allergy knowledge ($P = 0.004$) and food allergy

practices ($P = 0.005$), with a general increase in the scores from lower secondary school to the university level in accordance with findings from previous studies (19, 31). These results might indicate that higher education levels offer the respondents better access to information about food allergies.

Professional experience also was positively associated with both knowledge and practices; however, this association was statistically validated only for practices ($P = 0.003$). The general increasing tendency in knowledge along with professional experience, even when present, was not statistically validated ($P = 0.117$). This finding is evidence, in addition to theoretical reasoning, to support the conclusion that many of the food service workers develop their food allergy practices through their daily jobs. However, increasing the professional experience among food service workers is a difficult goal to achieve, mainly because of the high employee turnover specific to the food service industry and the fact that most employees are young, some of them in their first jobs.

In our study, staff members in restaurants obtained the highest scores for both knowledge and practices. The lowest scores for knowledge were from workers in fast food units, and the lowest scores for practices were from workers in catering operations. The difference between the highest and lowest scores was highly significant for both knowledge ($P = 0.004$) and practices ($P = 0.003$). In agreement with our results, Lee and Sozen (21) concluded that the type of facility significantly influenced food service worker knowledge scores. In contrast, other researchers reported no differences in food allergy knowledge across different types of food service establishments (22, 24). The inconsistency in findings suggests the need for more empirical studies specifically designed to examine differences in food allergic reactions among various types of restaurants.

For the distribution of knowledge across job positions, the highest scores were obtained by managers, and these scores were significantly different ($P = 0.04$) from the lowest scores (for the "Other" group). For practices, cooks had the highest scores, but the P value was $>10\%$ in all tests conducted. Lee and Sozen (21) reported no significant differences between overall mean scores for food allergy knowledge for the managerial staff and employees. In a study conducted by the Environmental Health Specialists Network, managers obtained a higher score than did employees for questions related to food allergies (31). However, Lee and Xu (22) reported that cooks had slightly higher food allergy knowledge scores than did workers in other positions in the restaurants. These findings suggest that training for the food service workers should be adjusted based on their job requirements. Managers in particular should continuously improve their knowledge of food allergies because many managers provide training for their staff.

The professional training of respondents was associated with higher scores for food allergy knowledge and practices, but significant results at the 5% level were obtained only for knowledge. Regarding the type of food allergy training, the results were similar for both knowledge and practices: a specific course was the most effective, a

hygiene course was moderately effective, and a course given at the workplace was the least effective. Clear global significance was found for practices ($P = 0.011$), and mixed results were obtained for knowledge (validation at only 10% in the Kruskal-Wallis test). In pairwise comparisons for practices, significant differences were found only between the specific course and the workplace course ($P = 0.041$). These results suggest that specific training influences practices but either does not offer enough food allergy knowledge or does not promote the retention of that information.

Even without significant results (at the 5% level) for food allergy knowledge, our results indicate that specific food allergy courses are the most appropriate for the training of managers and staff. Usually, these courses are designed as traditional lectures or classroom presentations (25). These traditional training methods have some limitations such as the lack of flexibility, the inability to permit learners to delve into additional information on a chosen topic, trainer controlled sessions, and a single learning level (20, 27). In several studies, online food allergy training programs have been identified as an alternative for the training of food service workers (5, 19, 20, 22). However, no online training programs are currently available in the Romanian food service sector.

Regardless of the training methods chosen, food allergy training should be provided to all employees, including wait staff, kitchen staff, and managers. To achieve desirable outcomes, food allergy training must be a continuous process and not a one-time event. Repeated retrieval of information is the key to long-term retention (18). Consequently, food allergy training should be provided at regular intervals (21, 31). Further studies could be conducted to investigate which training techniques are most successful in generating long-term retention of essential food allergy knowledge.

Ensuring the required level of training under the conditions of limited financial resources and the high rate of staff turnover specific to the food service industry represents a challenge for the management of food service premises. From a managerial perspective, access to a food allergy training program is hampered by various factors: a lack of commitment and motivation, time, costs, and staff turnover (1, 20, 22, 28, 29, 36). Conversely, employees claim that the main barriers to accessing a food allergy training program are factors such as a lack of time and interest (19–22). To ensure proper training and eliminate these barriers, a food allergy training program should (i) have a theme that is adapted to the participating food service workers' needs, professional experience, fields of activity, and education levels, (ii) be easily accessible, and (iii) be affordable. One limitation of our study is the use of self-reported survey answers. Reality might be different from what respondents reported, especially for practices, which are more difficult to test than knowledge. The study is also limited to the geographical area sampled (Timiș, Arad, and Caraș-Severin counties); therefore, the findings cannot be generalized to the practices of all Romanian food service workers. Differences may exist between these counties and other regions of Romania.

This study is the first to include a survey focused on food allergy knowledge and practices among Romanian food service workers. The findings indicate that Romanian food service workers have a moderate level of food allergy knowledge and use best practice some of the time, suggesting that existing training programs in this field are inadequate. Although the majority of the food service workers may be able to inform their customers about allergens in their products, we identified knowledge and practice areas that need improvement, including the symptoms of food allergic reactions, the control of anaphylaxis emergencies, and the prevention of food allergen cross-contact. These findings indicate that the content of the existing training courses must be updated and/or new training material must be developed to better cover these essential topics. Both worker knowledge and worker practice scores differed significantly by education level and type of food premises. Higher knowledge scores were obtained by trained staff, but improved practices were associated with only specific food allergy courses. Food service worker knowledge in the field of food allergies could be improved through low-cost and easily accessible training programs adapted to workers' needs and characteristics (i.e., professional experience, job description, and education level). More studies based on national surveys are needed to extend these conclusions to the Romanian food service workers as a whole.

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