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Food allergy knowledge, attitudes and practices of foodservice workers at restaurants in Lebanon: Findings from a national cross-sectional study

Sara Nasseredine, Marwa Diab El Harake, Samer A. Kharroubi *, Imad Toufeili

Department of Nutrition and Food Sciences, Faculty of Agricultural and Food Sciences, American University of Beirut, Beirut, Lebanon

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ABSTRACT

Introduction: Dining out at restaurants could be challenging for people with food allergies who ought to depend on food service workers or restaurant staff to prepare allergen-free food.
Objective: The present paper aims to explore knowledge, attitudes and practices related to food allergy among food service workers and managers at Lebanese restaurants.
Methods: A nationally representative survey was conducted among restaurants' food service workers and managers in Lebanon. Through face-to-face interviews, food service workers and managers filled in a multicomponent questionnaire containing two sections: (1) sociodemographic characteristics and work experience, and (2) knowledge, attitudes and practices related to food allergy. An additional section related to the restaurant characteristics was completed by managers only.
Results: A total of 137 restaurants' food service workers and managers completed the surveys. Results indicated that all foodservice workers and managers had positive attitudes towards serving "special customers"; however, many (72%) had limited knowledge and malpractices related to food allergies. Restaurants' managers with adequate knowledge of menu ingredients and those who received food allergy training had significantly higher knowledge scores as compared to their counterparts ($\beta = 1.339$, $p = 0.016$ and $\beta = 3.062$, $p = 0.007$ respectively). Both very low and low food service experience resulted in lower staff knowledge scores (very low: $\beta = -2.160$, $p < 0.01$, low: $\beta = -1.664$, $p = 0.003$) and lower practice scores (very low: $\beta = -1.492$, $p < 0.01$, low: $\beta = -0.730$, $p = 0.038$). However, previous food allergy training yielded higher staff knowledge scores ($\beta = 1.736$, $p = 0.003$). Lower educational level (low: $\beta = -2.12$, $p < 0.001$, moderate: $\beta = -0.680$,$p = 0.033$, high: $\beta = -0.712$,$p = 0.017$) correlated with lower staff practice scores. However, previous food allergy training yielded higher staff and manager practice scores ($\beta = 2.472$,$p < 0.01$ and $\beta = 3.075$,$p = 0.003$ respectively). Managers' practice scores were also correlated to allergen-free menu ($\beta = 1.479$, $p = 0.015$).
Conclusions: The results of this study show that improved legislation, training of restaurant staff, and food allergy knowledge are highly recommended to prevent severe allergic reactions upgrade patient safety. It is recommended that the Lebanese Ministry of Health enact regulations requesting restaurants to implement effective food allergies' management plans.

1. Introduction

Food allergies are caused when the immune system overreacts to allergenic proteins in foods. This unfavorable immune response is triggered in sensitive individuals upon the inhalation, consumption, or contact with certain foods. The clinical symptoms of an allergic reaction can be mild (itchy mouth, a few hives), severe (throat tightening, difficulty breathing), or anaphylactic (sudden and fatal) (McAdams et al., 2018). Evidence indicates that the incidence of food allergies is increasing chiefly due to changes in the environment, lifestyles, and dietary habits (Loh & Tang, 2018). To this end, food allergies increased from 9.1% to 13% between 2001 and 2010, and 18% of the US population, or 25 million Americans, have been reported to suffer from food allergies in 2018 (Gupta et al., 2019; U.S. Census Bureau, 2019; Verrill et al., 2015). About 7.5% of the population in Canada, or 2.5 million Canadians, are known to be affected by food allergies (McAdams et al.,

* Corresponding author. Department of Nutrition and Food Sciences, Faculty of Agricultural and Food Sciences, American University of Beirut. P.O.BOX: 11-0236, Riad El Solh 1107-2020, Beirut, Lebanon.
E-mail address: sk157@aub.edu.lb (S.A. Kharroubi).

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2018), and two million individuals, accounting for 1–2% of the population, are reported to suffer from food allergies in the United Kingdom (Food Standards Agency, 2017). More than 170 foods have been reported to trigger food allergies (FARE, 2019). However, the number of foods that are most frequently associated with food allergies is relatively-small and include celery, eggs, lupin, milk, mustard, peanuts, seafood, sesame, soy, sulfites, tree nuts, and wheat in Canada, the UK, and the US (AllergyUK, 2021; FARE, 2019; McAdams et al., 2018). In common with other developing countries, official data on food allergies in Lebanon are unavailable or, at least, difficult to locate. However, independent research indicates that food allergy in Lebanon affects around 4.1% of infants and children and 3.2% of adults (Irani & Maalouly, 2015). Further, the most common foods associated with food allergies and their frequency among the Lebanese population include cow's milk in infants and young children (30.4% and 17.4%, respectively), hazelnut and wheat in adults (9.9% and 8.5%, respectively), sesame seed (3.8% in infants, 2.7% in children, and 1.9% in adults) and peanut (15.8% in infants, 8.3% in children, and 7.1% in adults) (Irani & Maalouly, 2015).

Food allergies cause significant morbidity and, in certain cases, result in fatalities. To this end, food has been reported to be the top trigger in anaphylactic cases admitted to hospitals in Canada with children being particularly at high risk and accounting for 84.5% of the cases admitted to the pediatric emergency departments (McAdams et al., 2018). A total of 8.6% of food-allergic adults have been admitted to the emergency departments due to food anaphylaxis in the US in 2018 (Gupta et al., 2019), and an increase from 1.23 to 4.04 per 100,000 population per year in hospital admissions due to food anaphylaxis, between 1998 and 2018, has been reported for the United Kingdom (Conrado et al., 2021). There is no cure for food allergies and, therefore, sensitive individuals must exercise due vigilance for avoiding contact with and ingestion of the culprit foods (Gupta et al., 2019).

Food allergy reactions are known to take place in restaurants with 31% to 50% of survey respondents reporting an un-expected allergic reaction to foods after eating in a restaurant (Lee & Sozen, 2018). Furthermore, fatal anaphylactic reactions to foods have been traced to restaurants with 18 of 63 (28%) and 16 of 48 (31%) of the fatalities being associated with foods ingested in restaurants, catering, or from takeaways in the USA and UK, respectively (Carter et al., 2019).

Surveys on food allergy knowledge, attitudes, and practices of food handlers are particularly effective in mapping the strengths and shortcomings of restaurants' personnel in preparing allergen-free meals and their preparedness to deal with food allergy episodes likely to take place on the premises. Results from such surveys conducted in the different parts of the world indicate the existence of serious gaps in knowledge about food allergies, misconceptions about culinary operations that would ensure the absence of food allergens in the prepared meals, miscommunication between front-of-the-house and back-of-the-house personnel on the preparation and serving of meals to possible food-allergic customers, substandard preparedness to deal with food allergy incidents, suboptimal access to resources on food allergy, and a relative lack of training on food allergies (Jianu & Golet, 2019; Lee & Sozen, 2018; McAdams et al., 2018; Sogut et al., 2015; Soon, 2020).

A study on food safety knowledge, attitudes, and practices of food handlers in several foodservice establishments in Lebanon revealed substantial gaps in knowledge and suboptimal practices that were mostly related to factors governing bacterial contamination and multiplication and safe storage of foods (Faour-Klingbeil et al., 2015). A related study at hospitals in Lebanon showed low knowledge of food safety amongst foodservice staff as well as several malpractices in the hygienic handling of foods (Bou-Mitri et al., 2018). However, no studies have surveyed the knowledge, attitudes, and practices of food handlers and managers on food allergy at restaurants in Lebanon. In addition to their contribution to the literature on food allergy, such studies are of pivotal importance to the restaurant and hospitality industry and the public health sector in Lebanon and countries at similar stages of development. Further, documenting the current practices on food allergies in the hospitality and restaurant industry in Lebanon will be of relevance to the movement of people and goods among countries given the increasing trend towards globalization. Such studies will also be of interest to countries in the region given the paucity of similar studies reported from the MENA region. Accordingly, the objectives of the present study are to a) assess the knowledge, attitudes, and practices of food service personnel at restaurants in Lebanon, b) compare knowledge, attitudes, and practices among managers and staff, c) benchmark the findings against similar facilities in other countries, and d) identify the potential needs of the restaurant industry for measures to upgrade the safety standards and/or practices on food allergy.

2. Methods

2.1. Study setting and population

A descriptive, cross-sectional survey was conducted among Lebanese foodservice workers to explore their knowledge, attitudes, and practices regarding food allergies. The Principal Investigator secured restaurant managers' approval before approaching their employees, conducting the study at their premises, and examining the menu for some parameters. Employees were approached and invited to participate in the study during their break/free time in order not to disrupt the workflow of the restaurant.

Data collection took place between September 2017 and February 2018. A list of all restaurants from an online database from all over the Lebanese governorates was obtained. From this list, restaurants were chosen via a stratified random sampling technique. The strata represented all six Lebanese governorates and so restaurants were randomly chosen from the list of all restaurants within each stratum. The number of restaurants chosen was proportional to the restaurants' size in each stratum. Sample size calculations indicated that a minimum of 137 participants (managers, workers, and servers only two from each foodservice) must be recruited to estimate a prevalence of 5% with a 95% confidence interval (CI) and a margin of error of 5%. The sample size was determined using the WHO sample size calculator, available on the following link: www.who.int/ncds/surveillance/steps/resources/sample _size_calculator.xls (WHO. STEPS, 2019). For the presnt study, restaurants were defined as facilities that prepare and serve food or beverages to customers (chain, independent). Food catering centers or, mobile food units, temporary food stands, restaurants in supermarkets were excluded from the study.

2.2. Recruitment

Managers or owners of the food establishments were approached to particpate in the present study. In case manager was unavailable, three more visits took place before removing the food establishment of interest from the list. Further, in case manager was not interested in participating, the following food establishment in the list was approached. After obtaining permission from the restaurant manager, food service workers (managers, chefs, and servers) aged between 18 and 65 years from the different restaurants were invited to participate in the survey using a direct approach at the restaurant premises. However, food service workers had the option to agree or refuse to participate in the study. Interested participants who agreed to participate in the survey were provided with a consent form that explained the objective of the study, procedures to be undertaken, potential risks and benefits of participation, and all related information. Food service workers were urged to ask any questions regarding the research study or request further clarification before they agree to take part in the survey. Food service workers who were unable or unwilling to give consent for the study were not included.

The interested participants were contacted for survey administration at a date and time according to their preference and availability. The

investigators conducted on-site surveys, in a private setting, with a manager, a food worker, and a server. Participants were asked to fill in a self-administered survey after providing their oral consent. Two survey forms were developed to evaluate employees' knowledge, attitudes, and practices in the foodservice sector focusing on the socio-demographic characteristics of foodservice employees (e.g. years of experience in the present restaurant, food safety certification, etc.) and the restaurant characteristics (only for managers) (e.g. chain versus independent ownership, number of meals served in a normal day, etc.). An information sheet with background on food allergies, types of food allergens, and what to do in case a customer experienced an allergic reaction, was provided for each manager at the recruited restaurant after survey completion. The completion of the questionnaire took approximately 15–20 min. The data collectors were trained on how to conduct effective and efficient data collection during surveys. The study protocol was reviewed ethically approved by the Institutional Review Board (IRB) at the American University of Beirut prior to the data collection.

2.3. Data collection

The employees were asked to fill the surveys in a closed room at the restaurant to avoid potential manager-employee clashes that might arise. To preempt possible jeopardy of their employability status, the research team made sure that the manager was not present when the food workers were filling the survey. The data collectors explained to potential study participants (food service workers) that their participation in the study is voluntary and refusal to take part in the data collection will not have any negative impact on their jobs. Furthermore, the data collection process was completely anonymous and the participants had the right to stop the survey at any point during the process. The filled surveys were collected by the research team directly after completion by the participants.

2.4. Study instruments

Two survey forms were developed to evaluate employees' knowledge, attitudes, and practices. One survey form was administered to the managers (Appendix I) and another form was presented to the servers and chefs (Appendix II).

The investigators also asked questions to assess the food sector employees' knowledge, attitudes, and practices towards food allergies, which comprised:

- 7 questions about the employees' knowledge of food allergy,
- 14 questions about the employees' attitudes towards food allergies, and
- 8 questions about the employees' practices regarding food allergy.

In addition, the investigators observed the restaurant and then checked its menu to explore any extra characteristics about the restaurant (e.g. items' prices, number of critical violations during last inspection, etc.) and food allergy documentation (e.g. allergens stated on the menu, records in the kitchen, etc.).

After finishing the surveys, the manager and the employees were briefed about the aforementioned information sheet on food allergies. A copy of this sheet was kept with the manager to ensure future improvements in food allergy-related knowledge practices and attitudes (Please refer toAppendix III).

The design of the questionnaire used in the data collection for this study was informed by a thorough review of relevant literature (Lee & Xu, 2015; Radke et al., 2016) and by a careful examination of the local context. The content validity of this questionnaire was confirmed by a food science expert and a biostatistician. The questionnaire was initially developed in English, subsequently translated to the Arabic language (since some of the participants talked Arabic) and then back-translated to English. The two translations were carried out to verify the parallel-form reliability of the questionnaire. Any disagreement that occurred in the back-translated version was resolved to provide a precise reading. Finally, the final version of the questionnaire was pilot-tested on a convenient sample of 10 participants to enhance its comprehension, validity and reliability. The results of the pilot testing phase of the questionnaire were not included in this study.

2.5. Statistical analysis

Scores were developed for the knowledge, practices, and attitudes for every respondent category (i.e. manager, food worker and server). With regards to knowledge and practices scores, the numbers of right responses (out of 7) and (out of 8) were summed up respectively and every group's median score was used to dichotomize the respondents as having a higher or lower level. For example, the knowledge score for each participant was calculated by coding each correct answer as 1, and incorrect answer as 0, and then summing these values such that the highest possible knowledge score was 7. Participants with knowledge scores <4 were considered to have low knowledge levels, whereas those with scores ≥ 4 were considered to have high knowledge level. As for the attitude scores, each response was assigned point values as follows: strongly disagree (SA) $=$ 1, disagree (D) $=$ 2, unsure (UN) $=$ 3, agree (A) $=$ 4, and strongly agree (SA) $=$ 5. A 1 point score was provided for SA and A, and 0 points for D and SD. Then, every for each participant, the assigned values for all the 14 attitude questions were summed to obtain their respective attitude score and then every group's median score was used to divide the respondents into those having relatively positive or less positive attitudes.

Data were checked for completeness and were then entered into the Statistical Package for the Social Sciences (SPSS) version 24.0 for data analysis. Descriptive statistics were displayed as means and standard deviations (SD) for continuous variables or as counts (n) and proportions (%) for categorical ones. Chi-square and independent t-tests were used to assess the associations between sociodemographic characteristics and scores of knowledge, attitudes, and practices (KAP) among the study sample. Univariate and multivariate linear regressions were applied to investigate which factors (social or work characteristics) are associated with KAP scores. In the regression model, the KAP score was used as the dependent variable while the sociodemographic and work-related characteristics (including age, gender, education), which showed statistical significance in the simple analysis, were added to the muliple model as independent variables. Beta (β) coefficients and their respective 95% confidence intervals (CI) were obtained. In all analyses, a p-value below 0.05 was considered statistically significant.

3. Results

3.1. Restaurants, managers and staff characteristics

Restaurants characteristics: Managers interview data showed that half of the surveyed restaurants were independently owned, 67.5% were classified as full service and 45% had American menus (Table 1a). More than half of the participating restaurants (52.5%) had more than 3 managers, 57.5% had more than 10 workers at the restaurant, 45.0% had a food item priced more than $20 and 42.5% recieved more than one critical violation after the last inspection. Additionally, 40% of managers indicated serving ranges of 1–100 meals per day and 35% reported a person in duty. Data related to strategies that should be adopted by restaurants to control food allergies showed that some restaurants had menus which included a thorough description of the ingredients in each food item (n $=$ 37, 92.5%), prepared special meals for food allergic customers (n $=$ 11, 27.5%), provided separate allergen-free menu (n $=$ 5, 12.5%), provided food allergens information in the kitchen area (n $=$ 13, 32.5%) and provided modified recipes (n $=$ 14, 35.0%).

Managers Data: 40 out of 137 surveys were filled by managers.

Table 1a
Characteristics of restaurants included in the study.

Restaurant type (N = 40)	n (%)
Chain	20 (50.0)
Independent	20 (50.0)
Service type	
Full service	27 (67.5)
Quick service	13 (32.5)
Menu type	
American	18 (45)
Non-American	22 (55)
No. of meals served per day	
1–100	16 (40.0)
101–300	13 (32.5)
>300	11 (27.5)
No. of managers or persons in charge that work in this restaurant	
<3	19 (47.5)
≥3	21 (52.5)
No. of workers other than managers that work in this restaurant	
<10	17 (42.5)
≥10	23 (57.5)
Highest priced food item on the menu	
< $10	7(17.5)
$10-$20	15(37.5)
> $20	18(45.0)
No. of critical violations received after the last inspection	
0	19 (47.5)
1	4 (10)
>1	17 (42.5)
Person in duty	
No	26(65.0)
Yes	14(35.0)
Description of menu ingredients	
No	3(7.5)
Yes	37(92.5)
Preparing special meals for food allergic customers	
No	29 (72.5)
Yes	11(27.5)
Provided separate allergen-free menu	
No	35 (87.5)
Yes	5 (12.5)
Provided food allergens information in the kitchen area	
No	27(67.5)
Yes	13(32.5)
Modified recipes	
No	26(65.0)
Yes	14(35.0)

Table 1b
Characteristics of managers and staff recruited in the study.

Parameters	Managers N = 40	Staff N = 97
	n (%)	n (%)
Gender		
Male	36 (90)	63(64.9)
Female	4 (11)	34 (35.1)
Highest educational level		
Elementary	0	5(5.2)
Intermediate School	0	19(19.6)
Technical diploma	8 (20)	37(38.1)
University	32(80)	36(37.1)
Experience in food service		
<2 years	9 (22.5)	34 (35.1)
2-4 years	19 (47.5)	29(29.9)
5-7 years	2 (5)	20(20.6)
7-9 years	7 (17.5)	14(14.4)
>10	3 (7.5)	0
Job type		
Full time	–	77(79.4)
Part time	–	20 (20.6)
Received training in food allergies		
Yes	13(32.5)	27 (27.8)
No	27 (67.5)	70 (72.2)

Among the managers, 36 were males (90%) and 4 were females (10%) (Table 1b). The managers' ages ranged between 23 and 55 years (mean = 33.18 ± 7.795). The majority of managers reported having a university education (n = 32, 80%). As for the years of foodservice experience, 9 out of 40 managers had 2–4 years of experience in the field (47.5%) and only 3 managers had more than 10 years of foodservice experience (7.5%). A relatively low number of managers had food allergy training (n = 13, 32.5%). Half of the managers (n = 20, 50%) reported working in independent restaurants, while the other half reported working for chain restaurants. More than two in three participants (n = 27, 67.5%) indicated full-service dining as their restaurant type and the rest (n = 13, 32.5%) managed a quick-service type facility.

Staff Data: Of the 97 polled staff, 64.9% were males, 37.1% had a university education, and 79.4% were full-time workers (Table 1b). More than one in three participants reported having less than 2 years of experience at restaurants (n = 34, 35.1%) and only 27.8% (n = 27) reported receiving training on food allergies while working at present restaurant.

3.2. Food allergy knowledge score

Managers: The mean score of food allergy knowledge for the managers was 4.20 ± 1.95 out of a maximum score of 7. More than two in three surveyed managers (72.5%) failed to identify at least 6 major food allergens. Only 42.5% of the participants knew that they have to call the emergency in case a food allergy reaction occurred at the restaurant. Of the polled managers, 47.5% (n = 19) believed that a person suffering from food allergy can die from ingesting the allergen (Table 2). Nearly half of the managers (n = 19, 47.5%) reported that someone who consumes foods they are allergic to might die, while 60% (n = 24) of them correctly indicated that removing a food allergen from a meal after it has been prepared does not make it safe for a food-allergic consumer.

Linear regression results of managers' knowledge scores

A single linear regression identified 10 predictors that were significantly correlated with the managers' knowledge scores. The identified

Table 2
Descriptive data on restaurant's managers and staff food allergy knowledge.

Question	Managers N = 40 n (%)	Staff N = 97n (%)	Managers vs Staff **chi-square (χ_c^2)/P-value**
Participants identified at least 6 major food allergens			
Yes	11 (27.5)	25 (25.8)	**χc^2 = 100.048/**
No	29 (72.5)	72 (74.2)	**p < 0.01**[a]
Which of the following should you do if a customer is having a bad food allergic reaction?			
Suggest that customer drinks water	4 (10.0)	24 (24.7)	χ_c^2=3.987/
Call the emergency (Correct)	17 (42.5)	33 (34.0)	p = 0.263
Ask the customer to take their medicine	16 (40.0)	32 (33.0)	
Suggest that the customer throw up	3 (7.5)	8 (8.2)	
Someone with food allergy can die from eating the food they are allergic to:			
Yes (Correct)	19 (47.5)		**χc^2 = 50.837/**
No	14 (35.0)	31 (32.0)	**p < 0.01**[a]
Unsure	7 (17.5)	49 (50.5) 17 (17.5)	
Taking a food allergen out of a meal after it has been made is one way to make it safe for food allergic customer:			
Yes	9 (22.5)	41 (42.3)	χ_c^2 = 5.445/
No (correct)	24 (60.0)	39 (40.2)	p = 0.06
Unsure	7 (17.5)	17 (17.5)	

[a] Estimates shown in bold are those that are statistically significant at p < 0.01.

predictors included restaurant type, description of menu ingredients, availability of modified recipe, and managers' foodservice experience (Table 3). No significant differences were observed between the overall mean knowledge score of participants and their salaries or social status. All the significant predictors obtained from single regression were analyzed by multiple linear regression. Two predictors were found to be significantly associated with the manager's knowledge scores. Managers at restaurants who incorporated descriptions of the menu ingredients and those who received food allergy training showed better knowledge scores, respectively ($\beta = 1.339$, $p = 0.016$; $\beta = 3.062$, $p = 0.007$).

Staff: Regarding the 7 knowledge questions, the mean score of food allergy knowledge was 4.21 ± 1.756 out of a maximum score of 7. For major food allergen identification, a relatively low proportion of the staff ($n = 25$, 25.8%) managed to rightly identify at least 6 major food allergens. Half of the staff failed to correctly indicate that a food-allergy person might die from consuming the allergen-containing food. Only 33 (34%) of the staff knew that when allergic reactions occur at their premises they must contact the emergency immediately. As for taking a food allergen out of a ready-to-eat meal, only 40.2% correctly indicated that such action does not render the meal safe for consumption by food-allergic consumers.

Linear regression results of staff knowledge scores

Single Linear regression analysis showed 8 significant predictors of staff knowledge scores (Table 3). Subjecting the 8-identified significant predictors to multiple linear regression analysis indicated that the determinants of knowledge scores included years of foodservice experience (Very low: $\beta = -2.160$, $p < 0.01$), (Low: $\beta = -1.664$, $p = 0.003$), and previous training received ($\beta = 1.736$, $p = 0.003$).

Comparison of manager and staff knowledge scores and responses

Out of a maximum score of 7, both groups had equivalent median knowledge scores at 4.20 ($SD = 1.951$, $n = 40$) for managers and 4.21 for staff ($SD = 1.756$, $n = 97$). The Knowledge scores did not differ significantly between the 2 respondent groups ($p = 0.986$).

Regarding knowledge questions, as indicated in the cross-tabulations results, significant differences were observed between the managers' and staff's answers in two knowledge questions. More managers correctly identified at least 6 food allergens as compared to the staff (27.5 vs 25.8%, respectively, $\chi^2_c = 100.048$, $p < 0.01$). In addition, a significantly greater proportion of managers were able to correctly identify that a food-allergy person might die from consuming the food they are allergic to (47.5% vs. 32%, $\chi^2_c = 50.837$, $p < 0.01$, Table 2). Further, multiple linear regression showed that food allergy training was

Table 3
Predictors of managers and staff knowledge scores.

Predictors	Managers				Staff			
	Simple Linear B coefficient, P-value		Multiple Linear B coefficient, P-value		Simple Linear B coefficient, P-value		Multiple Linear B coefficient, P-value	
Female	−0.5	0.366	–		−0.816	0.028*	−0.225	0.440
Restaurant Type (chain)	−1.3	0.003*	−0.310	0.309	N/A[d]			
Highest Price					N/A[d]			
Low	−1.429	0.092	0.23	0.586				
Moderate	−1.467	0.03*	0.318	0.397				
High	Reference		Reference					
Person on duty	2.989	0.0*	0.591	0.172	N/A[d]			
Description of menu	2.739	0.017*	1.339	0.016*	N/A[d]			
Allergen free menu	2.286	0.012*	−0.072	0.908	N/A[d]			
Documentation in dining	2.286	0.012*	−0.661	0.262	N/A[d]			
Documentation in kitchen	3.236	0.0*	−0.661	0.262	N/A[d]			
Modified recipes	2.659	0.0*	−0.314	0.487	N/A[d]			
Educational level	1.188 a	0.125 a	–					
No school					−2.250,		−0.014	
Low					−1.250	0.03*	−0.646	0.984
Moderate					−1.791	0.06*	−0.286	0.179
High					Reference	0.0*	Reference	0.523
Job Type	N/A[b]		–		−0.890	0.043*	−0.149	0.657
Salary	0.235 c	0.789 c	–					
Low					−0.719	0.421	0.118	0.870
Moderate					1.383	0.01*	−0.184	0.620
High					−0.719	0.136	0.166	0.686
Very high					Reference		Reference	
Experience								
Very low	−4.556	0.0*	−0.314	0.487	−2.908	0.0*	−2.160	0.0*
Low	−3.088	0.0*	0.123	0.923	−2.488	0.0*	−1.664	0.02*
Moderate	−0.667	0.365	−0.240	0.777	−0.843	0.084	−0.839	0.09
High	0.33	0.607	1.156	0.186				
Very high	Reference				Reference		Reference	
Experience at this Rest.	2.234	0.0*	0.228	0.640	0.836	0.026*	−0.394	0.234
Training	3.692	0.0*	3.062	0.007*	2.573	0.0*	1.736	0.003*
Predictors	Managers				Staff			
	Simple Linear B coefficient, P-value		Multiple Linear B coefficient, P-value		Simple Linear B coefficient, P-value		Multiple LinearB coefficient, P-value	
Special Meals								
Low	−3.655	0.001*	−0.617	0.467	1.707	0.0*	0.332	0.332
Moderate	−0.667	0.541	−0.495	0.480	2.033	0.007*	0.768	0.768
High	Reference				Reference		Reference	

[a]Educational level is categorized into two groups (Technical, university) in Managers data set.
[b]Data were obtained from Staff questionnaires only.
[c]Salary is categorized into two groups (High, very high) in Managers data set.
[d]Data were obtained from Managers questionnaires only.
*Estimates shown in bold are those that are statistically significant at $p < 0.05$.

a significant predictor for both the managers' and staff's knowledge scores (β = 3.062, p = 0.007 and β = 1.736, p = 0.003, Table 3).

3.3. Attitudes toward serving customers with food allergies

Managers: Nearly all the managers (95%) strongly agreed or agreed that servers and kitchen staff ought to be educated about food allergies (Table 4). The majority of managers (87.5%) strongly agreed or agreed that restaurants ought to attempt to meet the food-allergic consumers' special orders. However, only a few managers (15%) agreed or strongly agreed that a person with a food allergy should be able to bring their meals when eating out at the restaurant premises.

The demographic charactestics, knowledge, and previous training status were included into the regression model as independent variables with the attitude score as the dependent variable. Few predictors were associated with the attitude score because nearly all the managers scored high on attitude (data not shown). Results revealed that managers who served more than 300 meals per day had higher odds of having bigger food allergy attitude score than those who served 100 meals or fewer (OR = 1.88, p < 0.05).

Linear regression results of managers attitude scores

Single linear regression analysis of the managers' attitude scores showed only one significant predictor, which is the total number of meals prepared at the restaurant, where the low number of meals prepared decreases managers' attitude score by 1.114 points (β = −1.114, p = 0.017).

Staff: The majority of staff strongly agreed or agreed that servers and kitchen staff ought to be educated about food allergies (90.5% vs. 93.8% respectively) Table 4. In addition, most food workers (79.4%) strongly agreed or agreed that restaurants must attempt to meet the special requests of the food-allergic customers'. However, 42.3% of food workers disagreed that a person with a food allergy should be able to get their meals when eating out. No significant predictors of staff attitude scores were obtained.

Table 4
Descriptive data on managers and staff food allergy attitude.

Attitude	Managers N = 40 n (%)	Staff Managers vs. Staff N = 97 n (%)	chi-square (χ_c^2)/ P-value
Servers should be knowledgeable about food allergies			χc^2 = 2.697/
Strongly Agree	17 (42.5)	32 (33)	p = 0.441
Agree	21 (52.5)	56 (57.5)	
Neutral	1 (2.5)	8 (8.2)	
Disagree	1 (2.5)	1 (1)	
Strongly Disagree	0	0	
Kitchen staff should be knowledgeable about food allergies			χ_c^2 = 4.047/
Strongly Agree	17 (42.5)	26 (26.8)	p = 0.256
Agree	21 (52.5)	65 (67)	
Neutral	1 (5)	4 (4.1)	
Disagree	0	2 (2.1)	
Strongly Disagree	0	0	
Restaurant should try to meet food allergic customers' special requests			χc^2 = 3.971/
Strongly Agree		15 (15.5)	p = 0.410
Agree	10 (25) 25 (62.5)	62 (63.9)	
Neutral	5 (12.5)	14 (14.4)	
Disagree	0	5 (5.2)	
Strongly disagree	0	1 (1)	
Someone with food allergy should be able to bring his/her own meals when dining out:			χ_c^2 = 5.263/
Strongly Agree	2 (5)	0 (0)	p = 0.261
Agree	4 (10)	8 (8.2)	
Neutral	15 (37.5)	43 (44.3)	
Disagree	17 (42.5)	41 (42.3)	
Strongly Disagree	2 (5)	5 (5.2)	

Linear regression results of staff attitude scores

Single linear regression analysis showed that high monthly income of staff was associated with significantly lower attitude scores (High income: β = −1.094, p = 0.03). However, no significant associationswere identified by multiple linear regression analysis.

Comparison of manager and staff attitudes scores and responses

Both managers and staff had similar median attitude scores (median score = 10) and average scores (mean score for managers = 10.7, SD = 1.203, n = 40 and mean score for staff = 10.57, SD = 1.767, n = 97) out of a maximum score of 14. T-test indicated that the attitude scores were not significantly different between the 2 participant groups (p = 0.257, Table 4). Multiple linear regression showed no significant predictors for both managers' and staff's attitude scores.

3.4. Food allergy practices scores

The responses of managers and staff toward food allergy practice questions are displayed in Table 5.

Managers: Out of 8 practice questions, the mean practice score was 4.58 ± 2.049 out of a maximum score of 8. Twenty four managers out of 40 answered correctly that the service staff should be able to recognize the ingredients in the menu and indicate whether it contains any known allergen to preempt possible allergic reactions. The majority of managers (n = 34, 85%) stated that if unsure about the ingredients in a menu they persuade the customer that the meal is free from allergens.

Linear regression results of managers practices scores

The predictors of managers' practice scores identified from single linear regression analysis included restaurant characteristics such as a person on duty (β = 3.291, p < 0.01), description of menu ingredients (β = 2.423, p = 0.047), and the availability of an allergen-free menu

Table 5
Descriptive data of managers and staff food allergy practices questions.

Practice	Managers N = 40 n (%)	Staff N = 97 n (%)	Managers vs Staff **chi-square (χ_c^2)/P-value**
Which of the following should service staff do in order to prevent allergic reaction			
Cook food to right temperature	7 (17.5)	29 (29.9)	
Be able to identify ingredient in menu and determine if it contains any allergen (Correct)	24 (60)	51 (52.6)	χc^2 = 0.625/
Use Dishwasher	6 (15.0)	13 (13.4)	p = 0.453
Keep food safe from bacterial growth	3 (7.5)	4 (4.1)	
If unsure about the ingredients in a menu item, I still assure the customer that the allergen is not present.			
Never	34 (85.0)	11 (11.3)	
Sometimes	4 (10.0)	18 (18.6)	$\chi c2$ = 114.103/ p < 0.01
Always	2 (5.0)	68 (70.1)	

($\beta = 3.0$, $p < 0.01$) amongst others (Table 6). Also, some managers' characteristics were considered predictors of practice scores such as managers' foodservice experience (Very low: $\beta = -5.111$, $p < 0.01$), (Low: $\beta = -3.877$, $p < 0.01$), current experience at this restaurant ($\beta = 2.33$, $p < 0.01$) and food allergy training ($\beta = 3.934$, $p < 0.01$). Based on multiple linear regression, the predictors of practice scores were the availability of an allergen-free menu ($\beta = 1.479$, $p = 0.015$) and receiving food allergy training ($\beta = 3.075$, $p = 0.003$).

Staff: In the practices section, 8 questions were asked to the staff and the mean practice score was 4.55 ± 1.942 out of a maximum score of 8. When asked what can they do to avoid an allergic reaction from occurring, 51 staff out of 97 answered correctly, specifically that the service staff should be able to recognize the ingredients in the menu and indicate whether it contains any known allergen. A relatively high proportion of the staff (70.1%, $n = 68$) stated that if unsure about the ingredients in a menu they guarantee the customer that the meal is free from allergens.

Linear regression results of staff practices scores

Two predictors were found to be significantly associated with the manager's practice scores (Table 6). Managers at restaurants who provided separate allergen-free menu and those who received food allergy training showed practice knowledge scores, respectively ($\beta = 1.479$, $p = 0.015$; $\beta = 3.075$, $p = 0.003$). The factors that had impact on staff practice scores included years of food service experience (very low: $\beta = -1.492$, $p < 0.01$, low: $\beta = -0.730$, $p = 0.038$), educational level (low: $\beta = -2.12$, $p < 0.01$, moderate: $\beta = -0.680$, $p = 0.033$, high: $\beta = -0.712$, $p = 0.017$) and previous food allergy training received ($\beta = 2.472$, $p < 0.01$).

Comparison of manager and staff practice scores and responses

The median practice score for the 2 groups was 4 for both managers and staff. The average practice score for managers and staff were 4.58 ($SD = 2.049$, $n = 40$) and 4.55 ($SD = 1.942$, $n = 97$), respectively, out of a maximum score of 8. The practice scores of the 2 respondent groups (managers and staff) were not significantly correlated (Table 6). However, there were significant differences between responses of the two groups for the following practice question "If unsure about the ingredients in a menu item; I still assure that the allergen is not present". A significantly higher percentage of staff answered that if not sure about the ingredients in a menu item they "never" assure that the allergen is not present as compared to managers (85% vs. 11.3%, $\chi^2_c = 114.103$, $p < 0.01$, Table 5). Finally, food allergy training influenced the two groups' practice scores (Managers: $\beta = 3.075$, $p = 0.003$; Staff: $\beta = 2.472$, $p < 0.001$, Table 6).

4. Discussion

To the best of our knowledge, this is the first study to assess the knowledge, practices, and attitudes of restaurant personnel about food allergy across all governorates in Lebanon. The study sought to explore differences between the managers and employees in the aforementioned

Table 6
Predictors of managers and staff practices scores.

Predictors	Managers				Staff			
	Single Regression		Multiple Regression		Single Regression		Multiple Regression	
	B coefficient	**P-value**	**B coefficient**	**P-value**	**B coefficient**	**P-value**	**B coefficient**	**P-value**
Highest Price	**−1.96**	**0.029***	0.408	0.238	N/A[d]		–	
Person on duty	**3.291**	**0.0***	0.772	0.058	N/A[d]		–	
Description of Menu	**2.423**	**0.047***	0.861	0.069	N/A[d]		–	
Allergen free Menu	**3.0**	**0.0***	**1.479**	**0.015***	N/A[d]		–	
Documentation in dining	**2.086**	**0.031***	−0.049	0.919	N/A[d]		–	
Documentation in kitchen	**3.479**	**0.0***	−0.131	0.807	N/A[d]		–	
Modified recipes	**3.071**	**0.0***	0.381	0.359	N/A[d]		–	
Social Status								
Married	Reference	–	–	–	**4.063**	**0.043***	1.128	0.235
Good	0.095	0.888			3.513	0.072	1.465	0.120
Not Good	−1.571	0.467			2.5	0.291	0.807	0.469
Widowed					Reference			
Experience								
Very low	**−5.111**	**0.0***	−0.613	0.651	**−3.092**	**0.0***	**−1.492**	**0.0***
Low	**−3.877**	**0.0***	−0.011	0.992	**−2.323**	**0.021***	**−0.730**	**0.038***
Moderate	−0.667	0.379	−0.868	0.262	−0.157	0.758	−0.206	0.528
High	Reference		−0.543	0.496	reference			
Educational level	0.875[a]	0.286[a]						
No school					**−4.844**	**0.0***	**−2.128**	**0.0***
Low					**−2.865**	**0.0***	**−0.680**	**0.033***
Moderate					**−2.850**	**0.0***	**−0.712**	**0.017***
High					reference		reference	
Salary	0.873[c]	0.343[c]						
Low					−1.594,	0.112	−0.375	0.424
Moderate					**−1.368,**	**0.003***	−0.051	0.834
High					−0.744	0.167	0.039	0.884
Very high					reference			
Special Meals								
Low	**−3.914**	**0.0***	−0.297	0.702	**2.158**	**0.0***	−0.023	0.935
Moderate	−0.389	0.699	−0.668	0.297	**2.4**	**0.003***	−0.220	0.605
High	reference				reference			
Experience at this rest.	**2.33**	**0.0***	0.305	0.484	**1.285**	**0.002***	−0.257	0.243
Training	**3.934**	**0.0***	**3.075**	**0.003**	**3.657**	**0.0***	**2.472**	**0.0***

aEducational level is categorized into two groups (Technical, university) in Managers data set.
b Data were obtained from Staff questionnaires only.
cSalary is categorized into two groups (High, very high) in Managers data set.
dData were obtained from Managers questionnaires only.
*Estimates shown in bold are those that are statistically significant at $p < 0.05$.

indices and how the restaurant industry responds to food allergies. The data showed that both managers and staff lack the requisite knowledge about food allergy, apply suboptimal practices and only few having received training on food allergy. However, both groups of employees exhibited a positive attitude towards accommodating food-allergic customers.

No significant differences were found between the relatively-low knowledge scores of managers and staff at 4.20 ± 1.95 and 4.21 ± 1.76, out of a mximum score of 7, respectively. The data also revealed that less than half of the restaurants' staff and managers were knowledgeable on several aspects including "someone with food allergy can die from eating the food they are allergic to" and "taking a food allergen out of a meal after it has been made is one way to make it safe for food allergic customer". Further, important gaps in knowledge among food service staff and managers were identified in the study population. Specifically, restaurant staff members were less likely to identify at least 6 major food allergens compared to managers. Additionally, 42.5% of managers and 34% of staff were knowledgeable about the proper action, viz. calling the emergency, to be taken when allergic reactions happen at their premises. Notwithstanding the differences in the format of questionnaires, the levels of difficulty of the questions and the methods of data collection, the present findings are similar to observations from a telephone survey of Indian restaurants in the UK that found only one in three participants responded correctly to food allergy knowledge questions and one in four staff managed to correctly identify 3 common food allergens (Common et al., 2013). However, the present findings are in stark contrast to data from other reports where markedly higher knowledge scores were achieved and superior preparedness to deal with food-allergy incidents by most of the managers and/or staff in the restaurant industries in Canada, USA and Romania (Jianu & Golet, 2019; Lee & Sozen, 2018; McAdams et al., 2018; Radke et al., 2016). The present observations are particularly troublesome in being reflective of the presence of serious gaps in knowledge on food allergies of restaurant personnel in Lebanon. To this end, concerted actions by the different stakeholders are warranted for upgrading the ability of food service personnel, at restaurants in Lebanon, to manage food allergic customers and respond to food allergy-related emergencies at the workplace.

No significant differences were observed in the practices' scores between the managers and staff. However, a significantly higher proportion of managers (85 for managers vs. 11.3% for staff; Table 5) indicated that they will not serve meals to food-allergic customers if they suspect the presence of allergens in the meal (Table 5). This serious malpractice of the staff suggest serious shortcomings in communication, at least in part, between the managers and their subordinates and highlight the need for more effective communication between managers and food preparers and servers and the need to address the pivotal importance of transparency when communicating with the customers. Further, though did not show differences, 17.5% of the managers and 29.9% of staff incoorectly noted that cooking foods to the right temperature would destroy the allergens. This misconception is possibly rooted in the established belief that heating purifies foods from all health-threatening agents including microrganisms, conatminants, and allergens. The destruction of food allergens by boiling and frying operations is a common misconception among restaurant personnel and had been reported by several workers (Jianu & Golet, 2019; Lee & Sozen, 2018; McAdams et al., 2018; Radke et al., 2016).

Several participants' characteristics and the availability of resources at the workplace were significantly associated with food allergy knowledge and practice scores (Tables 3 and 6). More specifically, males in the staff group exhibited higher knowledge scores ($\beta = -0.816$ $p = 0.028$, Table 3), both very low and low food service experience resulted in lower staff knowledge scores (very low: $\beta = -2.160$, $p < 0.01$, low: $\beta = -1.664$, $p = 0.003$, Table 3) and lower practice scores (very low: $\beta = -1.492$, $p < 0.01$, low: $\beta = -0.730$, $p = 0.038$, Table 6). Additionally, lower educational level (low: $\beta = -2.12$, $p < 0.001$, moderate: $\beta = -0.680$,$p = 0.033$, high: $\beta = -0.712$, $p = 0.017$, Table 6) correlated with lower staff practice scores. It is possible that employees with higher education levels have higher interest and better access to information about food allergies. Accordingly, these observations suggest that restaurants should accord more educated and more experienced workers with leadership incentives and have them more engaged in food allergy training and house operations. Furthermore, the description of menu items and the presence of allergen-free menus was associated with higher managers' knowledge scores and practice scores, respectively ($\beta = 1.339$, $p = 0.016$; $\beta = 1.479$, $p = 0.015$, Tables 3 and 6), and food allergy training was found to be significantly associated with higher managers' and staff's knowledge (Managers: $\beta = 3.062$, $p = 0.007$, Staff: $\beta = 1.736$, $p = 0.003$) and practices scores (Managers: $\beta = 3.075$, $p = 0.003$; Staff: $\beta = 2.472$, $p < 0.001$). The availability of resources for the management of the food-allergic customers seems to sensitize the restaurant personnel to acquire knowledge on food allergy and adopt better practices and that receiving training is pivotal for the accumulation of the requisite knowledge and development of sound practices for preempting and dealing with incidents of food allergy at the workplace. Similar associations among the personnel characteristics and availability of resources at the workplace with knowledge and practices scores have been noted by several workers (Elsahoryi et al., 2020; Jianu & Golet, 2019; Loerbroks et al., 2019; Radke et al., 2016; Taha et al., 2020).

The present study indicates that the attitudes of restaurant managers and staff were generally positive regarding food-allergic customers despite their low knowledge and practice scores. This finding is similar to that reported in a study from Turkey where personnel exhibited positive attitudes and confidence in providing "safe" meals to food-allergic customers despite apparent gaps in their knowledge about food allergy (Sogut et al., 2015). Attitude scores have been reported to be positively related to knowledge scores with participants well-versed in knowledge about food allergy normally exhibiting high scores on attitudes (Lee & Sozen, 2018; Lee & Xu, 2015; McAdams 2018). Accordingly, the positive attiude scores are perversely counter-intuitive given the low levels of knowledge about food allergy exhibited by the particpants in the present work. The perceived ability to deal with potential life-threatening food allergy incidents without the requisite knowledge to do so is a concerning issue from the standpoint of both public health and the restaurant's reputation. Therefore, concerted efforts should be made by the management to addres the root-cause of such attitudes through a combination of effective training and measures to affect the needed behavioral changes.

Our findings revealed that the knowledge, attitudes, and practices' scores did not differ significantly between managers and staff. However, some differences were detected in the responses to some knowledge and practice questions. In particular, managers were more likely to identify at least 6 major food allergens as compared to staff members. Further, more managers than staff/servers were found to caution customers about the possible presence of allergens in their meals. This may be related to the significantly higher educational levels and knowledge scores of the managers as compared to those of the staff consistent with findings from previous research (Lee & Sozen, 2018; Radke et al., 2016; Sogut et al., 2015). These findings indicate that even when managers are well-versed on food allergies, they fail to communicate/share the relevant information to/with their subordinates. These communication gaps need to be rectified for ensuring the preparation and serving of safe allergen-free meals at foodservice facilities. These gaps and their detrimental consequences on health, and the reputation of restaurants can be surmounted by providing restaurant staff with effective food allergy management resources including ingredient lists, dedicated kitchen equipment, written plans, and training modules on food allergy for acquiring the essential knowledge and sound practices for dealing with food allergies. The importance of providing restaurant staff with effective food allergy management resources is underscored by a recent study that indicated the availability of organizational resources, including

training and technology, was positively correlated with employee motivation, engagement, and performance (McAdams et al., 2018).

According to the Food Standards Agency, information on allergen-containing ingredients must include product specification sheets, ingredients, labels, and recipes (Clark et al., 2011). Also, the "Food Safety Modernization Act (21 CFR Part 117)" stipulates that restaurants must have a risk assessment plan in place for handling allergens (Andrews et al., 2018). Furthermore, several national (and international) "Food Codes" state that restaurants should have a person in charge during all hours of operation who is knowledgeable on food allergy (Andrews et al., 2018; Carter et al., 2019). In contrast, no food regulations and laws require the food industries, in Lebanon, to indicate the possible food allergens on their food labels. Further, there are no related regulations and/or laws requiring the implementation of food allergy management plans in the national foodservice facilities.

In the present work, food allergy training was associated with a positive manager and server knowledge (Managers: $\beta = 3.062$, $p = 0.007$, Staff: $\beta = 1.736$, $p = 0.003$) and attitudes (Managers: $\beta = 3.075$, $p = 0.003$; Staff: $\beta = 2.472$, $p < 0.001$). In contrast, a previous study found that food allergy training influenced attitudes but did not result in better food allergy knowledge (Radke et al., 2016). McAdams et al. (2018) found that the completion of food allergy training programs was associated with more positive attitudes toward food allergen management. Possible relevant material for such training may contain information on major food allergens, menu items containing food allergens, symptoms of allergic reactions, interaction with food allergic customers, preparing and responding for a food allergic reaction, and preventing cross-contact with allergens. It is possible that through focused food allergy training programs, employees can acquire an appreciation of the importance of accommodating food-allergic diners and more confidence in managing food allergy concerns. Future studies should address tailoring training modules to the needs of the different groups of restaurant personnel, the modes, and frequency of offering the developed modules to the concerned parties. It is noteworthy that despite the many companies/organizations that offer food safety-related certifications, in Lebanon, no dedicated training and certification on food-allergy training and management exist.

This study has several limitations. First, the data collection depended on self-reported answers for knowledge, attitudes, and practices, all of which could be liable to errors because of memory recall and/or social desirability bias. Second, although the survey conducted in this study was nationally representative, the cross-sectional type of the study ruled out any inference about the change in knowledge, attitudes or practices over time among food service workers and managers in Lebanon. Third, the study might suffer from a selection bias as participants who agreed to participate in our study might already have more awareness on this topic and would, therefore, score higher on food-allergy knowledge than non-respondents. Lastly, the presented study depended mainly upon quantitative evaluation. Further research to qualitatively explore food workers' and managers' knowledge, attitudes and practices regarding food allergy could provide a full assessment of the subject matter.

5. Conclusion and recommendations

In conclusion, the results of this study revealed that all food service workers and managers at Lebanese restaurants had positive attitudes towards serving "special customers"; however, many had limited knowledge and malpractices related to food allergies. Restaurants are encouraged to muster enough resources and develop effective preventive practices to handle requests for allergen-free meals and deal with potential food-allergy incidents at their premises. The ability of private food safety and quality bodies to provide training and certification on food-allergy management plans and the national regulatory agencies to enact the relevant laws and regulations are also warranted.

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This article contains data collected from interviewing participants after obtaining their oral consent. The study has been reviwed and ethically approved by the Institutional Review Board (IRB) at the American University of Beirut (AUB).

Consent for publication

Not applicable.

Availability of data and material

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Code availability

Not applicable.

CRediT author statement

Sara Nasseredine: Data curation, Investigation, Formal analysis, Writing- Original draft preparation. **Marwa Diab El Harake**: Visualization, Writing - Review & Editing. **Samer A. Kharroubi**: Methodology, Software, Formal analysis, Validation, Visualization, Supervision, Writing- Original draft preparation, Writing - Review & Editing. **Imad Toufeili**: Conceptualization, Resources, Project administration, Writing-Original draft preparation, Writing - Review & Editing. **Samer A Kharroubi** and **Imad Toufeili** have contributed equally to this manuscript.

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

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