

39 were the leading cause of food allergic reactions among Korean infants (Kim, Chang, Han, Ahn, &
40 Lee, 2011). Wu *et al.* (2012) reported seafood (i.e. shrimp, crab, mollusc and fish) as the most
41 common food allergen in Taiwan.

42
43 In Malaysia, food and food ingredients such as cereal containing gluten (including wheat, rye, barley
44 and oat), nut and nut products including peanut, soybean, fish and fish products, milk and milk
45 products (including lactose) and egg and egg products are known to cause hypersensitivity and must
46 be declared on labels (MOH, n.d.). Yadav and Naidu (2015) reported a higher sensitisation towards
47 egg white and cow's milk in children less than 2 years in Malaysia. Prawn was the most common food
48 allergen in children up to 12 years (Gendeh, Mujahid, Murad, & Rizal, 2004) and in adults with allergic
49 rhinitis in Malaysia (Wan Majdiah, Nurul Khaiza, Suzina, Che Maraina, & Norr Suryani, 2016). Other
50 studies related to food allergens involved the survey of knowledge and practices of food allergen
51 management. For example, Ajala *et al.* (2010) evaluated food handlers' knowledge on food allergy
52 management while Ahuja and Sicherer (2007) investigated the factors that affect the provision of
53 allergen-safe meals. Similarly, Dupuis *et al.* (2017) and Lee and Sozen (2016) assessed restaurant
54 workers' and food handlers' knowledge, attitude, and training in food allergy management.
55 Awareness and understanding of food allergen management in Thai food companies were conducted
56 by Waisarayutt *et al.* (2014) whilst Dzwolak (2017) evaluated compliance of food allergen
57 management in small food facilities in Poland. In Malaysia, similar studies among food handlers
58 (Shafie & Azman, 2015), hospitality students (Din, Rashid, & Ramli, 2015), medical science students
59 (Redhwan, Low, Mustafa, Robert, & Ali, 2011) had been carried out. A nationwide survey carried out
60 by the Malaysian Society of Allergy and Immunology (MSAI) and Universiti Putra Malaysia reported
61 that there is still a big gap between awareness of food allergies and its implications on health
62 (Murugappan, 2016).

63
64 A number of food safety knowledge, attitudes and practices (KAP) of food handlers' studies had been
65 carried out in developing countries (Zanin, da Cunha, de Rosso, Capriles, & Stedefeldt, 2017)
66 including Malaysia (Abdul Mutalib *et al.*, 2012; Abdullah Sani & Siow, 2014; Siow & Abdullah Sani,
67 2011; Tan, Bakar, Karim, Lee, & Mahyuddin, 2013). Structural equation modelling is used as a
68 confirmatory technique to determine model validity and had been used in a number of food safety
69 studies (Baser, Ture, Abubakirova, Sanlier, & Cil, 2017; Chen, 2017; Lagerkvist & Okello, 2016; Lim,
70 Chye, Sulaiman, Mohd Suki, & Lee, 2016), HACCP practices (Ko, 2013), eliminating pesticide residues
71 (Wang, Tao, Yang, Chu, & Lam, 2017) and checking expiry dates (Shah & Hall-Phillips, 2017). There
72 is currently lack of food allergen KAP studies among consumers that utilise the SEM technique. Based
73 on the literature and the limited study on consumers' knowledge, attitude and practices towards food
74 allergen it is crucial to explore the current understanding of food allergen handling among general
75 consumers. In this study, the author postulates Figure 1 based on the relationship as suggested by

76 Baser *et al.* (2017), Lim *et al.* (2016), Schwartz (1975) and Shafie and Azman (2015). Figure 1
77 represents the following hypotheses:

78

79 H1: Food allergen knowledge directly affects food allergen handling practices

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

81 H3: Food allergen knowledge and attitude are correlated.

82

83 Insert Figure 1 here

84

85 A number of studies on food allergen management among food handlers had been conducted.

86 Although it is crucial to understand the implementation of food allergen management among food

87 handlers, consumers too have the responsibility to ensure food safety and safe food allergen

88 management. Hence, this study utilises structural equation modelling (SEM) to examine the

89 relationship between knowledge, attitude and the self-reported practices of food allergen handling

90 among consumers in a developing country.

91

92 **Materials and Methods**

93 Questionnaire development

94 The questionnaire was constructed and divided into 5 sections: (i) demographics (6 questions); (ii)

95 purchasing habits (4 questions); (iii) knowledge (10 questions); (iv) attitudes (10 questions); and (v)

96 practices (10 questions). The questions were developed based on Choi and Choi (2016), Marchisotto

97 *et al.* (2016) and Shafie and Azman (2015). In the food allergen knowledge section, participants were

98 provided with optional answers of "yes", "no" or "uncertain" to prevent participants from selecting the

99 correct answer by chance. Each correct answer received 1 point, while incorrect or uncertain answers

100 were not allocated any points. The attitude and practices sections allow participants to rate on a 5-

101 point Likert scale of strongly disagree/never to strongly agree/always. Participants were invited to

102 complete all sections. The questionnaire was provided in both English and Malay languages. A pilot

103 study was conducted among 20 participants who were not included in the actual study to evaluate

104 the language, clarity and suitability of wording.

105

106 Data collection

107 The questionnaire was uploaded onto an online survey system (Survey Monkey) and sent to 560

108 consumers (adults) all around Malaysia between June – August 2017. The subjects were targeted

109 based on the author's personal contacts where they were invited through email and social media that

110 contain the link to direct the consumers to the survey. Participants experiencing food allergies or are

111 caring for family members with food allergies were encouraged to post the link in their own social

112 media page to generate more responses via the snowballing technique. Snowball sampling is

113 particularly useful in identifying potential hidden subjects (e.g. food allergic subjects) where subjects

114 are hard to locate (Ali, Guo, Sherwani, & Ali, 2017). Although food allergic subjects can be invited to
115 participate from support groups, currently, there is no allergy support group in Malaysia. The
116 Malaysian Society of Allergy and Immunology is hoping to initiate such groups (Lim, 2012). Survey is
117 a useful tool to obtain a high volume of information from a large number of people in a short period
118 of time (MacLeod 2014). A total of 325 questionnaires were returned. Of this, 285 surveys were valid
119 resulting in a successful response rate of 50.89%. This is similar to other studies carried out by New
120 *et al.* (2017) and Lee and Lee (2005), but lower than the food safety survey in Saudi Arabia (66.08%)
121 (Al-Shabib, Husain, & Khan 2017) and Republic of Ireland (76.8%) (Moreb, Priyardashini, & Jaiswal,
122 2017).

123

124 Statistical analysis

125 Descriptive and Exploratory Factor Analysis (EFA) was conducted using Statistical Package for Social
126 Science (SPSS) 22.0 software. EFA was performed to extract valid items for knowledge, attitude and
127 practices. This is based on factor loadings of the scale items greater than 0.40 (Baser *et al.*, 2017).
128 Confirmatory Factor Analysis (CFA) was performed using Analysis of Moment Structures (AMOS) and
129 confidence level was set at 95%.

130

131 **Results and Discussion**

132 Female makes up three quarter of the respondents. Almost 90% of the respondents are within the 18
133 – 25 and 26 -35 years group and exposed to higher education. This is similar to other research that
134 found a larger proportion of respondents were female (Achon, Serrano, Garcia-Gonzalez, Alonso-
135 Aperte, & Varela-Moreiras, 2017; Lake *et al.*, 2006) and more educated people are more likely to
136 participate in surveys (Curtin, Presser, & Singer, 2000). This is largely attributable to the survey
137 subject matter. It is highly likely that females dominate the food purchasing and preparation role
138 (Lake et al., 2006). Although more than half of the respondents had not experienced food allergic
139 reactions before, a large proportion of them (60%) reported that their family members have had
140 experienced the symptoms of food allergies or potentially intolerances. Crustaceans (n=150) were
141 reported as the most common causative agent of food allergies, followed by peanuts (n=38) and tree
142 nuts (n=30) (Table 1).

143

144 Insert Table 1 here

145

146 This coincides with other studies that shellfish is a major sensitising food source in Asian children
147 (Chiang *et al.*, 2007; Shek *et al.*, 2010; Wu *et al.*, 2012). The abundance of seafood in this region
148 (Boye, 2012; Lee, Thalayasningam, & Lee, 2013) and exposure to insects (e.g. cockroaches, dust
149 mite) also increases the likelihood of shellfish sensitisation (Chiang *et al.*, 2007). Respondents also
150 reported reactions to other type of food products such as alcohol, bird's nest, pineapple, turmeric,
151 monosodium glutamate, mango, chicken, *rambutan* (tropical, hairy fruit native to Southeast Asia),

152 coconut, coconut milk and kiwifruit. Anaphylactic reactions to exotic food such as sago worms (Yew &
153 Kok (2012) and bird's nest from swiftlets (de Bruyne & Lee, 2004) had been reported. Participants
154 who had experienced food allergic reactions (including those with family members who experienced
155 food allergies) were more likely to look for food allergen information on the labelling ($t[282] = 2.14, p$
156 < 0.05). Both groups rated that they seldom purchase food products that are labelled in a language
157 they are not familiar with and even less so if the label contains precautionary statements (Table 2).
158 This is in contrast with Hefle *et al.* (2007), Marchisotto *et al.* (2017) and Mills, Wang and Kattan
159 (2016) who reported that consumers choose to ignore precautionary statements and purchased food
160 products bearing advisory statements.

161

162 Insert Table 2

163

164 More than 90% of the respondents were aware that food allergies are not common but can be
165 serious and the only way to prevent food allergic reactions is to avoid the food allergen (Table 3).
166 More than half did not know that food allergens are protein-based and hands that had been in
167 contact with food allergens can cross contaminate other surfaces. When it comes to cleaning
168 effectively before meal preparation, more than 80% consumers were aware that effective cleaning
169 could help to prevent cross contamination. However, when probed further, there is a possibility that
170 consumers were not aware of the correct procedures in cleaning as only 30% disagreed that rinsing
171 utensils with water alone are sufficient to remove food allergens. However, consumers scored highly
172 on the question about using separate cooking oil for allergen-free meals to prevent cross
173 contamination. According to MOH (n.d.), monosodium glutamate (MSG) is not considered as food
174 causing hypersensitivity of which slightly more than 60% of the respondents were correct. However,
175 in some populations particularly among those with asthma or atopy, MSG can cause 'Chinese
176 Restaurant Syndrome' characterised by palpitations, general weakness and numbness (Geha *et al.*,
177 2000; Rangan & Barcelouz, 2009). According to Murugappan (2016) Malaysians were aware of
178 common food allergens such as seafood (89.9%), tree nuts (47%) and soy (44.3%). There was also
179 lower awareness among Malaysians about cow's milk as a food allergen (8.3%). No comparison was
180 made between different age groups due to the high number of participants categorised as millennials
181 (i.e. born in 1996 and onwards). According to Leal, Ruth, Rumble, and Simonne (2017), the
182 millennials or younger generation were identified as having the least amount of food safety
183 knowledge and mostly learned about food safety from their parents.

184

185 Insert Table 3 here

186

187 Respondents mostly agreed with the statements in Table 4. With the exception of A9, the mean
188 scores ranged positively from 4.00 – 4.56. A9 scored lowest among the statements and represented a
189 general disagreement among the respondents in diluting the food allergen with water. Table 5

190 suggested a good level of self-reported food allergen handling practices. This is evident in P4 where
191 the consumers seldom use the same dish cloth for all purposes. Having separate dish cloth for
192 different activities (e.g. cleaning, drying) and for different meals (e.g. conventional and allergen
193 meals) can help to prevent cross contamination. This is similar to the principle of utilising different
194 utensils for raw or cooked meat and fresh produce. Similarly, in P9, consumers often wash their
195 hands prior to preparing allergen free meals. Although consumers strongly agreed that if a person is
196 suffering from food allergic reactions, he or she should get immediate treatments, however, a
197 majority of the respondents were not confident when it comes to handling an emergency situation
198 (due to food allergic reactions) at home or when eating out.

199

200 Insert Tables 4 and 5 here

201

202 EFA was applied in factor analysis to extract the items for knowledge, attitude and practices. The
203 score of > 0.40 is used to select items (Baser *et al.* 2017). A total of one item each from attitude and
204 practices were removed. The Kaiser-Meyer-Olkin (KMO) measure of sampling value for food allergen
205 knowledge, attitude and practices were 0.647, 0.886 and 0.874 respectively. These values fulfil Hair,
206 Black, Babin, Anderson, and Tatham (2010) who stated that the criterion of validity should be > 0.60.

207

208 Insert Figure 2 here

209

210 Insert Table 6 here

211

212 The relationship between food allergen knowledge, attitude towards food allergens and food allergen
213 handling practices is shown in Figure 2. In order to evaluate the model fit, Hair, Anderson, Tatham
214 and Black (1998) recommended observing more than one indicator. The indices such as Comparative
215 Fit Index (CFI) was estimated at 0.905 and indicates a good fit (Table 6). CFI is commonly used as a
216 fit index as it is least affected by sample size (Fan, Thompson, & Wang, 1999). Both the Goodness of
217 Fit (GFI) and Normed Fit Index (NFI) measured slightly below the accepted values but were
218 comparable to Baser *et al.* (2017) and Wang *et al.* (2017). The Root Mean Square Error of
219 Approximation (RMSEA) was measured below 0.10 (MacCallum, Browne, & Sugawara, 1996) and is
220 considered a good fit if below 0.06 (Hu & Bentler, 1999). Based on the indices and comparison with
221 other studies, the hypothesised model had an acceptable fit.

222

223 Insert Table 7 here

224

225 Figure 2 and Table 7 demonstrate the magnitude and direction of relationship of the model. Food
226 allergen knowledge has a negative relationship ($\beta_1 = -0.271$, $p < 0.05$) with food allergen handling
227 practices hence supporting H1. One could draw the theoretical interpretation from Figure 2 that food

228 allergen handling practices will decrease 0.27 unit with each incremental unit in knowledge. This does
229 not indicate a direct linear relationship between knowledge and practices but the possibility that
230 having good food allergen knowledge does not translate into good practices. Previous studies
231 indicated similar results where Baser *et al.* (2017) and Ko (2013) revealed that food safety knowledge
232 has a negative relationship with food safety behaviour. Vo, Le, Le, Minh and Nuorti (2015) reported
233 that although there were positive effects of training on knowledge, however, knowledge alone was
234 insufficient to change food safety practices. Studies of trained food handlers (Rahman, Arif, Bakar, &
235 Tambi, 2012) and insufficiently trained food handlers (Garayoa, Vitas, Diez-Leturia, & Garcia-Jalon,
236 2011) found that knowledge was not translated into good practices. There is a possibility that
237 increasing knowledge can increase optimistic bias (OB) (Miles, Braxton, & Frewer, 1999). OB occurs
238 when individuals felt shielded against risks or negative effects or 'why it won't happen to me'
239 perception (Weinstein, 1984). Training or education based only on scientific communication may not
240 encourage changes in behaviour or practices (Green *et al.*, 2005; Park, Kwak, & Chang, 2012).
241 According to Bandura (2001), people are able to learn new knowledge, skills, rules, beliefs and
242 attitudes in social systems. Although food safety education on allergens can be provided – this does
243 not necessarily translate into practices. Hence, one way to approach food allergen education is
244 through the social cognitive theory which emphasises enactive or vicarious learning from the social
245 environment (Schunk, 2012a; Schunk and Usher, 2012). Enactive learning occurs through the
246 consequences of performing actions e.g. accidental cross contamination of utensils with food allergen
247 may result in allergic reactions hence leading to increased awareness in future food preparation.
248 Enactive learning is useful as an informative indicator to repeat or not repeat a behaviour (Schunk,
249 2012a). Meanwhile, vicarious learning occurs by observing other people, non-human characters,
250 electronic or print (Schunk 2012b).

251

252 The second hypothesis postulates that attitude affects practices and H2 is sustained based on Table
253 7. Attitude has a positive and significant relationship with food allergen practices ($\beta_1 = 0.43$,
254 $p < 0.05$). Figure 2 indicates that good practice increases by 0.43 unit with each unit increase in
255 attitude. A positive attitude reflects the level of motivation and care required to manage food
256 allergens effectively. Lim *et al.* (2016) also found food safety attitude as the most important factor in
257 influencing consumers' food safety behaviour. Attitude represents beliefs and can serve as a mediator
258 between knowledge and practices. Dudeja, Singh, Sahni, Kaur and Goel (2017) found that food
259 handlers in hospital settings with positive attitude helped to improve food safety practices whilst
260 Abdul-Mutalib *et al.* (2012) reported that positive attitude among food handlers resulted in safe food
261 storage practices. In addition to knowledge and attitudes, other factors such as experience, values
262 and emotions can influence individuals' thinking and judgement about the severity and acceptability
263 of risks. Risk perceptions can motivate consumers to take action to avoid, prevent, adapt to or even
264 ignore the risks (Wachinger, Renn, Begg, & Kuhlicke, 2013). Studies of risk perceptions towards food
265 safety had been conducted. Parra, Kim, Shapiro, Gravani, & Bradley (2014) found that home food

266 safety practices among Mexican-Americans were associated with perceptions and awareness of risks
267 whilst Tiozzo, Mari, Ruzza, Crovato and Ravarotto (2017) reported that there was a sense of
268 incomplete control due to lack of information on recognising and preventing food risks among
269 consumers in northeast Italy. This highlights the paradox of risk perceptions as different personal
270 (e.g. age, gender, education level, profession, personal experience) and contextual factors (e.g. area
271 of living, economy, country) can be important determinants of risk perceptions.

272

273 There is an insignificant relationship between food allergen knowledge and attitude in this study. In
274 other words, knowledge and attitude independently influenced practices. Zanin and Stedefeldt (2017)
275 provided an excellent review of past KAP studies and how knowledge and attitude influenced food
276 safety practices. However, most studies were focused on food handlers. As food handlers, they are
277 likely to be in contact with food or food contact surfaces and may be involved in preparation of raw
278 materials, cooking, serving and cleaning (Dudeja & Singh, 2017), hence it is crucial to understand
279 how training, education and personal beliefs affect food handlers' practices. Other studies involving
280 food safety KAP among consumers were also conducted. For example, Samapundo, Cam Thanh,
281 Xhaferi and Devlieghere (2017) conducted a study among consumers in Vietnam and found adequate
282 attitude levels whilst consumers of street food in Haiti exhibited average attitude levels towards food
283 safety (Samapundo, Climat, Xhaferi, & Devlieghere, 2017). Tan *et al.* (2013) found weak correlations
284 between knowledge and hand hygiene attitudes among food handlers in Malaysia including practices.
285 KAP of food allergens among consumers are scarce in comparison. KAP can be combined with the
286 Theory of Planned Behaviour to further understand how attitude, perceived behavioural control and
287 social norms affect food allergen management practices. The current food allergen knowledge –
288 attitudes – practices model can be expanded to include trust particularly if one is studying consumers'
289 behaviour while eating out (Begen *et al.*, 2016; Begen *et al.*, 2018). Furthermore, it is worth
290 categorising and studying the specific measured variable in detail i.e. purchasing and understanding
291 food labels, meal preparation and prevention of cross contamination and whilst eating out.

292

293 The only current method to prevent food allergy is complete avoidance of the trigger food. This
294 requires vigilance from both consumers and food business operations. Food businesses are
295 encouraged to provide clear written or verbal allergen information to consumers. In the UK,
296 signposting of allergen information helps to ensure customers know where to find the information
297 (FSA, 2015). Begen *et al.* (2017) also recommended that food allergic individuals should make
298 allergen enquiries when eating out. This is particularly important in Malaysia as the provision of food
299 allergen information is currently not a legal requirement. Food handlers in Malaysia are required to
300 attend the Food Handlers Training programme as specified in Food Hygiene Regulations (2009). The
301 topics focused on food safety topics such as personal hygiene, good hygiene/manufacturing practices,
302 risk of food poisoning and food laws and regulations. Although some food safety training providers
303 voluntarily incorporate food allergen management in the module, it is strongly recommended that all

304 food handlers should be made aware of the importance of food allergen management and the risk of
305 food allergic reactions.

306

307 **Conclusion**

308 In general, the consumers in this study demonstrates moderate knowledge of food allergen and
309 highly positive attitudes and self-reported practices. Within SEM, it is found that although the
310 consumers are moderately knowledgeable, this does not translate into practices. However, an
311 increase in personal beliefs can help to boost good practices. Understanding consumers' risk
312 perceptions towards food allergen – particularly among consumers with food allergic reactions or
313 those caring for individuals with food allergic reactions can narrow the attitudinal – good food
314 allergen practices (GAP). A number of food safety research had been conducted but food allergen
315 studies remain sparse in Malaysia. The main limitations of this study were the small sample size and
316 the findings cannot be generalised outside the study sample. Although the present study was
317 conducted with a small sample size, this can be considered a pilot study to understand consumers'
318 knowledge, attitude and practices in managing food allergens. Understanding how consumers think
319 about and respond to risks (i.e. respond to food allergens and impact of cross contamination) will aid
320 risk mitigation strategies. Food allergy creates a significant health burden and can further impact
321 upon consumer's social and quality of life. National and international efforts should focus on food
322 safety and appropriate food allergen management practices. More importantly, correct food allergen
323 labelling is crucial to inform consumers of the presence of allergens.

324

325

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