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Title	Food allergen knowledge, attitude and practices among UK consumers: A structural modelling approach
Type	Article
URL	<a href="https://clock.uclan.ac.uk/26408/">https://clock.uclan.ac.uk/26408/</a>
DOI	<a href="https://doi.org/10.1016/j.foodres.2019.03.008">https://doi.org/10.1016/j.foodres.2019.03.008</a>
Date	2019
Citation	Soon, Jan Mei (2019) Food allergen knowledge, attitude and practices among UK consumers: A structural modelling approach. Food Research International, 120. pp. 375-381. ISSN 0963-9969
Creators	Soon, Jan Mei

It is advisable to refer to the publisher's version if you intend to cite from the work.  
<https://doi.org/10.1016/j.foodres.2019.03.008>

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1 **Food allergen knowledge, attitude and practices among UK consumers: A structural**  
2 **modelling approach**

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5 **Abstract**

6 Food allergies are becoming more prevalent and affect up to 1 – 2% of adults and 5- 8% of children  
7 in the UK. This study investigated the food allergen knowledge, attitude towards food allergens and  
8 food allergy management practices among food allergic and intolerant consumers and / or their  
9 family members and carers. Questionnaires were distributed at three major Free From events in the  
10 UK in 2017 and 2018. Structural Equation Modelling (SEM) was used as a confirmatory technique to  
11 determine the model's validity. Cereals containing gluten, milk and eggs were the most common  
12 triggers reported by the consumers. Other trigger foods such as chocolate, garlic, maize, onions, red  
13 and white meat, spices, and fruits such as apples and cherries were also reported. Consumers  
14 demonstrated very good understanding on the severity of allergic reactions, prevention method and  
15 hidden egg ingredients. Overall, consumers were relatively good in the knowledge section. The  
16 participants were motivated in their personal allergen avoidance towards food allergens especially in  
17 checking food labels, preference for more free from product choices and handwashing. Consumers  
18 did not rely on dietary apps or social media to find out about allergen-free food products. Both  
19 knowledge and attitude did not translate into food allergy management practices. Significant  
20 correlation between knowledge and attitude was identified suggesting that as knowledge decreases,  
21 so will their attitude scores. This study suggests that targeted and systematic food allergy  
22 management topics and peer support could be used to improve consumers' knowledge and attitude  
23 to positively impact food allergen handling practices.

24  
25 **Highlights**

26 Consumers demonstrate relatively good knowledge in food allergens  
27 Food allergen knowledge and attitude did not directly affect food allergen handling practices  
28 A significant relationship between knowledge and attitude was identified

29  
30 **Keywords:** food allergy; intolerance; prevention; Structural Equation Modelling

31  
32 **Introduction**

33 The prevalence of food allergy in infancy has increased to 10% particularly in westernised regions  
34 and is more common among children compared to adults (Osborne et al., 2011; Sicherer & Sampson,  
35 2018). Food allergy is an adverse immune reaction that occurs upon exposure to specific food  
36 (Moore, Stewart, & de Shazo, 2017) and symptoms range from mild skin reactions to severe

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37 anaphylactic reactions. At the global level, Codex stated that the eight common food allergens  
38 (cereals containing gluten, egg, milk, soy, peanuts, tree nuts, fish and shellfish) shall be declared  
39 (Codex, 1985). These eight main food allergens contribute 90% of food allergic reactions (Bush &  
40 Hefle, 1996). In the UK, food businesses are regulated by the EU Food Information for Consumer  
41 Regulation No. 1169/2011 (EU FIC). Food businesses are required to present allergen information  
42 clearly (emphasis by font, style or background colour) for prepacked foods in the list of ingredients.  
43 Food businesses such as food services providing and selling non-prepacked foods are required to  
44 provide allergen information for the inclusion of any of the 14 specified food allergens (celery, cereals  
45 containing gluten, crustaceans, egg, fish, lupin, milk, molluscs, mustard, peanuts, sesame seeds,  
46 soya, sulphur dioxide and tree nuts) (Regulation EU No. 1169/2011).

47  
48 Peanuts, tree nuts and fish are the most common cause of food allergic reactions among adults in the  
49 UK while children are commonly affected by milk, eggs and peanuts (NHS, 2016). Strict avoidance of  
50 food allergens is the main preventative and management of food allergic reactions. However,  
51 adherence to an allergen-free diet could be challenging particularly when consumers are dining out or  
52 purchasing ready meals (Begen et al., 2018). According to Versluis et al. (2014), between 21 – 31%  
53 of accidental consumption of allergens occurred while eating in restaurants and 13 – 23% occurred at  
54 workplace or school canteens. Each year in the UK, 10 patients die from food-induced anaphylaxis  
55 due to undeclared allergenic ingredients (FSA, n.d.). Recent fatalities due to presence of food  
56 allergens in takeaway meals and sandwiches underscore the importance of food allergen  
57 management, food allergen labelling and allergy awareness among catering staff (BBC News, 2018a,  
58 b; Soon, 2018a).

59  
60 A number of food allergen management studies had been carried out among food service workers  
61 (Ajala et al., 2010; Dupuis et al., 2016; Soon, 2018a; Wham & Sharma, 2014). Food service staff  
62 often receive food allergy training and such training had proven positive in Bailey, Kindratt, Smith, &  
63 Reading (2014) where restaurant employees were able to answer food allergy questions, better  
64 management of food allergens (e.g. review ingredient lists) and improved communication with  
65 customers. Food service staff are provided with the essential training and knowledge of food allergen  
66 management (Lee & Sozen, 2016). On the other hand, individuals with food allergic reactions and/or  
67 intolerance often rely on their own initiatives to learn and manage their conditions and associated  
68 risks. Children and vulnerable individuals manage their conditions with support from family members,  
69 carers or healthcare providers. A number of consumer studies are associated with eating out practices  
70 (Begen et al., 2018; Leftiwch et al., 2011) and food allergen labelling and purchasing habits (Barnett  
71 et al., 2011; Marchisotto et al., 2017). Food allergy management deals with food allergen avoidance,  
72 managing symptoms, treatment of allergic reactions as a result of accidental exposure and  
73 communicating food allergic consumers' needs (Davis & Kelso, 2018; Venter, Sicherer, & Greenhawt,  
74 2019). There remain limited studies on knowledge of food allergic consumers and/or their family

75 members and carers', their attitude and practices towards food allergens. This study investigates the  
76 food allergen knowledge, attitude towards food allergens and food allergy management practices  
77 among food allergic and/or intolerant consumers and / or their family members and carers. Food  
78 allergen knowledge refers to the understanding of or information about food allergen acquired  
79 through experience or education while attitude is a feeling or opinion about food allergies and  
80 practice refers to the action or application of food allergy management (Cambridge Dictionary, 2019a,  
81 b, c). Structural equation modelling (SEM) method was used as a confirmatory technique to  
82 determine the proposed model validity. SEM had been used in a number of food safety studies  
83 (Baser, Ture, Abubakirova, Sanlier, & Cil, 2017; Chen, 2017; Lim, Chye, Sulaiman, Mohd Suki & Lee,  
84 2016) and only one study had utilised SEM in food allergy study (Soon, 2018b). In this study, the  
85 author postulates the following hypotheses based on Baser et al. (2017), Lim et al. (2017), Schwartz  
86 (1975), Shafie and Azman (2015) and Soon (2018b). The following hypotheses are proposed:

87

88 H1: Food allergen knowledge does not directly affect food allergen handling practices

89 H2: Attitude towards food allergen directly affects food allergen handling practices

90 H3: Food allergen knowledge and attitude are correlated

91

## 92 **Methodology**

### 93 **Questionnaire development**

94 The questionnaire was constructed and divided into five sections: (i) demographics; (ii) epidemiology;  
95 (iii) knowledge (10 questions); (iv) attitude (10 questions); and (v) practices (10 questions). The  
96 questions were developed based on previous studies (Choi & Choi, 2016; Marchisotto et al., 2016;  
97 Shafie & Azman, 2015; Soon, 2018b). In the food allergen knowledge section, participants were  
98 given options e.g. "yes", "no" or "uncertain" to prevent participants from selecting the correct answer  
99 by chance. In the attitude and practices section, participants were asked to rate based on a Likert  
100 scale of 1 (strongly disagree / never) to 5 (strongly agree / always). A pilot study was conducted  
101 among 20 participants (excluded from the actual study) to ensure the clarity and suitability of  
102 wordings.

103

### 104 **Data collection**

105 The author visited two main Free From events in Liverpool (3 – 4 Nov 2017 and 3 – 4 2018) and  
106 London (7 – 9 July 2017). Another Free From event scheduled in Glasgow in 3 – 4 March 2018 was  
107 cancelled. The Free From event caters to consumers with allergies and intolerance needs and exhibits  
108 a number of free from food, cosmetics and household items. It draws 12,000 number of visitors in  
109 2017 (ACC Liverpool Group, 2018). Consumers experiencing food allergies or intolerance, or those  
110 who are carers to individuals with food allergies / intolerance and those interested in free from food  
111 products were invited to participate in the study. The reason why family members were included in  
112 the survey was because third party allergen avoidance is also practiced by family members and carers

113 and they require the skills and experience to manage food allergens at home and interpret food  
114 allergen information (Gowland, 2015). The study was explained to them using an information sheet  
115 and consent was obtained prior to completing the survey. The author utilised a face to face approach  
116 during such events as it returns a higher response rate as consumers are interested in the topic.

117

### 118 **Statistical analysis**

119 Descriptive and Exploratory Factor Analysis (EFA) was conducted using SPSS 24.0. EFA was  
120 performed to extract items from knowledge, attitude and practices based on factor loadings greater  
121 than 0.4 (Baser et al., 2017; Soon, 2018b). Based on the extracted items, SEM was conducted using  
122 Analysis of Moment Structures (AMOS) and confidence level was set at 95%.

123

### 124 **Results and Discussion**

125 A total of 254 questionnaires were returned of which 252 were valid. All the consumers approached  
126 and invited by the author agreed to participate in the study, resulting in a 100% response rate. Most  
127 of the respondents were females, with the highest representative from the 45 – 54 and 55 – 64 year  
128 old categories. This is similar to previous surveys in the UK where female respondents dominated the  
129 samples (Cole, Peek, & Cowe, 2018; Gadema & Oglethorpe, 2011). Females also tend to be the main  
130 decision maker in food purchasing decisions (Cole et al., 2018) and main caregivers (DunnGalvin et  
131 al., 2006; Swinkels, van Tilburg, VerbakeL, & van Groenou, 2017). Almost 40% of the respondents  
132 graduated with a degree and about 10% have a postgraduate degree reflecting a highly educated  
133 group of consumers. More than 45% of the consumers and about 37% of the consumers' family  
134 members have had not experienced food allergic reactions before but this could be due to the fact  
135 that consumers with food intolerance, coeliac disease (CD) patients or those with personal lifestyle  
136 choices also participated in the study. Participants were mostly diagnosed by general practitioners,  
137 allergists and other healthcare practitioners (e.g. consultants, gastroenterologists and dietitians). It is  
138 interesting to note that 30 respondents self-diagnosed their food allergies / intolerance. Cereals  
139 containing gluten (35%), milk (17.8%), eggs (6.9%) and peanuts (6.4%) were the most common  
140 causative agents reported by the participants (Table 1). Cow's milk, wheat, egg, soy, peanut, tree  
141 nuts, fish and shellfish results in the majority of food allergic reactions in Europe (Nwaru et al., 2014).  
142 In the UK, food allergy affects about 1 – 2% of adults and 5- 8% of children (Buck, Hattersley, &  
143 Kimber, 2010). Coeliac disease patients selected cereals containing gluten as the main causative  
144 ingredients that aggravate their autoimmune disease. About 1 – 2% of the global population are  
145 affected by CD (Collin, Vilppula, Luostarinen, Holmes, & Kaukinen, 2018). The incidence rate of CD  
146 was 19.1 per 100,000 person in the UK (West, Fleming, Tata, Card, & Crooks, 2014).

147

148 Insert Table 1 here

149

150 More than 90% of the respondents were aware of the danger of food allergens and the best way to  
151 avoid an allergic reaction is to avoid the causative agent. There was less certainty when it comes to  
152 the potential for cross contact of allergens via hands as 15.9% and 16.7% answered incorrectly or  
153 were uncertain about the statement. 38.1% believed that tree nuts are similar to peanuts while 48%  
154 were uncertain about this statement. A third of the respondents knew that high temperature cooking  
155 does not destroy food allergen and more than half recognised that rinsing cooking utensils with water  
156 only is insufficient. 46.4% were uncertain that most food allergens are protein-based products. More  
157 than half of the respondents knew that buckwheat is not listed as a food allergen in UK/EU and up to  
158 89% of the respondents are aware of potential hidden egg ingredients in food products (Table 2).  
159 Most of the respondents have good understanding of hidden allergenic ingredients in food products  
160 and knew that consuming even a small amount of food allergen will cause an allergic reaction and in  
161 severe cases, it can be fatal. Respondents scored 67% in the overall knowledge section and were  
162 relatively good. This demonstrates that the respondents understood what is needed to control and  
163 manage their food allergies and/or intolerance.

164

165 In Soon (2018a), one third of takeaway staff did not know that allergens can be transferred by  
166 hands. Food allergens can be transferred from hands during food preparation (Sheehan et al., 2018).  
167 Brough et al. (2013) revealed that peanut protein persisted on hands 3 hours after peanut  
168 consumption. Thermal processing can influence allergenicity by modifying the allergenic protein via  
169 protein denaturation, restructuring of disulfide bonds or formation of new intra/inter molecular bonds  
170 (Ekezie, Cheng, & Sun, 2018). The changes that occur may influence allergenicity positively,  
171 negatively or indifferently, e.g. the modified structure of proteins may introduce new allergy  
172 generating sites or loses the original allergenicity (Vanga & Raghavan, 2017). It is true that most food  
173 allergens are glycoproteins (oligosaccharide + protein) (Ekezie et al., 2018) but respondents may  
174 associate food allergenicity with the type of food product rather than the composition and structure of  
175 the food allergens. Foods with hidden allergens can be dangerous for food allergic patients. Anibarro,  
176 Seoane and Mugica (2007) reported that 22.4% of 530 food reactions were considered to be due to  
177 hidden allergens. Food allergy knowledge and awareness are critical to the safety of consumers with  
178 food allergy. This is particularly important to family members and/or carers of food allergic individuals  
179 as they are faced with the expectation to manage food allergies, recognise symptoms and treat food  
180 allergic reactions and anaphylaxis. Equipped with food allergy knowledge can boost confidence and  
181 improve food allergy prevention strategies and preparedness for anaphylaxis (Gupta et al., 2009;  
182 Tsuang et al., 2019).

183

184 Insert Table 2 here

185

186 There were strong agreement among respondents concerning checking of food labels, preference for  
187 more free from choices and that one should wash their hands after coming into contact with food

188 allergens. Respondents also felt that there should be more information provided about allergen-free  
189 food when ordering food online and agreed that it is their responsibility to inform staff of their food  
190 allergies if ordering via telephone. Consumers were less certain about purchasing of food with  
191 allergenic ingredients even if other household members can consume the product with no adverse  
192 health effects. Neither were consumers confident in being able to handle a food allergy emergency  
193 situation (Table 3).

194

195 Studies had been conducted among food allergic consumers who disregard food labels especially  
196 those bearing food allergen advisory statements (Robertson et al., 2013). Consumers are confused  
197 with Precautionary Allergen Labelling (PAL) and the use of PAL often frustrate and restrict consumers'  
198 food choices (Ong, 2008; Sharma, Pereira, & Williams, 2015). There's a higher level of risk taking  
199 among consumers because of 'label fatigue' among consumers which increase the tendency to  
200 disregard advisory labels (Robertson et al., 2013). In Sheth et al. (2008) and Sheth et al. (2010), the  
201 authors found 6.3% and 8.3% (n=695) of allergic individuals who ignored PAL went on to have a  
202 resultant allergic reaction to material that was present in the food through cross contamination.  
203 Edwards and Thomas (2018) recommended the triple check of food labels i.e. read the label at the  
204 store, when unpacking the groceries and before serving. It is encouraging to note that respondents  
205 felt very strongly about checking of food labels. Handwashing is key to prevent cross contact of food  
206 allergens and Perry, Conover-Walker, Pomes, Chapman and Wood (2004) recommended that hands  
207 should be washed with soap to remove protein residue. Perry et al. (2004) found that using plain  
208 water and antibacterial hand sanitiser left detectable peanut on hands. When ordering food online in  
209 the UK, consumers with food allergens are directed to contact the restaurants / takeaways directly to  
210 determine if allergen-free meals could be prepared and delivered. At the moment, there are limited  
211 information and studies in this area, and is definitely worth exploring. The uncertainty in dealing with  
212 a food allergy emergency demonstrates the importance of competence in using an auto-injector and  
213 calling the emergency helpline if someone is suffering from a food allergic reaction.

214

215 Insert Table 3 here

216

217 Consumers frequently read the food labels to check for allergenic ingredients and wash their hands  
218 before preparing allergen-free meals. When dining out, consumers frequently inform staff about their  
219 food allergies and would verify that their meals are indeed allergen-free when served. On the  
220 contrary, the respondents seldom use dietary apps or Quick Response (QR) codes to find out if food  
221 products contain any allergens. There were also less reliance on social media to find suitable eateries  
222 when dining out. Not all respondents find the advisory labelling helpful though (Table 4).

223

224 Insert Table 4 here

225

226 According to Begen et al. (2016), consumers with food allergies / intolerances preferred to rely on  
227 written information before and during their eating out experiences. This can be done by checking the  
228 venue websites, checking the recipes on the internet and menus displayed in the restaurant window.  
229 Verbal information from knowledgeable and perceptive staff increased consumers' confidence in the  
230 safety of their meals. Potentially, the reliance on written and verbal information provided by the  
231 restaurants enable consumers to be confident in their meals. Most consumers did not use food allergy  
232 apps to determine if a product is suitable or to find out more information about the ingredients. There  
233 are multiple dietary apps provided to food allergy and intolerant users today such as the Foodmaestro  
234 food app which helps to validate if a product is suitable and to look for alternative products across  
235 major retailers in the UK (Foodmaestro, 2017). The Biteappy (2018) app helps to search for allergy  
236 friendly restaurants worldwide. It is worth exploring the type and source of information used by food  
237 allergic individuals (e.g. advice from healthcare practitioners, online allergy support group, media,  
238 restaurant reviews) to make their decisions in food choices and allergy management. Precautionary  
239 allergen labelling (PAL) remains an area of confusion. Walker, Hazel and Points (2018) proposed that  
240 a target should be agreed on between government and retailers for a reduction in the variants of PAL  
241 wordings within the next three years.

242

243 EFA was applied in factor analysis to extract the items for knowledge, attitude and practices. The  
244 score of  $< 0.40$  is used to select items (Baser et al. 2017). A total of four items from knowledge,  
245 three items from attitude and one item from practices were removed. The Kaiser-Meyer-Olkin (KMO)  
246 measure of sampling value for food allergen knowledge, attitude and practices were 0.614, 0.603 and  
247 0.696 respectively. These values fulfil Hair, Black, Babin, Anderson, and Tatham (2010) who stated  
248 that the criterion of validity should be  $> 0.60$ . Hair, Anderson, Tatham and Black (1998) also  
249 recommended observing more than one indicator to evaluate the model fit (Table 5).

250

251 Insert Table 5 here

252

253 CFI measured 0.90 indicating a good model fit. GFI and NFI were slightly below the cut off value but  
254 were comparable to Baser et al. (2017) and Wang et al. (2017). The RMSEA and RMR measured  
255 below 0.08 (Hu & Bentler, 1999; MacCallum et al., 1996). Based on the indices and comparison with  
256 other similar studies, the hypothesised model had an acceptable fit.

257

258 Insert Figure 1 here

259

260 Insert Table 6 here

261

262 Figure 1 and Table 6 explains the magnitude and relationship between food allergen knowledge,  
263 attitude towards food allergen and food allergy management practices. Food allergen knowledge has



264 a negative and insignificant relationship ( $\beta_1 = -0.02, p > 0.05$ ) with food allergy management practices  
265 hence supporting H1. The theoretical interpretation from Figure 1 is that food allergy management  
266 practices will decrease 0.02 unit with each incremental unit in knowledge. Although this does not  
267 indicate a direct, linear relationship between knowledge and practices, but this finding reiterates that  
268 having good food allergen knowledge may not translate into good practices. Previous studies by  
269 Baser et al. (2017), Soon (2018b) and Ko (2013) support this finding.

270

271 Attitude towards food allergens were found to have a positive and insignificant relationship with  
272 practices ( $\beta_1 = 0.05, p > 0.05$ ) hence rejecting H2.  $\beta_1$  indicates that food allergy management  
273 practices increase by 0.05 unit with each unit increase in attitude. This contradicts previous findings  
274 where Baser et al. (2017), Soon (2018) and Lim et al. (2016) reported significant relationship  
275 between food safety attitude and practices. Although the respondents scored highly in most of the  
276 attitude mean items, this does not translate into food allergy management practices. This could be  
277 due to the fact that consumers seldom rely on apps or social media to check out suitable products or  
278 restaurants. Okumus, Ali, Billgihan, & Ozturk (2018) suggested that consumers' intention to use and  
279 adoption of dietary apps can be increased by increasing the apps' performance, ease of usage, social  
280 influence and degree of user innovativeness. The consumers in this study also did not often  
281 purchase, whole unprocessed ingredients to prepare their meals from scratch. In fact, they would like  
282 to have more free-from choices, indicating that consumers would prefer to purchase ready meals or  
283 semi-finished ingredients that do not contain the allergenic materials. Time saving in meal  
284 preparation was identified as a key driver in food choices (Casini et al., 2019). The two key strategies  
285 employed by the respondents in this study are handwashing before preparing allergen-free meal and  
286 communicating their needs to food service staff when eating out. There is a significant and negative  
287 relationship between food allergen knowledge and attitude in this study ( $\beta_1 = -0.20, p < 0.05$ ),  
288 supporting H3. This indicates that knowledge and attitude dependently affect practices. As knowledge  
289 decreases, so will their attitude towards food allergens. Tan et al. (2013) found weak correlations  
290 between knowledge and attitude among food handlers while Soon (2018b) found insignificant  
291 relationship between both attributes among consumers.

292

293 The current best method to prevent food allergic reactions would be to adhere to a strict free-from  
294 diet. However, researchers are working on oral immunotherapies to build up tolerance for food  
295 allergens (Blumchem et al., 2018; Wasserman et al., 2018). The PALISADE Group of Clinical  
296 Investigators (2018) revealed encouraging results where peanut oral immunotherapy resulted in  
297 desensitisation among children and adolescents who were highly allergic to peanuts. Such trials can  
298 potentially prevent food allergic reactions and life-threatening circumstances as consumers' tolerance  
299 levels are increased and could tolerate accidental consumption of food allergens. This coupled with  
300 vigilant safe food handling and food allergy management practices can help to ensure the safety of  
301 consumers with food allergies. Food safety is not synonymous with the total absence of risk (FAO,

302 WHO, 1997). Similarly, zero risk for food allergic individuals is not a realistic option. Consumers,  
303 regulators, clinical researchers and food industry are working towards defining a tolerable level of risk  
304 (Madsen et al., 2010). Madsen et al. (2012) reported that the guiding principle in defining acceptable  
305 risk is the concept of minimising the overall risk and hence, the burden of disease caused by food  
306 allergy. Begen et al. (2016, 2018) carried out in-depth interviews to gain understanding of  
307 consumers' preferences for food allergy and intolerance (FAI) information and impact of such  
308 information when eating out while Begen et al. (2017) reported on the experiences of family  
309 members and carers' who eat out with children with FAI. In addition to quantitative surveys, it is  
310 recommended that in-depth interviews be carried out with the consumers to explore their views and  
311 food allergen handling practices especially the adoption of dietary apps in managing FAI.

312

### 313 **Conclusion**

314 Consumers demonstrated relatively good knowledge in food allergens and are motivated in their  
315 personal allergen avoidance towards food allergy management. Most respondents however did not  
316 resort to using dietary apps or social media to find out more information about food products.  
317 Consumers also prefer to have more free-from choices and may not have time to prepare meals from  
318 scratch. The structural equation modelling showed an acceptable fit on food allergen knowledge,  
319 attitude and practices. Although knowledge and attitude did not directly affect their food allergy  
320 management practices, a significant relationship was identified between knowledge and attitude. A  
321 combination of knowledge and attitude can potentially modify food allergen handling practices. It is  
322 suggested that targeted and specific food allergy management topics and online or peer group  
323 support are provided to improve the knowledge-attitude relationships to positively influence their food  
324 allergen handling practices.

325

### 326 **References**

- 327 ACC Liverpool Group (2018). Free from show winter. Available at:  
328 <https://www.exhibitioncentreliverpool.com/whats-on/the-allergy-free-from-show-north/> [Accessed 16  
329 November 2018]
- 330
- 331 Ajala, A. R., Cruz, A. G., Faria, J. A., Walter, E. H., Granato, D., & Sant, A. S. (2010). Food allergens:  
332 Knowledge and practices of food handlers in restaurants. *Food Control*, *21*(10), 1318-1321.
- 333
- 334 Anibarro, B., Seoane, F. J., & Mugica, M. V. (2007). Involvement of hidden allergens in food allergic  
335 reactions. *Journal of Investigational Allergology and Clinical Immunology*, *17*(3), 168.
- 336
- 337 Bailey, S., Kindratt, T. B., Smith, H., Reading, D. (2014). Food allergy training event for restaurant  
338 staff; a pilot evaluation. *Clinical and Translational Allergy*, *4*, 26.
- 339
- 340 Barnett, J., Leftwich, J., Muncer, K., Grimshaw, K., Shepherd, R., Raats, M. M. et al. (2011). How do  
341 peanut and nut-allergic consumers use information on the packaging to avoid allergens. *Allergy*,  
342 *66*(7), 969-978.
- 343
- 344 Baser, F., Ture, H., Abubakirova, A., Sanlier, N., & Cil, B. (2017). Structural modelling of the  
345 relationship among food safety knowledge, attitude and behaviour of hotel staff in Turkey. *Food  
Control*, *73*(B), 438-444.

347  
348 BBC News (2018a). Pret a Manger to label products after allergy death. BBC News, 3 October 2018.  
349 Available at: <https://www.bbc.co.uk/news/business-45731201> [Accessed 10 November 2018]  
350  
351 BBC News (2018b). Megan Lee: Takeaway bosses jailed over allergy death. BBC News, 7 November  
352 2018. Available at: <https://www.bbc.co.uk/news/uk-england-lancashire-46123858> [Accessed 10  
353 November 2018]  
354  
355 Begen, F. M., Barnett, J., Payne, R., Roy, D., Gowland, M. H., & Lucas, J. S. (2016). Consumer  
356 preferences for written and oral information about allergens when eating out. *PLOS One*, *11*(5),  
357 e0156073.  
358  
359 Begen, F. M., Barnett, J., Barber, M., Payne, R., Gowland, M. H., Lucas, J. S. (2017). Parents' and  
360 caregivers' experiences and behaviours when eating out with children with a food hypersensitivity.  
361 *BMC Public Health*, *18*, 38  
362  
363 Begen, F. M., Barnett, J., Payne, R., Gowland, H., DunnGalvin, A., & Lucas, J. S. (2018). Eating out  
364 with a food allergy in the UK: Change in the eating out practices of consumers with food allergy  
365 following introduction of allergen information legislation. *Clinical & Experimental Allergy*, *48*(3), 317-  
366 324.  
367  
368 Bentler, P. M., & Bonnet, D. C. (1980). Significance tests and goodness of fit in the analysis of  
369 covariance structures. *Psychological Bulletin*, *88*(3), 588-606.  
370  
371 Biteappy (2018). Biteappy. Available at: <https://www.biteappy.com/#!/home> [Accessed 20 November  
372 2018]  
373  
374 Blumchen, K., Trendelenburg, V., Ahrens, F., Gruebl, A., Hamelmann, E., Hansen, G. et al. (2018).  
375 Efficacy, safety, and quality of life in a multi-center, randomized, placebo-controlled trial of low-dose  
376 peanut oral immunotherapy in peanut allergic children. *Journal of Allergy and Clinical Immunology: In  
377 Practice*, doi: 10.1016/j.jaip.2018.10.048  
378  
379 Brough, H. A., Makinson, K., Penagos, M., Maleki, S. J., Cheng, H., Douiri, A., Stephens, A. C.,  
380 Turcanu, V., & Lack, G. (2013). Distribution of peanut protein in the home environment. *Journal of  
381 Allergy and Clinical Immunology*, *132*(3), 623-629.  
382  
383 Buck, J., Hattersley, S., & Kimber, I. (2010). Food allergy – science and policy needs – The UK Food  
384 Standards Agency Research Programme. *Toxicology*, *278*(3), 319-325.  
385  
386 Bush, R. K., & Hefle, S. L. (1996). Food allergens. *Critical Reviews in Food Science and Nutrition*, *36*,  
387 S119-S163.  
388  
389 Cambridge Dictionary (2019a). Knowledge. Cambridge University Press. Available at:  
390 <https://dictionary.cambridge.org/dictionary/english/knowledge> [Accessed 17 December 2019]  
391  
392 Cambridge Dictionary (2019b). Attitude. Cambridge University Press. Available at:  
393 <https://dictionary.cambridge.org/dictionary/english/attitude> [Accessed 17 December 2019]  
394  
395 Cambridge Dictionary (2019c). Practice. Cambridge University Press. Available at:  
396 <https://dictionary.cambridge.org/dictionary/english/practice> [Accessed 17 December 2019]  
397  
398 Casini, L., Boncinelli, F., Contini, C., Gerini, F., Scozzafava, G., & Alfnes, F. (2019). Heterogenous  
399 preferences with respect to food preparation time: Foodies and quickies. *Food Quality and  
400 Preference*, *71*, 233-241.  
401  
402 Chen, M.-F. (2017). Modeling an extended theory of planned behavior model to predict intention to  
403 take precautions to avoid consuming food with additives. *Food Quality and Preference*, *58*, 24-33.

404  
405 Choi, J., & Choi, A. (2016). Perceptions of food labelling about allergens in food products in South  
406 Korea. *British Food Journal*, *118*(12), 2842-2854.  
407  
408 Codex (1985). Codex General Standard for the Labelling of Prepackaged Foods. CODEX STAN 1-1985  
409 (Rev 1-1991). Available at: <http://www.fao.org/docrep/005/Y2770E/y2770e02.htm#fn4> [Accessed 10  
410 November 2018]  
411  
412 Cole, M., Peek, H. and Cowen, D. (2018). UK consumer perceptions of a novel till-receipt 'traffic-light'  
413 nutrition system. *Health Promotion International*, doi.org/10.1093/heapro/day007  
414  
415 Collin, P., Vilppula, A., Luostarinen, L., Holmes, G. K. T., & Kaukinen, K. (2018). Review article:  
416 Coeliac disease in later life must not be missed. *Alimentary Pharmacology and Therapeutics*, *47*, 563-  
417 572.  
418  
419 Davis, C. M., & Kelso, J. M. (2018). Food allergy management. *Immunology and Allergy Clinics of*  
420 *North America*, *38*(1), 53-64.  
421  
422 DunnGalvin, A., Hourihane, J. O'B., Frewer, L., Knibb, R. C., Elberink, J. N. G. O., & Klinge, I. (2006).  
423 Incorporating a gender dimension in food allergy research: a review. *European Journal of Allergy and*  
424 *Clinical Immunology*, *61*(11), 1336-1343.  
425  
426 Dupuis, R., Meisel, Z., Grande, D., Strupp, E., Kounaves, S., Graves, A. et al. (2016). Food allergy  
427 management among restaurant workers in a large U.S. city. *Food Control*, *63*, 147-157.  
428  
429 Edwards, J. B. E., & Thomas, B. F. (2018). Putting THOUGHT into food allergens. *2018 Annual*  
430 *Virginia Head Start Conference*, 10 – 12 April 2018, Virginia. Available at:  
431 [https://www.headstartva.org/assets/Annual-Conference/2018-Conference/Workshop-](https://www.headstartva.org/assets/Annual-Conference/2018-Conference/Workshop-Handouts/Putting%20Thought%20into%20Food%20Allergens_faedadal.pdf)  
432 [Handouts/Putting%20Thought%20into%20Food%20Allergens\\_faedadal.pdf](https://www.headstartva.org/assets/Annual-Conference/2018-Conference/Workshop-Handouts/Putting%20Thought%20into%20Food%20Allergens_faedadal.pdf) [Accessed 19 November  
433 2018]  
434  
435 Ekezie, F.-G. C., Cheng, J.-H., & Sun, D.-W. (2018). Effects of nonthermal food processing  
436 technologies on food allergens: A review of recent research advances. *Trends in Food Science &*  
437 *Technology*, *74*, 12-25.  
438  
439 FAO.WHO (1997). Risk management and food safety. Report of a Joint FAO.WHO consultation. Rome,  
440 Italy, 27 to 31 January. *FAO Food and Nutrition Paper*, number 65. Available at:  
441 <http://www.fao.org/3/a-w4982e.pdf> [Accessed 17 February 2019]  
442  
443 Foodmaestro (2018). Foodmaestro Food App. Available at:  
444 <http://www.foodmaestro.me/consumer.html> [Accessed 20 November 2018]  
445  
446 FSA, Food Standards Agency (n.d.). Food allergy facts. Available at:  
447 <http://allergytraining.food.gov.uk/english/food-allergy-facts.aspx> [Accessed 23 November 2018]  
448  
449 Gadema, Z., & Oglethorpe, D. (2011). The use and usefulness of carbon labelling food: A policy  
450 perspective from a survey of UK supermarket shoppers. *Food Policy*, *36*(6), 815-822.  
451  
452 Gowland, M. H. (2015). Chapter 7. Consumer attitudes to allergens in foods. *Handbook of Food*  
453 *Allergen Detection and Control*. Woodhead Publishing Series in Food Science, Technology and  
454 Nutrition, 133-160.  
455  
456 Gupta, R. S., Kim, J. S., Springston, E. E., Smith, B., Pongracic, J. A., Wang, X., & Holl, J. (2009).  
457 Food allergy knowledge, attitudes, and beliefs in the United States. *Annals of Allergy, Asthma &*  
458 *Immunology*, *103*(1), 43-50.  
459

460 Hair, J. R. Jr., Anderson, R. E., Tatham, R. L., & Black, W. C. (1998). *Multivariate data analysis*. 5<sup>th</sup>  
461 Ed. New Jersey: Prentice-Hall.  
462

463 Hair, J. F., Black, B., Babin, B., Anderson, R. E., & Tatham, R. I. (2010). *Multivariate analysis: A*  
464 *global perspective*. New Jersey: Person Education Inc, Upper Saddle River.  
465

466 Hooper, D., Coughlan, J., & Mullen, M. (2008). Structural equation modelling: Guidelines for  
467 determining model fit. *Electronic Journal of Business Research Methods*, 6(1), 53-60.  
468

469 Hu, L. T., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis:  
470 Conventional criteria versus new alternatives. *Structural Equation Modeling* 6(1), 1-55.  
471

472 Kline, R. B. (1998). *Principles and practice of structural equation modelling*. Guilford Press, New York.  
473

474 Ko, W.-H. (2013). The relationship among food safety knowledge, attitudes and self-reported HACCP  
475 practices in restaurant employees. *Food Control*, 29, 192-197.  
476

477 Lee, Y. M., & Sozen, E. (2016). Food allergy knowledge and training among restaurant employees.  
478 *International Journal of Hospitality Management*, 57, 52-59.  
479

480 Leftwich, J., Barnett, J., Muncer, K., Shepherd, R., Raats, M., Gowland, M. H. et al. (2011). The  
481 challenges for nut-allergic consumers of eating out. *Clinical & Experimental Allergy*, 41(2), 243-249.  
482

483 Lim, T.-P., Chye, F. Y., Sulaiman, M. R., Mohd Suki, N., & Lee, J. S. (2016). A structural modelling on  
484 food safety knowledge, attitude, and behaviour among Bum Bum Island community of Semporna,  
485 Sabah. *Food Control*, 60, 241-246.  
486

487 MacCallum, R. C., Browne, M. W., & Sugawara, H. M. (1996). Power analysis and determination of  
488 sample size for covariance structure modelling. *Psychological Methods*, 1(2), 130-149.  
489

490 Madsen, C. B., Crevel, R., Chan, H. C., Dubois, A. E. J., DunnGalvin, A., Flokstra-de Blok, B. M. J. ET  
491 AL. (2010). Food allergy: Stakeholder perspectives on acceptable risk. *Regulatory Toxicology and*  
492 *Pharmacology*, 57(2-3), 256-265.  
493

494 Madsen, C. B., Hattersley, S., Allen, K. J., Beyer, K., Chan, C. H., Godefroy, S. B. et al. (2012). Can  
495 we define a tolerable level of risk in food allergy? Report from a Euro Preval/UK Food Standards  
496 Agency workshop. *Clinical & Experimental Allergy* 42(1), 30-37.  
497

498 Marchisotto, M. J., Harada, L., Kamdar, O., Smith, B. M., aserman, S., Sicherer, S. et al. (2017). Food  
499 allergen labelling and purchasing habits in the United States and Canada. *Journal of Allergy and*  
500 *Clinical Immunology: In Practice*, 5(2), 345-351.  
501

502 Moore, L. E., Stewart, P. H., & de Shazo, R. D. (2017). Food allergy: What we know now. *The*  
503 *American Journal of Medical Sciences*, 353(4), 353-366.  
504

505 NHS (2016). Food allergy. Available at: <https://www.nhs.uk/conditions/food-allergy/> [Accessed 10  
506 November 2018]  
507

508 Nwaru, B. I., Hickstein, L., Panesar, S. S., Muraro, A., Werferl, T., Cardona, V. et al. (2014). The  
509 epidemiology of food allergy in Europe: a systematic review and meta-analysis. *European Journal of*  
510 *Allergy and Clinical Immunology*, 69(1), 62-75.  
511

512 Okumus, B., Ali, F., Bilgihan, A., & Ozturk, A. B. (2018). Psychological factors influencing customers'  
513 acceptance of smartphone diet apps when ordering food at restaurants. *International Journal of*  
514 *Hospitality Management*, 72, 67-77.  
515

516 Ong, P. Y. (2008). Are allergy advisory statements helpful to patients with food allergy? *Journal of*  
517 *Allergy and Clinical Immunology*, 121(2), 536-537.

518

519 Osborne, N. J., Koplin, J. J., Martin, P. E., Gurrin, L. C., Lowe, A. J., Matheson, M. C. et al. (2011).  
520 Prevalence of challenge-proven IgE-mediated food allergy using population-based sampling and  
521 predetermined challenge criteria in infants. *Journal of Allergy and Clinical Immunology*, 127(3), 668-  
522 676.

523

524 Perry, T. T., Conover-Walker, M. K., Pomes, A., Chapman, M. D., & Wood, R. A. (2004). Distribution  
525 of peanut allergen in the environment. *Journal of Allergy and Clinical Immunology*, 113(5), 973-976.

526

527 Regulation (EU) No. 1169/2011. Regulation EU No. 1169.2011 of the European parliament and of the  
528 council of 25 October 2011. Official Journal of the European Union, L 304/18. Available at:  
529 <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32011R1169&from=en> [Accessed  
530 10 Nov 2018]

531

532 Robertson, O. N., Hourihane, J. O'B., Remington, B. C., Baumert, J. L., & Taylor, S. L. (2013). Survey  
533 of peanut levels in selected Irish food products bearing peanut allergen advisory labels. *Food*  
534 *Additives and Contaminants: Part A*, 30(9), 1467-1472.

535

536 Schwartz, N. E. (1975). Nutritional knowledge, attitudes, and practices of high school graduates.  
537 *Journal of the American Dietetic Association*, 66(1), 28-31.

538

539 Shafie, A. A., & Azman, A. W. (2015). Assessment of knowledge, attitude and practice of food  
540 allergies among food handlers in the state of Penang, Malaysia. *Public Health*, 129(9), 1278-1284.

541

542 Sharma G. M., Pereira, M., & Williams, K. M. (2015). Gluten detection in foods available in the United  
543 States – A market survey. *Food Chemistry*, 169, 120-126.

544

545 Sheehan, W. J., Taylor, S. L., Phipatanakul, W., & Brough, H. A. (2018). Environmental food  
546 exposure: What is the risk of clinical reactivity from cross-contact and what is the risk of sensitization.  
547 *Journal of Allergy and Clinical Immunology: In Practice*, 6(6), 1825-1832.

548

549 Sheth, S. S., Wasserman, S., Kagan, R., Alizadehfar, R., Primeau, M.-N., Elliot, S. et al. (2010). Role of  
550 food labels in accidental exposures in food-allergic individuals in Canada. *Annals of Allergy, Asthma &*  
551 *Immunology*, 104(1), 60-65.

552

553 Sheth, S. S., Wasserman, S., Kagan, R., Alizadehfar, R., Primeau, M. et al. (2008). Improving food  
554 labelling for the allergic consumer. *Journal of Allergy and Clinical Immunology*, 121(2), S183

555

556 Sicherer, S. H., & Sampson, H. A. (2018). Food allergy: A review and update on epidemiology,  
557 pathogenesis, diagnosis, prevention, and management. *Journal of Allergy and Clinical Immunology*,  
558 141(1), 41-58.

559

560 Soon, J. M. (2018a). 'No nuts please': Food allergen management in takeaways. *Food Control*, 91,  
561 349-356.

562

563 Soon, J. M. (2018b). Structural modelling of food allergen knowledge, attitude and practices among  
564 consumers in Malaysia. *Food Research International*, 111, 674-681.

565

566 Swinkels, J., van Tilburg, T., Verbakel, E., & van Groenou, M. B. (2017). Explaining the gender gap in  
567 the caregiving burden of partner caregivers. *Journal of Gerontology: Social Sciences*,  
568 doi.org/10.1093/geronb/gbx036

569

570 Tan, L. T., Bakar, F. A., Karim, M. S. A., Lee, H. Y., & Mahyuddin, H. Y. (2013). Hand hygiene  
571 knowledge, attitudes and practices among food handlers at primary schools in Hulu Langat district,  
572 Selangor (Malaysia). *Food Control*, 34, 428-435.

573  
574 The PALISADE Group of Clinical Investigators (2018). AR101 oral immunotherapy for peanut allergy.  
575 *New England Journal of Medicine*, doi: 10.1056/NEJMoa1812856  
576

577 Tsuang, A., Atal, Z., Demain, H., Patrick, K., Pistiner, M., & Wang, J. (2019). Benefits of school nurse  
578 training sessions for food allergy and anaphylaxis management. *Journal of Allergy and Clinical*  
579 *Immunology: In Practice*, 7(1), 309-311.  
580

581 Vanga, S. K., & Raghavan, V. (2017). Processing effects on tree nut allergens: A review. *Critical*  
582 *Reviews in Food Science and Nutrition*, 57(17), 3794-3806.  
583

584 Venter, C., Sicherer, S. H., & Greenhawt, M. (2019). Management of peanut allergy. *Journal of Allergy*  
585 *and Clinical Immunology: In Practice*, 7(2), 345-355.  
586

587 Versluis, A., Knulst, A. C., Kruizinga, A. G., Michelsen, A., Houben, G. F., & Baumert, J. L. (2014).  
588 Frequency, severity and causes of unexpected allergic reactions to food: a systematic literature  
589 review. *Clinical & Experimental Allergy*, 45(2), 347-367.  
590

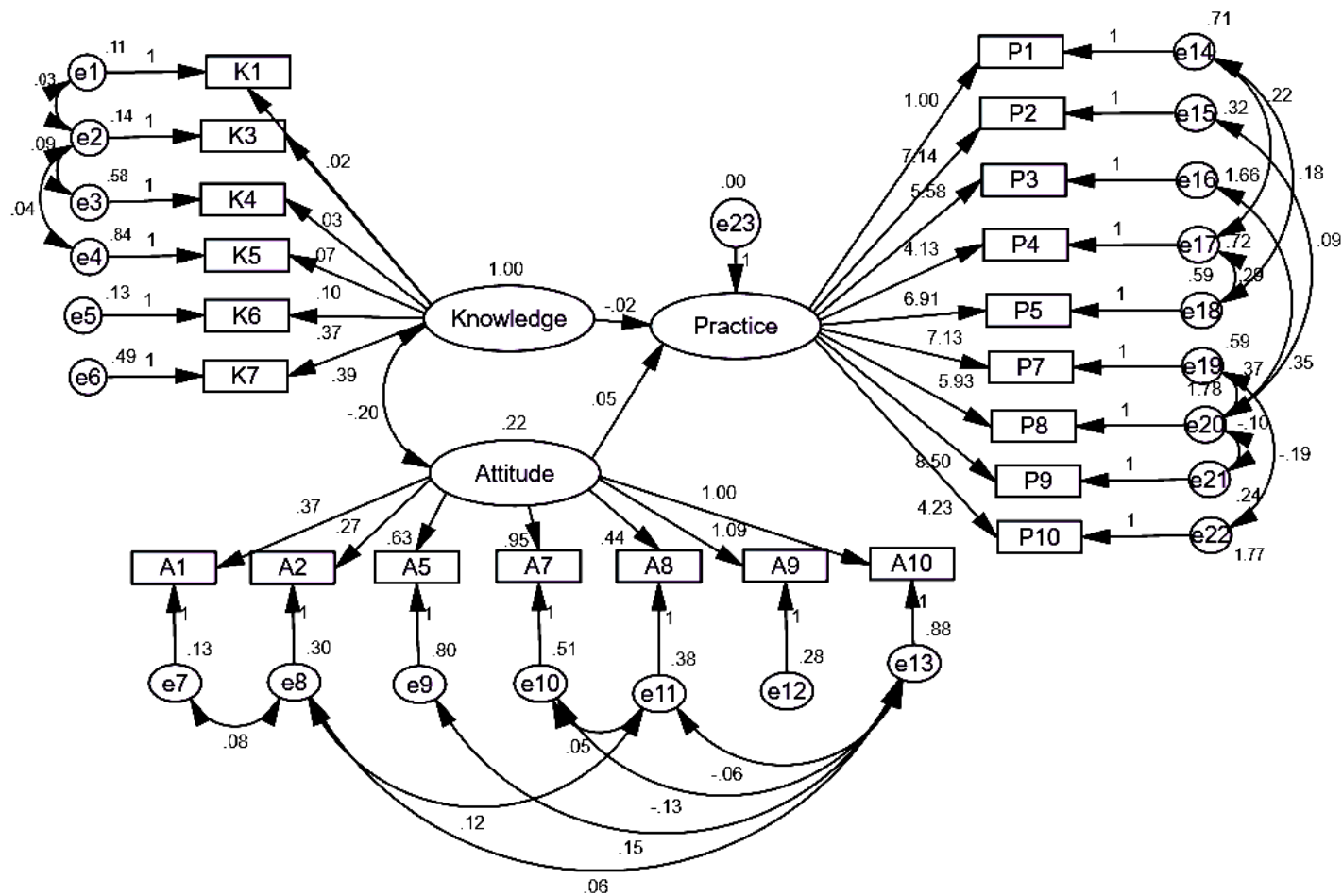
591 Walker, M. J., Gowland, M. H. & Points, J. (2018). Managing food allergens in the U.K. Retail Supply  
592 Chain. *Journal of AOAC International*, 101(1), 45-55.  
593

594 Wang, J., Tao, J., Yang, C., Chu, M., & Lam, H. (2017). A general framework incorporating  
595 knowledge, risk perception and practices to eliminate pesticide residues in food: A structural equation  
596 modelling analysis based on survey data of 986 Chinese farmers. *Food Control*, 80, 143-150.  
597

598 Wasserman, R. L., Hague, A. R., Pence, D. M., Sugerman, R. W., Silvers, S. K., Rolen, J. G., &  
599 Herbert, M. (2018). Real-world experience with peanut oral immunotherapy: Lessons learned from  
600 270 patients. *Journal of Allergy and Clinical Immunology: In practice*, doi: 10.1016/j.jaip.2018.05.023  
601

602 West, J., Fleming, K. M., Tatam L. J., Card, T. R., & Crooks, C. J. (2014). Incidence and prevalence of  
603 celiac disease and dermatitis herpetiformis in the UK over two decades: Population-based study.  
604 *American Journal of Gastroenterology*, 109, 757-768.  
605

606 Wham, C. A. and Sharma, K. M. (2014). Knowledge of café and restaurant managers to provide a  
607 safe meal to food allergic consumers. *Nutrition & Dietetics*, 71(4), 265-269.  
608  
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**Figure 1** Structural Equation Modelling of food allergen knowledge, attitude and practices among UK consumers



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613 **Table 1** Demographic characteristics of participants (n=252)

Variable	Items	Frequency (%)
Gender	Male	57 (23.0)
	Female	195 (77.0)
Age	18-24	22 (8.7)
	25-34	36 (14.3)
	35-44	44 (17.5)
	45-54	55 (21.8)
	55-64	50 (19.8)
	65 years and above	36 (14.3)
	Prefer not to say	12 (4.8)
Education	Primary education	2 (0.8)
	Secondary education	89 (35.3)
	HNC or Foundation degree	37 (14.7)
	Degree	99 (39.3)
	Masters	22 (8.7)
	Doctorate	3 (1.2)
Have you experienced food allergic reactions before (such as tingling or itching in mouth, swelling of lips, tongue, face or throat, dizziness, difficulty in breathing or fainting)?	Yes	108 (42.9)
	No	117 (46.4)
	Uncertain	27 (10.7)
Have your family member(s) experienced food allergic reactions before?	Yes	136 (54.0)
	No	92 (36.5)
	Uncertain	24 (9.5)
The food allergies and/or intolerance experienced by you or your family were diagnosed by:	Allergist	62 (24.6)
	General practitioner	77 (31.0)
	Paediatrician	21 (8.3)
	Emergency physician	2 (0.8)
	Dermatologist	0
	Self-diagnosis	30 (11.9)
	Other	32 (11.9)
	Not applicable	28 (10.3)
Please select the foods you or your family member(s) are allergic to. Check all that apply*:	Milk	92
	Molluscs (e.g. mussels, oysters)	4
	Peanuts	33
	Tree nuts (e.g. almonds, cashews, hazelnuts)	29
	Soybeans	22
	Eggs	36
	Fish	12
	Cereal containing gluten (wheat, rye, barley, oats)	181
	Lupin (a common garden plant and seeds from some varieties are used to make flour)	6
	Sulphites	20
	Celery	0
	Crustaceans (prawns, crabs, lobsters)	9

Mustard	9
Sesame seed	8
Others (e.g. anything high in histamine, chocolate, fermentable oligo-, di-, monosaccharides and polyols (FODMAP), fruits such as apples, cherries, garlic, maize, onions, red meat, spices, white meat)	32
Not applicable	25

614 Note: \*Participants can select more than one food allergens

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616 **Table 2** Food allergen knowledge (n=252)

No.	Questions	Correct answers Frequency (%)	Standard loadings
K1	Allergen can be serious and in severe cases result in death	True 240 (95.2)	0.80
K2	Ingesting a small amount of food allergen will cause an allergic reaction	True 225 (89.3)	<0.40
K3	The best way to prevent food allergic reaction is to avoid the allergen	True 238 (94.4)	0.71
K4	Allergens can be transferred by hands	True 170 (67.5)	0.89
K5	Tree nuts (e.g. almonds, cashew nuts, Brazil nuts) are similar to peanuts	False 35 (13.9)	<0.40
K6	High temperature cooking such as roasting, baking and deep frying can destroy food allergen	False 191 (75.8)	0.82
K7	Allergen cross contamination of cooking utensils can be prevented by rinsing with tap water	False 135 (53.6)	0.81
K8	Which of the following causes food allergic reaction? <b>Protein*</b>	<b>103 (40.9%)</b>	<0.40
	Salt	0	
	Sugar	9	
	Lipid	7	
	Unknown substance	16	
	Uncertain	117	
K9	Which of the following is not categorised as food allergen in UK/EU? <b>Buckwheat</b>	<b>128 (50.8%)</b>	<0.40
	Almonds	7	
	Fish	20	
	Milk	5	
	Mustard	23	
	Uncertain	69	
K10	If an individual is allergic to eggs, which of the following food should be avoided?		<0.40
	Mayonnaise	21	
	Pancakes	0	
	Meringues	0	
	Quiches	0	
	<b>All of the above</b>	<b>224 (88.9)</b>	
	Uncertain	7	

617 \*Bold letters indicate correct answers in K8 – K10

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**Table 3** Mean scores of items in attitude towards food allergens (1: Strongly disagree to 5: Strongly agree) (n=252)

Items	Description	Mean	Standard deviation	Standard loadings
A1	When purchasing food, labels should be checked if it contains any ingredients that can cause food allergic reaction	4.82	0.41	0.67
A2	There should be more free from choices to choose from	4.64	0.57	0.87
A3	I will not purchase food containing the food allergen (where I or a family member is allergic to) even though other household members are not allergic to it	3.25	1.32	<0.40
A4	Kitchen surfaces and cooking equipment are washed with hot soapy water and rinse to remove allergens	4.33	0.71	<0.40
A5	It is easy to prepare allergen-free meals by substituting with other types of ingredients (e.g. wheat can be substituted with quinoa)	4.06	0.95	0.71
A6	Hands should be washed thoroughly after coming into contact with allergenic products to avoid cross contact	4.64	0.49	<0.40
A7	It is my responsibility to inform food services if I have any food allergies	4.46	0.84	0.61
A8	When ordering food online, there should be more information provided about allergen free food	4.48	0.65	0.67
A9	When ordering food via telephone, it is my responsibility to ask for allergen free food	4.49	0.74	0.66
A10	I believe I can handle a food allergy emergency situation at home or when eating out	3.62	1.05	0.61

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**Table 4** Mean scores of items food allergen management practices (1: Never to 5: Always) (n=252)

Items	Description	Mean	Standard deviation	Standard loadings
P1	I purchase whole, unprocessed foods	3.67	0.85	0.65
P2	During shopping, I read the food labelling to check for allergenic ingredients	4.59	0.77	0.69
P3	I use apps or scan the QR code to find out if the ingredients contain any allergens	2.29	1.35	0.46
P4	I prepare my meals from scratch	3.93	0.90	0.59
P5	I look for alternative ingredients to use in my meal preparation or as food substitutes	3.90	0.92	0.74
P6	I wash my hands before preparing allergen-free meal	4.60	0.75	<0.40
P7	When eating out, I frequent restaurants that cater allergen-free meals	4.10	0.93	0.68
P8	I check social media to identify suitable restaurants	3.22	1.41	0.49
P9	I would inform the staff of my food allergies and seek confirmation that my meal is allergen-free when served	4.56	0.79	0.71
P10	I find the precautionary allergen labelling 'May contain' helpful	3.63	1.37	0.85

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**Table 5** Goodness of fit indices

<b>Fit indices</b>	<b>Model value</b>	<b>Accepted value</b>
$\chi^2/df$	1.98	< 3 <sup>1</sup>
Comparative Fit Index (CFI)	0.90	> 0.90 <sup>2</sup>
Goodness of Fit Index (GFI)	0.82	>0.90 <sup>3</sup>
Root Mean Square Error of Approximation (RMSEA)	0.06	<0.08 <sup>4</sup>
Normed Fit Index (NFI)	0.70	> 0.90 <sup>5</sup>
Root Mean Square Residual (RMR)	0.05	< 0.08 <sup>2</sup>

630 <sup>1</sup>Kline (1998)  
631 <sup>2</sup>Hu and Bentler (1999)  
632 <sup>3</sup>Hooper, Coughlan and Mullen (2008)  
633 <sup>4</sup>MacCallum et al. (1996)  
634 <sup>5</sup>Bentler and Bonnet (1980)  
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636 **Table 6** Estimates of hypothesis paths for food allergen knowledge, attitude and practice

<b>Hypothesis</b>	<b>Paths</b>	<b>Estimate</b>	<b>C.R.</b>	<b>P value</b>
H1	Knowledge → Practice	-0.02	-1.09	0.28
H2	Attitude → Practice	0.05	1.11	0.27
H3	Knowledge <--> Attitude	-0.20	-3.40	< 0.05

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