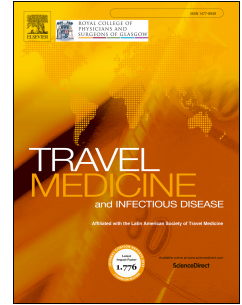


Journal Pre-proof

Assessing the knowledge of, attitudes towards, and practices in, food safety among migrant workers in Klang Valley, Malaysia

Maryam Nazir Chaudhary, Voon-Ching Lim, Norhidayu Sahimin, Erwin Martinez Faller, Pramod Regmi, Nirmal Aryal, Adzzie Shazleen Azman



PII: S1477-8939(23)00080-7

DOI: <https://doi.org/10.1016/j.tmaid.2023.102620>

Reference: TMAID 102620

To appear in: *Travel Medicine and Infectious Disease*

Received Date: 1 December 2022

Revised Date: 7 June 2023

Accepted Date: 13 July 2023

Please cite this article as: Chaudhary MN, Lim V-C, Sahimin N, Faller EM, Regmi P, Aryal N, Azman AS, Assessing the knowledge of, attitudes towards, and practices in, food safety among migrant workers in Klang Valley, Malaysia, *Travel Medicine and Infectious Disease* (2023), doi: <https://doi.org/10.1016/j.tmaid.2023.102620>.

This is a PDF file of an article that has undergone enhancements after acceptance, such as the addition of a cover page and metadata, and formatting for readability, but it is not yet the definitive version of record. This version will undergo additional copyediting, typesetting and review before it is published in its final form, but we are providing this version to give early visibility of the article. Please note that, during the production process, errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

© 2023 Published by Elsevier Ltd.

CRedit authorship contribution statement

Maryam Nazir Chaudhary: Formal analysis, methodology, data curation, validation, visualization, writing - Original Draft. **Voon-Ching Lim:** Supervision, formal analysis, methodology, validation, writing - original draft. **Norhidayu Sahimin:** Conceptualization, project administration, methodology, investigation, resources, validation, writing - review & editing, funding acquisition. **Erwin Martinez Fallerd:** validation, writing - review & editing. **Pramod Regmie:** validation, writing - review & editing. **Nirmal Aryal:** validation, writing - review & editing. **Adzzie Shazleen Azman:** Conceptualization, supervision, methodology, investigation, resources, validation, writing - original draft, funding acquisition.

1 **Assessing the knowledge of, attitudes towards, and practices in, food safety among**
2 **migrant workers in Klang Valley, Malaysia¹**

3

4 Maryam Nazir Chaudhary^a, Voon-Ching Lim^{a,b,c}, Norhidayu Sahimin^d, Erwin Martinez Faller^e,
5 Pramod Regmi^f, Nirmal Aryal^f, Adzzie Shazleen Azman^{a*}

6

7 ^a School of Science, Monash University Malaysia, Jalan Lagoon Selatan, Bandar Sunway,
8 Subang Jaya, 47500 Selangor, Malaysia

9 ^b Department of Biology, Faculty of Science, Chulalongkorn University, 10330 Bangkok,
10 Thailand

11 ^c National Primate Research Center of Thailand, Chulalongkorn University, 18110, Saraburi,
12 Thailand

13 ^d Tropical Infectious Diseases Research and Education Centre (TIDREC), Universiti Malaya,
14 Jln Profesor Diraja Ungku Aziz, 50603 Kuala Lumpur, Malaysia

15 ^e Pharmacy Department, School of Allied Health, San Pedro College, 12, Guzman St, Davao
16 City, Davao del Sur, Philippines.

17 ^f Faculty of Health and Social Sciences, Bournemouth University, Bournemouth, BH8 8GP,
18 United Kingdom.

19

20 ***Corresponding Author:** adzzieshazleen.azman@monash.edu

21

22 **Keywords:** food-borne diseases, food safety awareness, hygienic food handling, social media,
23 public health

24

¹Food-Borne Diseases (FBD); Knowledge, Attitudes and Practices (KAP); Low- and Middle-Income Countries (LMIC); Movement Control Order (MCO); Ministry of Health (MoH); Piecewise Structural Equation Modelling (PSEM).

25 **ABSTRACT**

26 **Background:** Annually, 600 million individuals are affected by food-borne diseases (FBD),
27 alongside 425,000 fatalities. Improving the general public knowledge of, attitudes towards, and
28 practices in, (KAP) food safety is necessary for minimizing FBD transmission. In Malaysia,
29 migrant workers account for 11.1% of the workforce, with a high proportion involved in food
30 and beverage services. Therefore, this study aimed (i) to evaluate the current food safety KAP,
31 and (ii) to identify the strategies to promote food safety awareness, among migrant workers
32 across occupational sectors in Klang Valley.

33 **Method:** A survey was conducted with 403 migrant workers through phone interviews and
34 online self-administered questionnaires. Piecewise structural equation modelling and
35 multinomial regression were applied to identify predictor variables for food safety KAP and to
36 explore differences across nationalities.

37 **Results:** The respondents were Nepalese, Filipino and Indonesian. The majority were male,
38 working in the services industry, had completed high school, aged between 30-39 years and
39 had worked in Malaysia for less than ten years. Knowledge was significantly correlated with
40 attitudes and practices. Female respondents had lower knowledge and attitude scores while
41 younger respondents had lower knowledge scores. Indonesian and Filipino respondents had
42 lower knowledge and attitudes scores than Nepalese respondents. Understanding food safety
43 information from social media was positively correlated with the respondents' food safety
44 knowledge and practices.

45 **Conclusion:** These findings highlighted: (i) the need to target female, younger, Indonesian and
46 Filipino migrant workers, and (ii) the potential of social media to improve public awareness of
47 food safety and hygienic practices.

48

49 1. Introduction

50 Approximately 600 million individuals are affected annually by food-borne diseases (FBD)
51 [1]. Around 425,000 lives are lost yearly, of which 125,000 are children aged below five [1].
52 In low- and middle-income countries (LMICs) within Southeast Asia, Sub-Saharan Africa and
53 South Asia, 75% of FBD resulted in fatalities [2]. FBD occurs through the ingestion of
54 pathogens or non-infectious agents (e.g., toxins), such as the hepatitis A virus which spreads
55 through the fecal-oral route, causing liver damage, jaundice and extreme fatigue [3].
56 *Salmonella enterica serovar* Typhi, through sewage contamination of food, causes typhoid
57 fever, headache, and appetite loss [3]. Dysentery, resulting from consumption of drinking water
58 contaminated with either parasitic *Entamoeba histolytica* or bacterial *Shigella dysenteriae*,
59 causes severe diarrhoea, vomiting, blood in faeces/vomit [3]. In Malaysia, food safety is a
60 health concern with the incidence rate per 100,000 population of 0.14 for hepatitis A, 0.20 for
61 typhoid and paratyphi, 0.48 for dysentery, and 28.93 for food poisoning; while all have a
62 mortality rate of 0.00, food poisoning has a mortality rate of 0.02 [4]. However, the official
63 FBD incidence figures are likely to be underestimated. Incidents may go unreported as
64 individuals may not consult medical professionals, considering their symptoms as a common
65 occurrence and transient inconvenience rather than signs of a potentially life-threatening
66 disease [3,5].

67 Globally, approximately 70% of all FBD are linked to catering and food service establishments
68 [6]. In Malaysia, the percentage of food premises shut down due to unsanitary practices rose
69 from 1.80% in 2018 to 2.58% in 2020 [7, 8], and more than 50% of the food poisoning incidents
70 were due to unhygienic food handling procedures [3,5]. This association between FBD and
71 restaurants is worrying as 67% of Malaysians dine out at least once a week [9]. Furthermore,
72 the Malaysian food services industry is highly reliant on migrant workers [10]. In Malaysia,

73 migrant workers are non-citizens or permanent residents who have been granted a Visit Pass
74 (Temporary Employment) [10,11]. They account for 11.1% of the Malaysian workforce, with
75 the majority being Indonesian (34%), Bangladeshi (28.3%) and Nepalese (15.3%) [12], and are
76 mostly employed in the manufacturing (36%), construction (19%), plantation (15%) and
77 services (14%) sectors [13]. In the past, studies have detected FBD-causing pathogens in
78 migrant workers involved in food handling in Malaysia, highlighting the increased risk of
79 transmission to the general public [14-16]. Although the detection rate of FBD pathogens
80 varied between the studies [14-16], the reported figures are nevertheless higher than similar
81 studies from Portugal [17], Qatar [18], South Africa [19], Iran [20] and Spain [21].

82 Oftentimes, migrant workers are unable to access health-related information, therefore
83 exhibiting poor health literacy, which results in their poor healthcare [22]. This may be
84 attributed to language barriers, cultural differences and limited knowledge of their rights, as
85 seen in Sweden [23], Thailand [24,25] and Italy [26]. In Malaysia, only 9.1% of 383 migrant
86 workers went for medical check-ups every six months, likely due to poor comprehension of
87 the local language [27]. Therefore, migrant workers are vulnerable to FBD, and those that are
88 involved in food handling may risk transmitting FBD to the public.

89 To determine strategies for curbing the spread of FBD, numerous studies have evaluated the
90 knowledge of, attitudes towards, and practices in, (KAP) food safety [28-34]. In Malaysia, the
91 food safety KAP among students, consumers and local food handlers have been investigated
92 [35-37], but understudied among migrant workers in the food service industry [27]. Therefore,
93 this study examined the food safety KAP among migrant workers across occupational sectors
94 in Klang Valley, Malaysia to (i) better understand how knowledge improves attitudes and
95 practices, with implications for public health, (ii) to identify specific cohorts to target for
96 awareness campaigns, and (iii) to examine the potential of social media as a platform for raising
97 food safety awareness.

98 **2. Methods**

99 **2.1. Ethical Consideration**

100 This study was approved by the Universiti Malaya Research Ethics Committee
101 (UM.TNC2/UMREC_1162). Informed consent was obtained from all participants prior to the
102 completion of the online questionnaire or phone interview.

103 **2.2. Questionnaire Development**

104 A preliminary questionnaire was first developed in English, following [27], and modified to
105 suit the current demographics of our respondents, who were employed in various sectors
106 including the food service industry. The final questionnaire consisted of six parts
107 (Supplementary File 1). Part A contained seven demographic questions about gender, age,
108 nationality, level of education, district of residence, current occupation sector and date of
109 commencing work in Malaysia. Part B contained five questions to elicit the illness history of
110 the respondents. Part C examined the respondents' knowledge of food safety and comprised
111 ten statements, each requiring respondents to choose 'True', 'False' or 'I am not sure' as their
112 response. Part D explored the attitudes towards food safety of respondents and contained five
113 statements, each requiring respondents to choose 'Strongly agreed', 'Agreed', 'Neutral',
114 'Disagreed', or 'Strongly disagreed' as their response. Part E evaluated the practices in food
115 safety of respondents and contained six statements, each requiring respondents to choose
116 'Usually', 'Sometimes' or 'Never' as their response. Part F assessed what sources respondents
117 used to obtain food safety information and their understanding of the information from these
118 sources; it contained eight questions, each requiring respondents to choose either 'Yes' or 'No'.

119 **2.3. Questionnaire Survey**

120 Data collection occurred in Klang Valley, between mid-2020 and 2021, during the government-
121 imposed Movement Control Order (MCO) in Malaysia as a response to the COVID-19
122 pandemic. The questionnaire was distributed using Google Form and was shared with the
123 coordinators to distribute to the respondents. Filipino and Nepalese respondents completed the
124 questionnaire in English. Due to limited English proficiency among Nepalese and Indonesian
125 respondents, Nepalese respondents underwent a phone interview conducted by their
126 coordinator, whereas Indonesian respondents completed the questionnaire in the Indonesian
127 language. A total of 455 individuals were approached for this study; 428 consented to complete
128 the survey, of which 403 responses were appropriately recorded without erroneous or
129 incomplete data, and used for data analyses.

130 **2.4. Data Analyses**

131 All data analyses [38] were conducted using R version 4.2.1 [39]. The internal consistency of
132 the responses was assessed using Cronbach's Alpha test, using 'alpha()' from the 'psych'
133 package [40]. As Cronbach's alpha value of ≥ 0.7 indicates acceptable internal consistency of
134 the responses to represent a single construct [9,34,36], while >0.8 indicates good internal
135 consistency [35], 0.75 was used as the cut-off point here. An initial Cronbach's alpha of 0.67
136 was obtained for Part C. Upon removal of two statements: '*Taking the vaccine can prevent*
137 *typhoid infections*' and '*Every individual needs to see, smell and taste a little of food before*
138 *starting to eat it*', the value improved to 0.75, and therefore, the remaining eight statements
139 were averaged to represent a construct C='Knowledge'. The Cronbach's alpha values
140 calculated for Parts D and E were 0.99 and 0.89, therefore, the scores for all statements were
141 averaged to represent the constructs, D='Attitude', and E='Practice'.

142 The normality of the data was assessed with Shapiro-Wilk tests using 'shapiro_test()' from the
143 'rstatix' package [41]; 'Knowledge' ($W(403)=0.77$, $p\text{-value}<0.001$), 'Attitude' ($W(403)=0.67$,

144 p-value<0.001) and 'Practice' ($W(403)=0.57$, p-value<0.001) were not normally distributed.
145 Linear regression analysis [6,9,33,34,39,42,43] was conducted using 'lm()' to identify
146 significant explanatory variables for response variables. The explanatory variables were
147 'Gender', 'Age', 'Years Working in Malaysia', 'Education', 'Occupation' and 'Understanding
148 of Food Safety Information from Social Media', whereas the response variables were food
149 safety 'Knowledge', 'Attitude' and 'Practice'. A global model was first constructed for each
150 response variable with all explanatory variables and 'dredge()' from 'MuMIn' package was
151 used to extract the best models from the global model [44]. The predicted residual error sum
152 of squares (PRESS) was determined using 'PRESS()' from the 'qPCR' package [45]. Selection
153 of the final model was based on the lowest delta AIC, highest AIC weight [46], highest adjusted
154 R^2 [47,48] and the lowest PRESS statistic [49]. The selected models were also supported by
155 the stepwise regression procedure, performed using 'stepAIC()' with the stepwise selection
156 technique (direction='both') from the 'MASS' package [48, 50]. The variation inflation factor
157 (VIF) was determined using the manually created function '1/(1-summary(model)\$r.squared)'
158 to assess multicollinearity between model variables [51]. 'ggplot()' from the 'ggplot2' package
159 was used to visualise the data [52].

160 The final linear regressions models were then used to create an overarching model via PSEM
161 [31,37,39,53], using 'psem()' from the 'piecewiseSEM' package [54]. Based on the linear
162 regression modelling results, 'Knowledge', 'Attitude' and 'Practice' were considered to be
163 correlated rather than directly causally associated, and therefore were indicated as correlated
164 errors in the PSEM. Note that tests of directed separation ($p>0.05$) indicated all of the variables
165 were independent of one another whereas Fisher's C test ($p>0.05$) confirmed that all potential
166 paths were included in the model; this criteria was used to select the final model [54]. The
167 comparative fit index (CFI), Tucker–Lewis index (TLI) and standardized root mean square

168 residual (SRMR) were obtained to assess whether the PSEM fit the data well [29,31,39,55,56],
169 using 'fitMeasures()' from the 'lavaan' package [57].

170 For post-hoc analyses, Wilcoxon rank-sum tests were conducted for explanatory variables with
171 binary data using 'wilcox.test()'. Kruskal-Wallis and Dunn's tests were conducted for
172 variables with non-binary data, using 'kruskal.test()' and 'dunn_test()' from the 'rstatix'
173 package [41]. Kruskal-Wallis and Dunn's tests indicated significant differences between
174 'Knowledge', 'Attitude' and 'Practice' among nationalities. To determine any association
175 between nationalities and other socio-demographic variables, multinomial regression [27] was
176 performed, using 'multinom()' from the 'nnet' package [50]. Chi-square tests were also
177 performed to assess any significant correlation between nationality and other socio-
178 demographic variables using the 'chisq.test()' function.

179 **3. Results**

180 **3.1. Socio-Demographic Profiles**

181 Of the 403 respondents, the respondents were mostly Nepalese, followed by Filipino and
182 Indonesian. The majority were male, working in the services industry, had completed high
183 school, aged between 30-39 years and had worked in Malaysia for less than ten years (Table
184 1). Of the 403 respondents, only 3.0% stated that they had previously suffered from typhoid
185 fever and 6.0% from food poisoning (Figure 1). Of those who had suffered from typhoid fever,
186 50.0% were Indonesian whilst 66.7% of those who had suffered from food poisoning were
187 Filipino. Respondents mostly obtained food safety information from social media (94.8%) and
188 least from posters/ billboards (55.1%) (Figure 2a). Similarly, 95.3% of respondents understood
189 food safety information from social media, and 57.1% from posters/ billboards (Figure 2b).

190

191 3.2. Food Safety KAP

192 The level of food safety knowledge amongst migrant workers was generally high, with an
193 average percentage score of 81.6 ± 1.2 (Figure 3a). Nearly all respondents correctly answered
194 the statement '*food contaminated by house flies can cause food poisoning*' (90.3%). The least
195 correctly answered statement was '*taking the vaccine can prevent typhoid infections*' (29.8%).
196 Respondents mostly showed positive attitudes towards food safety, with an average percentage
197 score of 81.1 ± 1.4 (Figure 3b). The statement with the highest combined agreement rate was
198 '*Clean restaurants are very important to prevent food poisoning*' (81.6%), whereas the
199 statement with the lowest agreement rate was '*Food handlers can be a source of food*
200 *poisoning*' (73.4%). Respondents frequently exercised appropriate food safety practices, with
201 an average percentage score of 90.4 ± 0.9 (Figure 3c). Nearly all respondents usually '*washed*
202 *their hands and cut their fingernails*' (93.1%). However, only 69.5% of the respondents usually
203 '*saw, smelled and tasted a little bit of food before eating it*', indicating the least exercised
204 practice.

205 3.3. Identifying Explanatory Variables for KAP

206 The final PSEM model (i) based on the results of linear regression modelling (Table 2, Table
207 A.1 and Figure 4), (ii) with lowest AIC value (38.107), (iii) $p\text{-value} > 0.05$ for all directed
208 separation tests and Fisher's C test ($C(12)=14.107$, $p=0.881$), and (iv) fitted the data well in
209 post-hoc assessments (Table A.2) was retained and visualised (Figure 5). 'Knowledge' and
210 'Practices' ($p\text{-value} < 0.001$; Figure 4a), as well as 'Knowledge' and 'Attitude' ($p\text{-value} < 0.001$;
211 Figure 4b) had positive association. 'Knowledge' was positively associated with 'Age' ($p\text{-value} < 0.001$;
212 Figure 4e), with respondents aged < 20 years having lower knowledge than those
213 aged 30-39 (Dunn's test $p\text{-value} = 0.002$), 40-49 (Dunn's test $p\text{-value} = 0.047$), and > 49 (Dunn's
214 test $p\text{-value} = 0.015$). Those aged 30-39 had higher knowledge than those aged 20-29 (Dunn's

215 test p -value <0.001) and 40-49 (Dunn's test p -value $=0.002$). 'Knowledge' was associated with
216 'Understanding of Food Safety Information from Social Media' ($p=0.005$; Figure 4f), with
217 respondents who understood food safety information from social media having higher
218 knowledge. 'Knowledge' was associated with 'Gender' (p -value <0.001 ; Figure 5d), with
219 female respondents having lower knowledge. 'Attitude' was negatively associated with 'gender'
220 ($p<0.001$; Figure 5h). 'Practice' was positively associated with 'Understanding of Food Safety
221 Information from Social Media' ($p<0.002$; Figure 5i), with respondents who understood food
222 safety information from social media exercised food safety practices more frequently. 'Gender'
223 was associated with 'Education' ($X^2(3)=50.16$, p -value <0.001), with more male respondents
224 having completed primary (37.0%) and high (55.0%) schools than female respondents (16.9%
225 and 49.4%).

226 3.4. Comparison across nationalities

227 'Knowledge' ($H(2)=153.50$, p -value <0.001), 'Attitude' ($H(2)=266.03$, p -value <0.001) and
228 'Practice' ($H(2)=8.96$, p -value <0.011) differed significantly across nationalities. Nepalese
229 respondents demonstrated higher levels of knowledge than Indonesian (Dunn's Test p -
230 value <0.001), and Filipino respondents (Dunn's Test p -value <0.001 ; Figure 6a). Indonesian
231 respondents showed higher levels of knowledge than Filipino respondents (Dunn's Test p -
232 value <0.001 ; Figure 6a). Nepalese respondents showed higher levels of attitudes than
233 Indonesian (Dunn's Test p -value <0.001 ; Figure 6b) and Filipino respondents (Dunn's Test p -
234 value <0.001 ; Figure 6b). Nepalese respondents demonstrated higher levels of practices than
235 Indonesian respondents only (Dunn's Test p -value <0.016 ; Figure 6c).

236 The final multinomial regression model with the lowest AIC value (246.234), lowest delta AIC
237 (0.000) and highest AIC weight (0.360) revealed which cohort to target for further food safety
238 awareness (Table 3). Occupation-wise, most Filipino respondents worked as domestic helpers

239 whereas most Indonesian and Nepalese respondents worked in the service industries
240 ($X^2(8)=242.77$, $p\text{-value}<0.001$). When compared to Nepalese respondents (also see Table 1),
241 (i) female respondents were mostly Indonesian or Filipino ($X^2(2)=233.78$, $p\text{-value}<0.001$),
242 (ii) Indonesian respondents were younger whilst Filipino respondents were older
243 ($X^2(8)=160.62$, $p\text{-value}<0.001$),
244 (iii) Filipino and Indonesian respondents have worked in Malaysia for a longer time
245 ($X^2(4)=79.61$, $p\text{-value}<0.001$), and
246 (iv) Indonesians received lower levels of education whilst Filipinos received higher levels
247 of education ($X^2(6)=177.75$, $p\text{-value}<0.001$).

248 **4. Discussion**

249 **4.1. Food Safety KAP**

250 The food safety knowledge score here (81.6%) is similar to other studies in Malaysia [9,35,58].
251 However, lower knowledge scores have been reported by studies involving food handlers in
252 Bangladesh (59.7%) [6], Ireland (73%) [59], Brazil (64%) [60], Turkey (43.4%) [61] and
253 migrant workers in Malaysia [27]. The higher knowledge score obtained here can be attributed
254 to the straightforward nature of the questionnaire, which excluded questions that require
255 extensive knowledge of food safety, such as foodborne pathogens, food storage, preparation
256 and handling methods, as seen in the aforementioned studies. Only 29.8% of our respondents
257 correctly identified the statement '*taking the vaccine can prevent typhoid infections*' to be true,
258 similar to past studies that have reported poor health literacy among migrant workers [23-26].
259 Thus, it is essential to ensure that migrant workers are well-aware of FBD vaccines to prevent
260 FBD transmission.

261 Here, respondents generally have positive attitudes towards food safety (81.1%), similar to
262 other studies in Malaysia [9,35,62]. On the other hand, university students in Kuala Lumpur
263 obtained a lower mean attitude score (69.5%) [58]. This discrepancy is likely because [58]
264 assessed subjective topics (e.g., pesticides, genetically-modified food) whereas the current
265 study used more appropriate and comprehensive statements related to food poisoning.

266 Respondents obtained an excellent average score for food safety practices (90.4%). In contrast,
267 other studies in Malaysia reported lower scores for local and foreign food handlers (79.5%)
268 [9], Malay food handlers (77.04%) [35] and university students (77.3%) [58]. Interestingly, [9]
269 also observed a higher practice score amongst non-Malaysians (83.7%) as compared to locals
270 (77.7%). This is likely due to their stricter adherence and compliance to existing governmental
271 regulations, to ensure that their legal rights to work in the country are not revoked [9]. However,
272 the ‘self-reported’ practices here may not reflect their actual practices; thus, monitoring their
273 daily routine would provide a more accurate score [29]. Furthermore, the use of multiple-choice
274 questions may have resulted in the over/underestimation of the respondents’ food safety KAP,
275 due to limited availability of responses, use of absolute terms and coincidentally correct
276 answers [63].

277 **4.2. Relationship Between KAP**

278 Here, knowledge of food safety and attitudes towards food safety are correlated, similar to
279 studies from Malaysia [9,35,37,64,65], Bangladesh [6], Turkey [31], Vietnam [30] and across
280 Africa and Asia [66]. Thus, possessing knowledge of food safety could lead to improved
281 attitudes towards food safety, indirectly leading to behavioural change. Despite obtaining high
282 scores for food safety knowledge especially regarding possible causes of FBD (Figure 3a), only
283 73.4% of respondents agreed or strongly agreed with the attitude statement that ‘*food handlers*
284 *can be a source of food poisoning*’. This may be due to personal bias, as 60.3% of respondents

285 worked in the service industries and likely did not consider themselves as potential threats to
286 public health. Globally, 70% of all FBD are linked to food service establishments and more
287 than 50% of all food poisoning incidents in Malaysia result from unhygienic food handling
288 procedures [3,5,6]. Thus, it is vital to ensure that respondents understand the potential role of
289 food handlers in FBD transmission, so that they can take appropriate precautionary measures.

290 **4.3. Relationship Between Knowledge and Practices**

291 Knowledge of, and practices in, food safety were correlated here, similar to other studies
292 [28,30,35,66]. Of our respondents, 87.3% correctly identified the statement '*Dirty hands and*
293 *long fingernails can cause food poisoning*', and subsequently, 93.1% stated that they usually
294 '*washed their hands and cut their fingernails*'. This is congruent with [9] who reported that
295 98.8% of their respondents washed their hands before handling food, while [27] reported that
296 94.3% did not keep '*long and coloured nails*'. However, a study reported a high score of 85.6%
297 for the statement '*To determine the safety of food, you should taste/smell/check the expiry date*
298 *before you eat*' [27]. Whereas, only 67.2% of our respondents correctly identified the
299 knowledge statement '*every individual needs to see, smell and taste a little of food before*
300 *starting to eat it*' as true, and only 69.5% stated that they usually '*saw, smelled and tasted a*
301 *little bit of food before eating it*'. Our lower scores may be because our statements did not
302 mention expiry dates, thus our statements are subjected to personal preferences. Of our
303 respondents, 80.4% usually '*checked the expiration date of a food*', similar to the figure
304 (84.0%) reported by [58]. In contrast, only 73.2% correctly identified the statement '*Expired*
305 *food can still be eaten if the food condition is still good*' as false. Despite being aware of the
306 consequences of consuming expired food, it is likely that our respondents may continue to do
307 so to save money, as past studies have revealed that low-income households generate less food
308 waste than high-income households [67-69]. This indicated that food safety knowledge does
309 not always translate into food safety practices among migrant workers [9,32,70], which may

310 be attributed to food insecurity, inadequate facilities at workplace (e.g., limited towels, shared
311 workstations, lack of first aid) and limited proficiency in the language used by food safety
312 awareness campaigns [5,9]. Overall, this implies that employers and the government should
313 provide incentives (e.g., leftover food for takeaway, personal towels and uniforms) and
314 intervention (e.g., educational material and training in particular languages) to nurture food
315 safety compliant practices.

316 **4.4. Targeted Groups for Training Based on Socio-Demographic Analyses**

317 Here, the lowest scores were obtained by respondents <30 years of age and the highest scores
318 by those aged >30, similar to other studies [9,34,71-73]. These findings highlighted the need
319 to target younger individuals for increased food safety education, especially since they are the
320 most active working members of society and thus, pose a greater risk of transmitting diseases
321 to others.

322 Male respondents showed higher levels of food safety knowledge and positive attitudes than
323 female respondents, similar to findings by [6,71,74]. Studies have reported positive association
324 between education and food safety KAP [9,27,30,32,35,43,65,70], and gender disparities in
325 education exist in our study. More male respondents had completed primary (37.0%) and high
326 schools (55.0%) compared to female respondents (16.9% and 49.4%), which may have
327 contributed to the greater food safety knowledge among the former. Hence, this study
328 highlighted the need to provide further education and training of FBD to female migrant
329 workers.

330 Nepalese respondents demonstrated higher levels of food safety knowledge and attitudes than
331 Indonesian and Filipino respondents. However, Nepalese respondents underwent a phone
332 interview to complete the questionnaire, where a coordinator was available to clarify their
333 thoughts. This may also have contributed to gendered differences in education, as most

334 Nepalese respondents (96.2%) were male and received higher levels of education, whereas
335 most Indonesian (76.1%) and Filipino (80.4%) respondents were female and received lower
336 levels of education. In addition, among respondents affected by typhoid fever and food
337 poisoning, most were Indonesian and Filipino, respectively. Most of our Filipino respondents
338 worked as domestic helpers whereas most Indonesian respondents worked in the services
339 industry. Thus, it is essential to raise food safety awareness among Filipino and Indonesian
340 migrant workers so that they can minimize FBD transmission through their food-handling
341 occupations.

342 Attendance of food safety training programs can increase the food safety knowledge of
343 individuals to ensure safe food handling practices and meet hygiene standards [9,27,75,76].
344 Therefore, the MoH should develop a food safety training program targeting the youth, women,
345 Indonesian and Filipino migrant workers to increase awareness of food safety and inculcate
346 safer food handling practices.

347 **4.5. Social Media as a Tool for Food Safety Awareness**

348 Our study ascertained that 95% of our respondents used social media to get information on
349 food poisoning, and that the respondents' understanding of food safety information from social
350 media positively influenced their knowledge of, and practices in, food safety, congruent to
351 [77,78]. These consequently highlighted the potential of social media to raise food safety
352 awareness and relay information. The benefits of social media include wider public outreach,
353 engagement with audiences (e.g., commenting, reposting), provision of timely information,
354 targeting specific cohorts and low cost [79]. Another study investigating the use of social media
355 in disseminating food safety news amongst Malaysian consumers found that 62% of
356 respondents agreed or strongly agreed that the use of social media can aid in preventing food
357 poisoning through food reviews [80]. Thus, social media is ideal for creating a tailored, targeted

358 awareness campaign for specific members of society. Platforms such as TikTok
359 (www.tiktok.com) and Instagram (www.instagram.com) would be suitable as they allow
360 dissemination of information in creative ways, through infographics, videos and reels which
361 can attract youth and women.

362 In Malaysia, the MoH has verified accounts on Twitter (www.twitter.com/kkmputrajaya),
363 Instagram (www.instagram.com/kementeriankesihatanmalaysia/) and Facebook
364 (www.facebook.com/kementeriankesihatanmalaysia/). The MoH frequently posts colourful,
365 educational infographics and animated clips on health-related topics. During the COVID-19
366 pandemic, the MoH used social media prominently for public service announcements,
367 including health precautions, updates on travel requirements and vaccine availability.
368 However, most of the content on the MoH's social media accounts is in Malay language,
369 hindering migrant workers from benefiting from it. Therefore, the MoH could work with the
370 respective embassies of migrant workers to create targeted food safety awareness campaigns
371 in particular native languages.

372 Drawbacks of using social media include information overload and the inability of users to
373 identify credible information [79,80]. Therefore, health authorities should assure social media
374 users of the credibility of their information by providing reliable references or sources (e.g.,
375 scientific articles with clickable links) in their educational material. Another study observed
376 that the highest food safety KAP scores were obtained by participants who underwent a
377 combination of Facebook and lecture intervention as compared to Facebook alone [77]. Thus,
378 social media must be used as a complement to traditional methods (e.g., physical posters and
379 lectures, local radio), rather than a replacement. Moreover, knowledge scores often attenuates
380 post-intervention, as seen in trained food handlers [75] and high schoolers [76], suggesting the
381 need for long-term intervention strategies such as posting on social media continuously to allow
382 positive feedback loop between knowledge, attitudes and practices.

383 5. Conclusion and Future Work

384 Generally, migrant workers across different occupational sectors in Klang Valley, Malaysia
385 showed high levels of knowledge of, attitudes towards, and practices in, food safety. Our results
386 revealed that improving food safety knowledge through training programs and social media
387 awareness campaigns can foster hygienic food handling practices among migrant workers. To
388 assess the effectiveness of social media in raising food safety awareness, pre- and post-
389 evaluations should be conducted to observe any improvement in food safety KAP scores. Our
390 study also revealed that female, younger, Indonesian and Filipino migrant workers should be
391 targeted for food safety interventions. Future work should involve migrant workers of other
392 nationalities commonly found in Malaysia, such as Bangladeshi, Indian and Burmese [13].
393 Overall, these findings can aid respective embassies and the Malaysian government in
394 developing targeted food safety interventions for migrant workers as a means to minimize FBD
395 transmission to the public and to protect their own health.

396 **CRedit authorship contribution statement**

397 **Maryam Nazir Chaudhary:** Formal analysis, methodology, data curation, validation,
398 visualization, writing - Original Draft. **Voon-Ching Lim:** Supervision, formal analysis,
399 methodology, validation, writing - original draft. **Norhidayu Sahimin:** Conceptualization,
400 project administration, methodology, investigation, resources, validation, writing - review &
401 editing, funding acquisition. **Erwin Martinez Fallerd:** validation, writing - review & editing.
402 **Pramod Regmie:** validation, writing - review & editing. **Nirmal Aryal:** validation, writing -
403 review & editing. **Adzzie Shazleen Azman:** Conceptualization, supervision, methodology,
404 investigation, resources, validation, writing - original draft, funding acquisition.

405

406 **Declaration of competing interest**

407 The authors declare no competing interests.

408

409 **Acknowledgments**

410 We express our sincere thanks to the coordinators; Mr. Ramesh Kumar Pajiyar and Ms. Babie
411 de Vera for helping us during the data collection, and to all volunteers that participated in the
412 study.

413

414 **Funding**

415 This work was supported by the Malaysian Society of Parasitology and Tropical Medicine
416 (MSPTM) for the Community Fund (Project PV008-2020) awarded to Dr. Norhidayu Sahimin
417 and Dr. Adzzie Shazleen Azman.

418 **References**

- 419 [1] World Health Organization. Food Safety, [https://www.who.int/news-room/fact-](https://www.who.int/news-room/fact-sheets/detail/food-safety)
420 [sheets/detail/food-safety](https://www.who.int/news-room/fact-sheets/detail/food-safety) ; 2022 [accessed 5 June 2023]
- 421 [2] Jaffee S, Henson S, Unnevehr L, Grace D, Cassou E. The Safe Food Imperative :
422 Accelerating Progress in Low- and Middle-Income Countries. Washington, DC: World Bank;
423 2019. <https://openknowledge.worldbank.org/handle/10986/30568>
- 424 [3] Abdul-Mutalib NA, Syafinaz AN, Sakai K, Shirai Y. An overview of foodborne illness and
425 food safety in Malaysia. *International Food Research Journal*. 2015;22(3):896-901.
- 426 [4] Ministry of Health. Health Facts 2021: Reference Data for 2020,
427 <https://www.moh.gov.my/index.php/pages/view/58?mid=19>; 2020 [accessed 29 January
428 2023].
- 429 [5] Soon JM, Singh H, Baines R. Foodborne diseases in Malaysia: A review. *Food Control*.
430 2011;22(6), 823-830. <https://doi.org/10.1016/j.foodcont.2010.12.011>
- 431 [6] Al Banna MH, Khan MSI, Rezyona H, Seidu A-A, Abid MT, Ara T, et al. Assessment of
432 Food Safety Knowledge, Attitudes and Practices of Food Service Staff in Bangladeshi
433 Hospitals: A Cross-Sectional Study. *Nutrients*. 2022;14(12):2540.
434 <https://www.mdpi.com/2072-6643/14/12/2540>
- 435 [7] Ministry of Health. Annual Report,
436 https://www.moh.gov.my/moh/modules_resources/bookshelf/MOH_Annual_Report_2020_m
437 [in/index.html#page/1](https://www.moh.gov.my/moh/modules_resources/bookshelf/MOH_Annual_Report_2020_m); 2020 [accessed 29 January 2023].
- 438 [8] Ministry of Health. Annual Report,
439 [https://www.moh.gov.my/moh/resources/Penerbitan/Penerbitan%20Utama/ANNUAL%20RE](https://www.moh.gov.my/moh/resources/Penerbitan/Penerbitan%20Utama/ANNUAL%20REPORT/ANNUAL%20REPORT%202018.pdf)
440 [PORT/ANNUAL%20REPORT%202018.pdf](https://www.moh.gov.my/moh/resources/Penerbitan/Penerbitan%20Utama/ANNUAL%20REPORT/ANNUAL%20REPORT%202018.pdf) ; 2018 [accessed 5 June 2023].

- 441 [9] Siau AMF, Son R, Mohhiddin O, Toh PS, Chai LC. Food court hygiene assessment and
442 food safety knowledge, attitudes and practices of food handlers in Putrajaya. *International Food*
443 *Research Journal*. 2015;22(5):1843-1854.
444 [http://www.ifrj.upm.edu.my/22%20\(05\)%202015/\(16\).pdf](http://www.ifrj.upm.edu.my/22%20(05)%202015/(16).pdf)
- 445 [10] Malaysian Employers Federation. Practical Guidelines for Employers on the Recruitment,
446 Placement, Employment and Repatriation of Foreign Workers in Malaysia,
447 https://www.mef.org.my/Attachments/MEFReport_PGERPERFWM.pdf; 2014 [accessed 29
448 January 2023].
- 449 [11] Simon J, Kiss N, Łaszewska A, Mayer S. Public Health Aspects of Migrant Health: A
450 Review of the Evidence on Health Status for Labour Migrants in the European Region. In:
451 WHO Health Evidence Network Synthesis Reports (43). Copenhagen: WHO Regional Office
452 for Europe; 2015. <https://www.ncbi.nlm.nih.gov/books/NBK379432/>
- 453 [12] Ministry of Finance. Chapter 3: Macroeconomic Outlook. *Economic Outlook 2021*,
454 https://www.mof.gov.my/portal/arkib/economy/ec_Main.html ; 2020 [accessed 5 June 2023].
- 455 [13] Yi S, Simler K, Loh WS, Tan Wei K. Who is Keeping Score Estimating the Number of
456 Foreign Workers in Malaysia (English). Malaysia: World Bank Group; 2020.
457 <https://doi.org/10.1596/33730>
- 458 [14] Woh PY, Thong KL, Behnke JM, Lewis JW, Mohd Zain SN. Characterization of
459 Nontyphoidal Salmonella Isolates from Asymptomatic Migrant Food Handlers in Peninsular
460 Malaysia. *Journal of Food Protection*. 2017;80(8):1378-1383. [https://doi.org/10.4315/0362-](https://doi.org/10.4315/0362-028x.Jfp-16-342)
461 [028x.Jfp-16-342](https://doi.org/10.4315/0362-028x.Jfp-16-342)
- 462 [15] Woh PY, Thong KL, Lim YAL, Behnke JM, Lewis JW, Mohd ZSN. Microorganisms as
463 an Indicator of Hygiene Status Among Migrant Food Handlers in Peninsular Malaysia. *Asia*
464 *Pacific Journal of Public Health*. 2017;29(7):599-607.
465 <https://doi.org/10.1177/1010539517735856>

- 466 [16] Sahimin N, Douadi B, Yvonne Lim AL, Behnke JM, Mohd Zain SN. Distribution of
467 *Giardia duodenalis* (Assemblages A and B) and *Cryptosporidium parvum* amongst migrant
468 workers in Peninsular Malaysia. *Acta Tropica*. 2018;182:178-184.
469 <https://doi.org/10.1016/j.actatropica.2018.02.033>
- 470 [17] Castro A, Santos C, Meireles H, Silva J, Teixeira P. Food handlers as potential sources of
471 dissemination of virulent strains of *Staphylococcus aureus* in the community. *Journal of*
472 *Infection and Public Health*. 2016;9(2):153-160. <https://doi.org/10.1016/j.jiph.2015.08.001>
- 473 [18] Eltai NO, Yassine HM, Al Thani AA, Abu Madi MA, Ismail A, Ibrahim E, et al.
474 Prevalence of antibiotic resistant *Escherichia coli* isolates from fecal samples of food handlers
475 in Qatar. *Antimicrobial Resistance & Infection Control*. 2018;7(1):78.
476 <https://doi.org/10.1186/s13756-018-0369-2>
- 477 [19] Lambrechts AA, Human IS, Doughari JH, Lues JFR. Bacterial contamination of the hands
478 of food handlers as indicator of hand washing efficacy in some convenient food industries in
479 South Africa. *Pakistan Journal of Medical Sciences*. 2014;30(4):755-758.
480 <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4121692/>
- 481 [20] Motazedian MH, Najjari M, Ebrahimipour M, Asgari Q, Mojtabavi S, Mansouri M.
482 Prevalence of Intestinal Parasites among Food-handlers in Shiraz, Iran. *Iranian Journal of*
483 *Parasitology*. 2015;10(4):652-657. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4724844/>
- 484 [21] Valero A, Ortiz JC, Fongaro G, Hernández M, Rodríguez-Lázaro D. Definition of
485 sampling procedures for collective-eating establishments based on the distribution of
486 environmental microbiological contamination on food handlers, utensils and surfaces. *Food*
487 *Control*. 2017;77:8-16. <https://doi.org/10.1016/j.foodcont.2017.01.013>
- 488 [22] Sørensen K, Van den Broucke S, Fullam J, Doyle G, Pelikan J, Slonska Z, et al. Health
489 literacy and public health: a systematic review and integration of definitions and models. *BMC*
490 *Public Health*. 2012;12:80. <https://doi.org/10.1186/1471-2458-12-80>

- 491 [23] Bergman L, Nilsson U, Dahlberg K, Jaensson M, Wångdahl J. Health literacy and e-health
492 literacy among Arabic-speaking migrants in Sweden: a cross-sectional study. *BMC Public*
493 *Health*. 2021;21(1):2165. <https://doi.org/10.1186/s12889-021-12187-5>
- 494 [24] Gilder ME, Moo P, Hashmi A, Norda P, Wai K, Pimanpanarak M, et al. “I can’t read and
495 don’t understand”: Health literacy and health messaging about folic acid for neural tube defect
496 prevention in a migrant population on the Myanmar-Thailand border. *PLoS One*. 2019;14(6).
497 <https://doi.org/10.1371/journal.pone.0218138>
- 498 [25] Kosiyaporn H, Julchoo S, Sinam P, Phaiyarom M, Kunpeuk W, Pudpong N, et al. Health
499 Literacy and Its Related Determinants in Migrant Health Workers and Migrant Health
500 Volunteers: A Case Study of Thailand, 2019. *International Journal of Environmental Research*
501 *and Public Health*. 2020;17(6):2105. <https://doi.org/10.3390/ijerph17062105>
- 502 [26] Vianello FA, Zaccagnini F, Pinato C, Maculan P, Buja A. Health status of female
503 Moldovan migrants to Italy by health literacy level and age group: a descriptive study. *BMC*
504 *Public Health*. 2020;20. <http://dx.doi.org/10.1186/s12889-020-09582-9>
- 505 [27] Woh PY, Thong KL, Behnke JM, Lewis JW, Mohd Zain SN. Evaluation of basic
506 knowledge on food safety and food handling practices amongst migrant food handlers in
507 Peninsular Malaysia. *Food Control*. 2016;70:64-73.
508 <https://doi.org/10.1016/j.foodcont.2016.05.033>
- 509 [28] Ahmed MH, Akbar A, Sadiq MB. Cross sectional study on food safety knowledge,
510 attitudes, and practices of food handlers in Lahore district, Pakistan. *Heliyon*.
511 2021;7(11):e08420. <https://doi.org/10.1016/j.heliyon.2021.e08420>
- 512 [29] da Cunha DT, de Rosso VV, Pereira MB, Stedefeldt E. The differences between observed
513 and self-reported food safety practices: A study with food handlers using structural equation
514 modeling. *Food Research International*. 2019;125:108637.
515 <https://doi.org/10.1016/j.foodres.2019.108637>

- 516 [30] Vo TH, Le NH, Le ATN, Tran Minh NN, Nuorti JP. Knowledge, attitudes, practices and
517 training needs of food-handlers in large canteens in Southern Vietnam. *Food Control*.
518 2015;57:190-194. <https://doi.org/10.1016/j.foodcont.2015.03.042>
- 519 [31] Baser F, Ture H, Abubakirova A, Sanlier N, Cil B. Structural modeling of the relationship
520 among food safety knowledge, attitude and behavior of hotel staff in Turkey. *Food Control*.
521 2017;73:438-444. <https://doi.org/10.1016/j.foodcont.2016.08.032>
- 522 [32] Angelillo IF, Viggiani NMA, Rizzo L, Bianco A. Food Handlers and Foodborne Diseases:
523 Knowledge, Attitudes, and Reported Behavior in Italy. *Journal of Food Protection*.
524 2000;63(3):381-385. <https://doi.org/10.4315/0362-028x-63.3.381>
- 525 [33] da Vitória AG, de Souza Couto Oliveira J, de Almeida Pereira LC, de Faria CP, de São
526 José JFB. Food safety knowledge, attitudes and practices of food handlers: A cross-sectional
527 study in school kitchens in Espírito Santo, Brazil. *BMC Public Health*. 2021;21(1):349.
528 <https://doi.org/10.1186/s12889-021-10282-1>
- 529 [34] Rossvoll EH, Lavik R, Ueland Ø, Jacobsen E, Hagtvedt T, Langsrud S. Food Safety
530 Practices among Norwegian Consumers. *Journal of Food Protection*. 2013;76(11):1939-1947.
531 <https://doi.org/10.4315/0362-028x.Jfp-12-269>
- 532 [35] Abdul-Mutalib N-A, Abdul-Rashid M-F, Mustafa S, Amin-Nordin S, Hamat RA, Osman
533 M. Knowledge, attitude and practices regarding food hygiene and sanitation of food handlers
534 in Kuala Pilah, Malaysia. *Food Control*. 2012;27(2):289-293.
535 <https://doi.org/10.1016/j.foodcont.2012.04.001>
- 536 [36] Ali AN, William AF, Prajapati SK, Ahmed NZ. A KAP Study on Food Safety and Hygiene
537 Among Private University Students in Kedah State, Malaysia. *Journal of Natural Remedies*.
538 2018;18(3). <https://doi.org/10.18311/jnr/2018/22289>

- 539 [37] Ruby GE, Ungku Zainal Abidin UF, Lihan S, Jambari NN, Radu S. Predicting intention
540 on safe food handling among adult consumers: A cross sectional study in Sibu district,
541 Malaysia. *Food Control*. 2019;106:106696. <https://doi.org/10.1016/j.foodcont.2019.06.022>
- 542 [38] Lim V-C, Sing K-W, Chong KY, Jaturas N, Dong H, Lee P-S, et al. Familiarity with,
543 perceptions of and attitudes toward butterflies of urban park users in megacities across East
544 and Southeast Asia. *Royal Society Open Science*. 2022;9(11):220161.
545 <https://doi.org/doi:10.1098/rsos.220161>
- 546 [39] R Core Team. A language and environment for statistical computing. In: R Foundation for
547 Statistical Computing, <https://www.R-project.org/>; 2022 [accessed 29 January 2023].
- 548 [40] Revelle W. psych: Procedures for Psychological, Psychometric, and Personality Research.
549 R package version 2.2.9. Northwestern University; 2022. [https://CRAN.R-](https://CRAN.R-project.org/package=psych)
550 [project.org/package=psych](https://CRAN.R-project.org/package=psych)
- 551 [41] Kassambara A. rstatix: Pipe-Friendly Framework for Basic Statistical Tests. R package
552 version 0.7.0.; 2021. <https://rpkgs.datanovia.com/rstatix/>
- 553 [42] Lee HY, Chik WNW, Bakar FA, Saari N, Mahyudin NA. Sanitation Practices among Food
554 Handlers in a Military Food Service Institution, Malaysia. *Food and Nutrition Sciences*.
555 2012;3(11):24497. <https://doi.org/10.4236/fns.2012.311204>
- 556 [43] Madaki YM, Bavorova M. Food safety knowledge of food vendors of higher educational
557 institutions in Bauchi state, Nigeria. *Food Control*. 2019;106:106703.
558 <https://doi.org/https://doi.org/10.1016/j.foodcont.2019.06.029>
- 559 [44] Bartoń K. MuMIn: Multi-Model Inference. R package version 1.47.1.; 2022.
560 <https://CRAN.R-project.org/package=MuMIn>
- 561 [45] Spiess A-N. qpcR: Modelling and Analysis of Real-Time PCR Data. R package version
562 1.4-1.; 2018. <https://CRAN.R-project.org/package=qpcR>

- 563 [46] Fabozzi FJ, Focardi SM, Rachev ST, Arshanapalli BG, Hoehstoetter M. Appendix E:
564 Model Selection Criterion: AIC and BIC. In: Fabozzi FJ, Focardi SM, Rachev ST, Arshanapalli
565 BG, Hoehstoetter M, editors. The Basics of Financial Econometrics: Tools, Concepts, and
566 Asset Management Applications (1 ed.), New York: John Wiley & Sons, Incorporated; 2014.
567 <https://doi.org/10.1002/9781118856406.app5>
- 568 [47] Jawlik AA. r , Multiple R , r^2 , R^2 , R Square, R^2 Adjusted. In: Jawlik AA, editor. Statistics
569 from A to Z : Confusing Concepts Clarified, New York: John Wiley & Sons Incorporated;
570 2016. <https://doi.org/10.1002/9781119272021.ch12>
- 571 [48] Surez E, Prez CM, Rivera R, Martnez MN. Selection of Variables in a Multiple Linear
572 Regression Model. In: Surez E, Prez CM, Rivera R, Martnez MN, editors. Applications of
573 Regression Models in Epidemiology, New York: John Wiley & Sons Incorporated; 2017.
574 <https://doi.org/10.1002/9781119212515.ch5>.
- 575 [49] Miller A. Subset Selection in Regression. 2nd ed. New York: CRC Press LLC; 2002.
576 <https://doi.org/10.1201/9781420035933>
- 577 [50] Venables WN, Ripley BD. Modern Applied Statistics with S. 4th ed. New York: Springer;
578 2002. <https://www.stats.ox.ac.uk/pub/MASS4/>
- 579 [51] Kacapyr E. A Guide to Basic Econometric Techniques. 2nd ed. New York: Routledge;
580 2014. <https://doi.org/10.4324/9781315706856>
- 581 [52] Wickham H. ggplot2: Elegant Graphics for Data Analysis. Springer-Verlag. 2016.
582 <https://ggplot2.tidyverse.org>
- 583 [53] Lim T-P, Chye FY, Sulaiman MR, Suki NM, Lee J-S. A structural modeling on food safety
584 knowledge, attitude, and behaviour among Bum Bum Island community of Semporna, Sabah.
585 Food Control. 2016;60:241-246.
586 <https://doi.org/https://doi.org/10.1016/j.foodcont.2015.07.042>

- 587 [54] Lefcheck JS. piecewiseSEM: Piecewise structural equation modelling in r for ecology,
588 evolution, and systematics. *Methods in Ecology and Evolution*. 2016;7(5):573-579.
589 <https://doi.org/10.1111/2041-210X.12512>
- 590 [55] Soon JM, Wahab IRA, Hamdan RH, Jamaludin MH. Structural equation modelling of
591 food safety knowledge, attitude and practices among consumers in Malaysia. *PLoS One*.
592 2020;15(7):e0235870. <https://doi.org/10.1371/journal.pone.0235870>
- 593 [56] Schumacker RE, Lomax RG, Schumacker R. *A Beginner's Guide to Structural Equation*
594 *Modeling: Fourth Edition*. London: Taylor and Francis. 2015.
595 <https://doi.org/10.4324/9781315749105>
- 596 [57] Rosseel Y. {lavaan}: An {R} Package for Structural Equation Modeling. *Journal of*
597 *Statistical Software*. 2012;48(2):1-36. <https://doi.org/10.18637/jss.v048.i02>
- 598 [58] Moy FM, Alias AA, Jani R, Abdul Halim H, Low WY. Determinants of self-reported food
599 safety practices among youths: A cross-sectional online study in Kuala Lumpur, Malaysia.
600 *British Food Journal (1966)*. 2018;120(4):891-900. <https://doi.org/10.1108/BFJ-04-2017-0224>
- 601 [59] Gruenfeldova J, Domijan K, Walsh C. A study of food safety knowledge, practice and
602 training among food handlers in Ireland. *Food Control*. 2019;105:131-140.
603 <https://doi.org/10.1016/j.foodcont.2019.05.023>
- 604 [60] da Cunha DT, Stedefeldt E, de Rosso VV. The role of theoretical food safety training on
605 Brazilian food handlers' knowledge, attitude and practice. *Food Control*. 2014;43:167-174.
606 <https://doi.org/10.1016/j.foodcont.2014.03.012>
- 607 [61] Baş M, Şafak Ersun A, Kıvanç G. The evaluation of food hygiene knowledge, attitudes,
608 and practices of food handlers' in food businesses in Turkey. *Food Control*. 2006;17(4):317-
609 322. <https://doi.org/10.1016/j.foodcont.2004.11.006>

- 610 [62] Albattat A. Food safety knowledge, attitude and practices among management and science
611 university students, Shah Alam. *Management Science Letters*. 2019;10.
612 <https://doi.org/10.5267/j.msl.2019.10.002>
- 613 [63] Al-Faris EA, Alorainy IA, Abdel-Hameed AA, Al-Rukban MO. A practical discussion to
614 avoid common pitfalls when constructing multiple choice questions items. *J Family*
615 *Community Med*. 2010;17(2):96-102. <https://doi.org/10.4103/1319-1683.71992>
- 616 [64] Ali A, Jie J, Prajapati S, Ahmed N, Iqbal M, Alshammari T. A KAP Study on Food Safety
617 and Hygiene Among Private University Students in Kedah State, Malaysia. *Journal of Natural*
618 *Remedies*. 2019;18:113-121. <https://doi.org/10.18311/jnr/2018/22289>
- 619 [65] Toh PS, Birchenough A. Food safety knowledge and attitudes: culture and environment
620 impact on hawkers in Malaysia.: Knowledge and attitudes are key attributes of concern in
621 hawker foodhandling practices and outbreaks of food poisoning and their prevention. *Food*
622 *Control*. 2000;11(6):447-452. [https://doi.org/10.1016/S0956-7135\(00\)00008-6](https://doi.org/10.1016/S0956-7135(00)00008-6)
- 623 [66] Odeyemi OA, Sani NA, Obadina AO, Saba CKS, Bamidele FA, Abughoush M, et al. Food
624 safety knowledge, attitudes and practices among consumers in developing countries: An
625 international survey. *Food Research International*. 2019;116:1386-1390.
626 <https://doi.org/10.1016/j.foodres.2018.10.030>
- 627 [67] Stancu V, Haugaard P, Lähteenmäki L. Determinants of consumer food waste behaviour:
628 Two routes to food waste. *Appetite*. 2016;96:7-17. <https://doi.org/10.1016/j.appet.2015.08.025>
- 629 [68] Szabó-Bódi B, Kasza G, Szakos D. Assessment of household food waste in Hungary.
630 *British Food Journal*. 2018;120(3):625-638. <https://doi.org/10.1108/bfj-04-2017-0255>
- 631 [69] Lopez Barrera E, Hertel T. Global food waste across the income spectrum: Implications
632 for food prices, production and resource use. *Food Policy*. 2021;98:101874.
633 <https://doi.org/10.1016/j.foodpol.2020.101874>

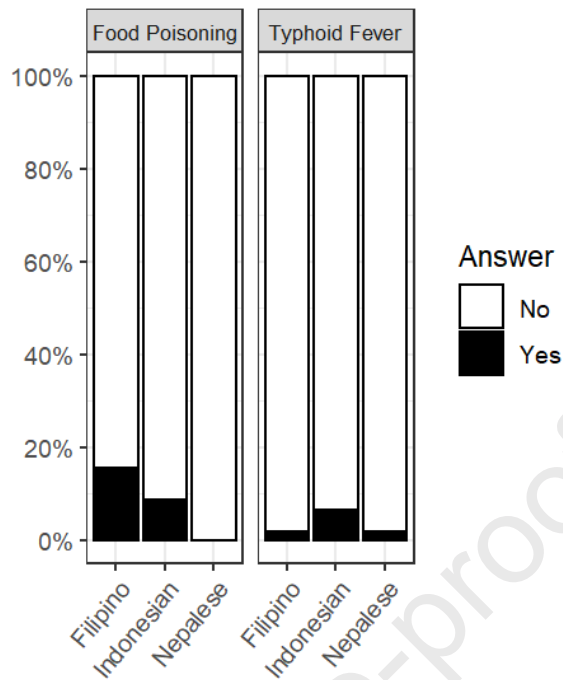
- 634 [70] Akabanda F, Hlortsi EH, Owusu-Kwarteng J. Food safety knowledge, attitudes and
635 practices of institutional food-handlers in Ghana. *BMC Public Health*. 2017;17(1):40.
636 <https://doi.org/10.1186/s12889-016-3986-9>
- 637 [71] Courtney SM, Majowicz SE, Dubin JA. Food safety knowledge of undergraduate students
638 at a Canadian university: results of an online survey. *BMC Public Health*. 2016;16(1):1147.
639 <https://doi.org/10.1186/s12889-016-3818-y>
- 640 [72] Low WY, Jani R, Halim HA, Alias AA, Moy FM. Determinants of food hygiene
641 knowledge among youths: A cross-sectional online study. *Food Control*. 2016;59:88-93.
642 <https://doi.org/10.1016/j.foodcont.2015.04.032>
- 643 [73] Fein SB, Lando AM, Levy AS, Teisl MF, Noblet C. Trends in U.S. Consumers' Safe
644 Handling and Consumption of Food and Their Risk Perceptions, 1988 through 2010. *Journal*
645 *of Food Protection*. 2011;74(9):513-1523. <https://doi.org/10.4315/0362-028x.Jfp-11-017>
- 646 [74] Amoah PA, Phillips DR. Socio-demographic and behavioral correlates of health literacy:
647 a gender perspective in Ghana. *Women & Health*. 2020;60(2):123-139.
648 <https://doi.org/10.1080/03630242.2019.1613471>
- 649 [75] McIntyre L, Vallaster L, Wilcott L, Henderson SB, Kosatsky T. Evaluation of food safety
650 knowledge, attitudes and self-reported hand washing practices in FOODSAFE trained and
651 untrained food handlers in British Columbia, Canada. *Food Control*. 2013;30(1):150-156.
652 <https://doi.org/10.1016/j.foodcont.2012.06.034>
- 653 [76] Majowicz SE, Hammond D, Dubin JA, Diplock KJ, Jones-Bitton A, Rebellato S, et al. A
654 longitudinal evaluation of food safety knowledge and attitudes among Ontario high school
655 students following a food handler training program. *Food Control*. 2017;76:108-116.
656 <https://doi.org/10.1016/j.foodcont.2017.01.011>

- 657 [77] Mayer AB, Harrison JA. Safe Eats: An Evaluation of the Use of Social Media for Food
658 Safety Education. *Journal of Food Protection*. 2012;75(8):1453-1463.
659 <https://doi.org/10.4315/0362-028X.11-551>
- 660 [78] James KJ, Albrecht JA, Litchfield RE, Weishaar CA. A Summative Evaluation of a Food
661 Safety Social Marketing Campaign “4-Day Throw-Away” Using Traditional and Social Media.
662 *Journal of Food Science Education*. 2013;12(3):48-55. <https://doi.org/10.1111/1541-4329.12010>
- 663
- 664 [79] Overbey KN, Jaykus L-A, Chapman BJ. A Systematic Review of the Use of Social Media
665 for Food Safety Risk Communication. *Journal of Food Protection*. 2017;80(9):1537-1549.
666 <https://doi.org/10.4315/0362-028X.JFP-16-345>
- 667 [80] Soon JM. Consumers' Awareness and Trust Toward Food Safety News on Social Media
668 in Malaysia. *Journal of Food Protection*. 2020;83(3):452-459. <https://doi.org/10.4315/0362-028X.JFP-19-415>
- 669
- 670
- 671

672 **Table 1. Socio-Demographic Profile of the 403 Respondents.**

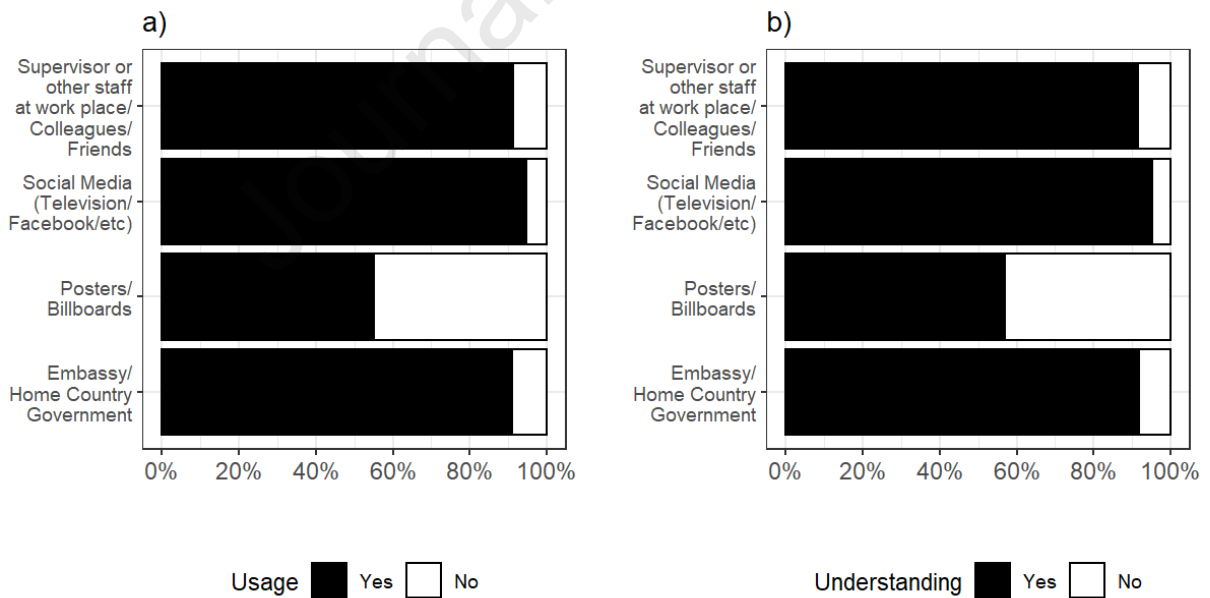
Variable	Nepalese		Indonesian		Filipino		Overall	
	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%
Sex								
Male	201	96.2	22	23.9	20	19.6	243	60.3
Female	8	3.8	70	76.1	82	80.4	160	39.7
Education								
No formal education	0	0	7	7.6	2	2.0	9	2.2
Primary school	89	42.6	26	28.3	2	2.0	117	29.0
High school	111	53.1	58	63.0	44	43.1	213	52.9
University	9	4.3	1	1.1	54	52.9	64	15.9
Age								
<20	0	0	6	6.5	0	0	6	1.5
20 - 29	38	18.2	44	47.8	4	3.9	86	21.3
30 - 39	146	69.9	25	27.2	40	39.2	211	52.3
40 - 49	25	12.0	14	15.2	41	40.2	80	19.9
>49	0	0	3	3.3	17	16.7	20	5.0
Occupation								
Construction	6	2.9	4	4.3	5	4.9	15	3.7
Domestic helpers	0	0	14	15.2	74	72.5	88	21.8
Manufacturing	42	20.1	0	0	10	9.8	52	12.9
Plantation	3	1.4	2	2.2	0	0	5	1.2
Services ¹	158	75.6	72	78.3	13	12.7	243	60.3
Years Working in Malaysia								
<10	208	99.5	81	88.0	66	64.7	355	88.1
10 - 20	0	0	8	8.7	23	22.5	31	7.7
>20	1	0.5	3	3.3	13	12.7	17	4.2

673 ¹ Includes retail workers, restaurant staff and pump attendants.



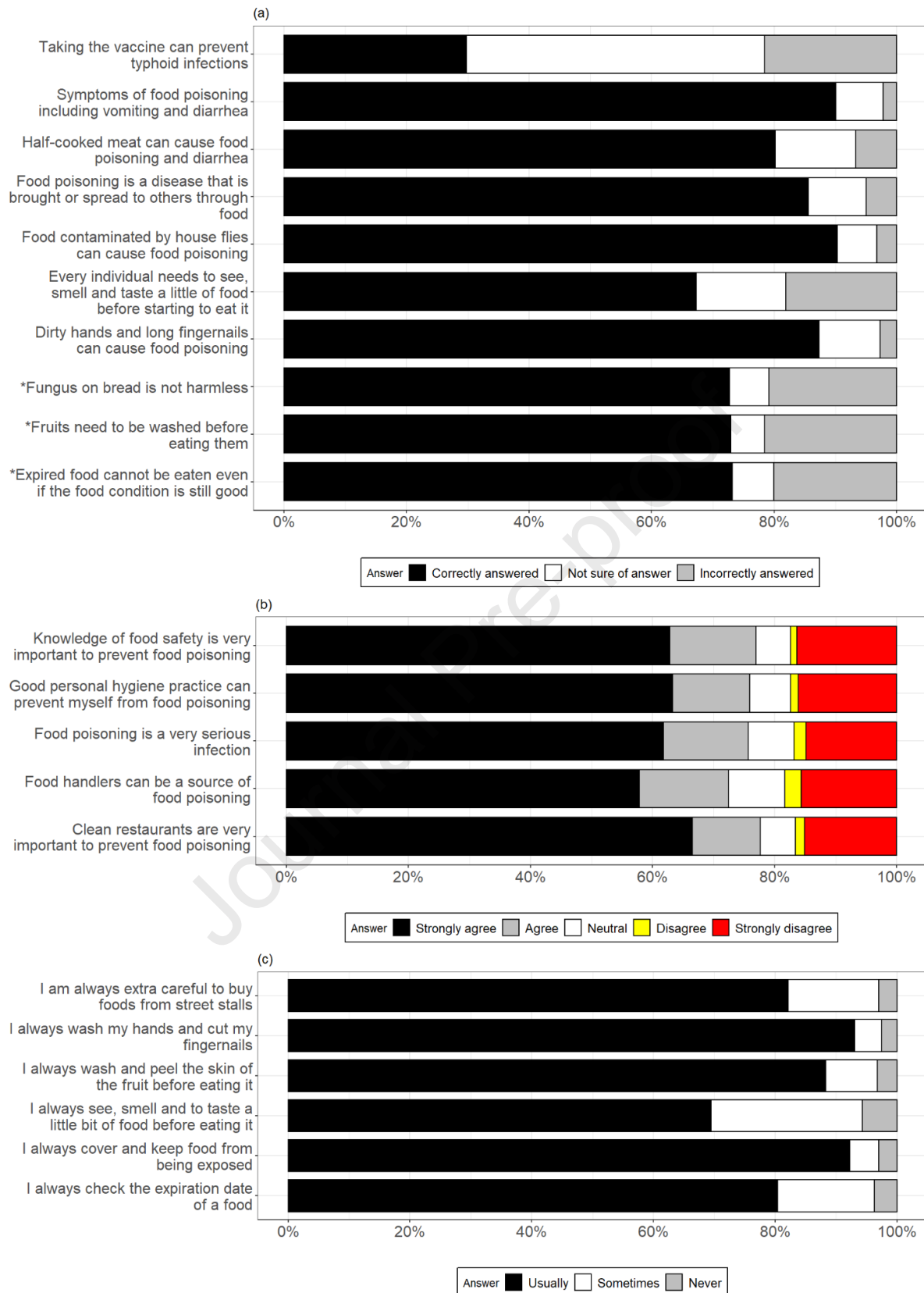
674 **Figure 1. Self-Reported Illness History of the 403 Respondents by Nationality.**

675



676

677 **Figure 2. Food Safety Information and Understanding from Different Sources.** a)
 678 Percentage of the 403 respondents who obtained food safety information from these sources.
 679 b) Percentage of the 403 respondents who understood food safety information from these
 680 sources.



681

682 **Figure 3. Responses from 403 Respondents for the Food Safety KAP Statements.** a)
 683 Knowledge of Food Safety. b) Attitudes Towards Food Safety. c) Practices in Food Safety.
 684 *These statements were originally negative but were reversely scored here and for the Linear
 685 Regression Modelling.

686 **Table 2. Final Linear Regression Models.** Three models were developed with the response
 687 variables 'Knowledge', 'Attitude' and 'Practice', respectively. Selection of the final model was
 688 based on the highest adjusted R², lowest delta AIC, highest AIC weight, and the lowest PRESS
 689 statistic. Delta AIC of <2 signifies that there is substantial supporting evidence for the candidate
 690 model, whereas AIC weights reflect the probability of a model being the best amongst all other
 691 possible models [46]. The adjusted R² value reflects the goodness of fit of the model and
 692 charges a penalty for increasing the number of predictors in a model [47,48]. The PRESS
 693 statistic measures the predictive ability of a model, with the lowest value signifying the best
 694 model [49]. The selected models were also supported by the stepwise regression procedure
 695 with the stepwise selection technique. Predictors were added sequentially, ensuring that each
 696 predictor met the preselected significance level (p-value<0.05) until all predictors in the model
 697 met this criterion and all those outside did not [48].
 698

Response Variable	Explanatory Variable	Estimate	Standard Error	P-Value
Knowledge¹	Intercept	0.153	0.077	0.048
	Attitude ²	0.064	0.007	< 0.001
	Practice ³	0.171	0.024	< 0.001
	Age ⁴	0.049	0.011	< 0.001
	Gender ⁵	- 0.092	0.022	< 0.001
	Understand.Social.Media ⁶	0.080	0.044	0.068
Attitude²	Intercept	4.209	0.423	< 0.001
	Knowledge ¹	2.618	0.285	< 0.001
	Practice ³	- 0.311	0.164	0.059
	Education ⁷	- 0.187	0.084	0.027
	Gender ⁵	- 0.861	0.131	< 0.001
Practice³	Intercept	1.291	0.095	< 0.001
	Attitude ²	- 0.035	0.014	0.014
	Knowledge ¹	0.624	0.089	< 0.001
	Understand.Social.Media ⁶	0.157	0.084	0.063

699 ¹ Knowledge of Food Safety of Respondents

700 ² Attitudes Towards Food Safety of Respondents

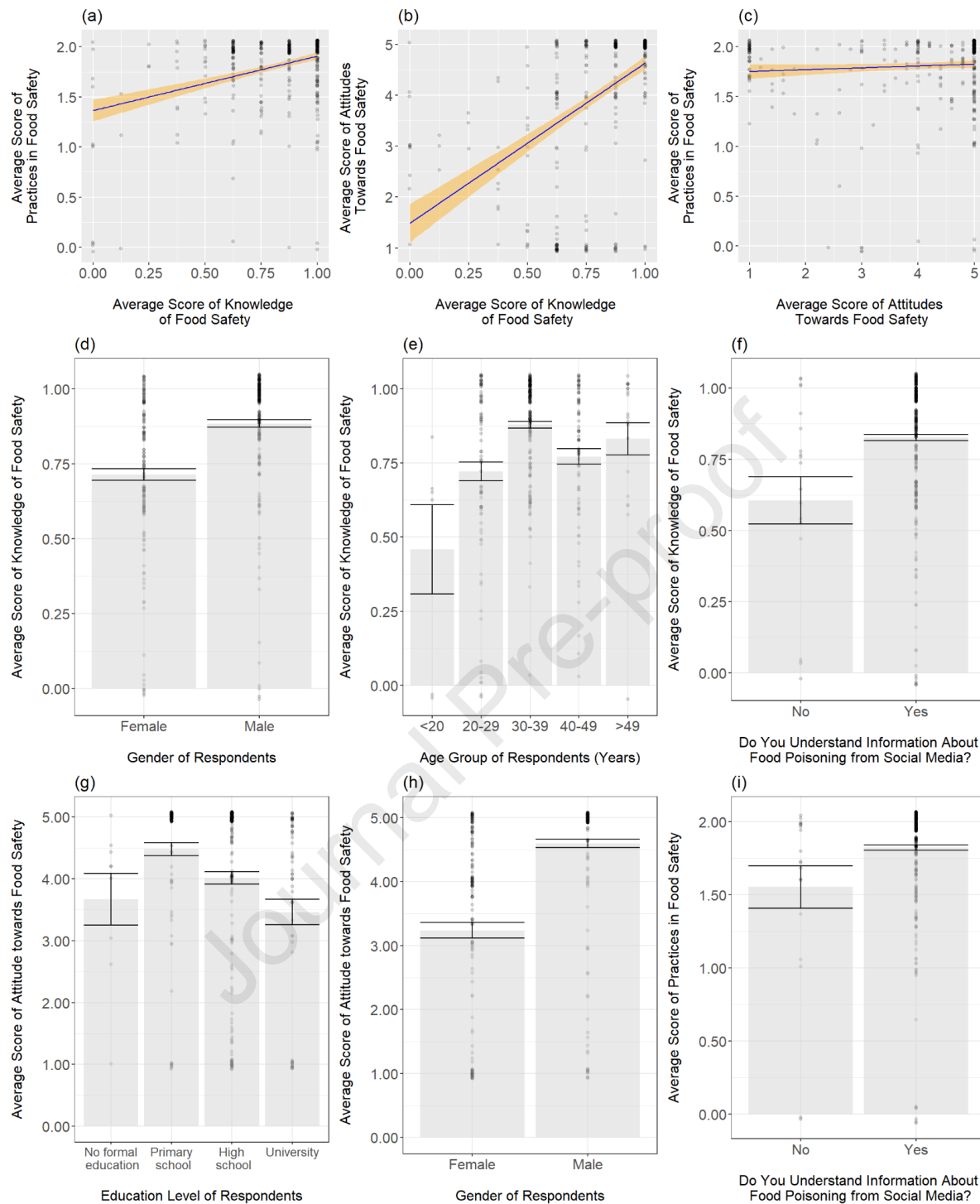
701 ³ Practices in Food Safety of Respondents

702 ⁴ Age Group of Respondents (Years)

703 ⁵ Gender of Respondents

704 ⁶ Understanding Food Safety Information from Social Media

705 ⁷ Education Level of Respondents

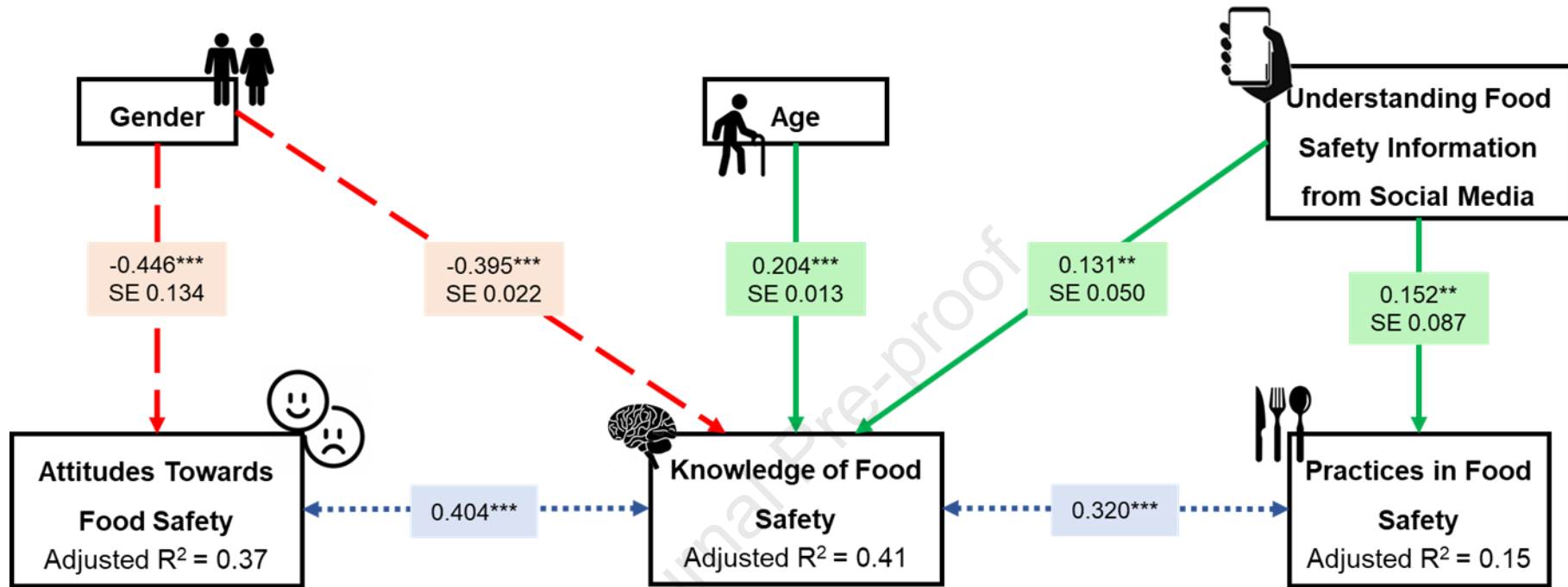


706

707 **Figure 4. Descriptive Analyses Based on the Three Linear Regression Models**
 708 **Constructed from 403 Responses.** (a) ‘Practice’ plotted against ‘Knowledge’, (b) ‘Attitude’
 709 plotted against ‘Knowledge’, (c) ‘Practice plotted against ‘Attitude’, (d) ‘Knowledge’ plotted
 710 against ‘Gender’, (e) ‘Knowledge’ plotted against ‘Age’, (f) ‘Knowledge’ plotted against
 711 ‘Understanding Food Safety Information from Social Media’, (g) ‘Attitude’ plotted against
 712 ‘Education’, (h) ‘Attitude’ plotted against ‘Gender’, (i) ‘Practice’ plotted against
 713 ‘Understanding Food Safety Information from Social Media’. Line of best fit (blue) with 90%
 714 confidence interval (orange) was plotted for (a), (b) and (c). Responses were superimposed on

715 predicted group mean (grey) and standard error of means (blue bar) for (d), (e), (f), (g), (h) and
716 (i).

Journal Pre-proof



717

718 **Figure 5. Piecewise Structural Equation Modelling for Food Safety KAP.** Arrowheads indicate the pathway of the relationship, where one
 719 variable influenced another. Green arrows with solid lines indicate a positive relationship between the two variables, red arrows with dashed lines
 720 indicate a negative relationship between the two variables whereas blue arrows with dotted lines indicate a positive correlation between the two
 721 variables. Note that the variables with binary responses were coded in such: Female/Yes=1; Male/No=0. Asterisks represent the significance levels
 722 of p-values in increasing order: *=p<0.05, **=p<0.01 and ***=p<0.001. SE indicates standard error. The adjusted R² value indicates the goodness
 723 of fit of the model, similar to R², but it charges a penalty for increasing the number of predictors in a model [47,48].

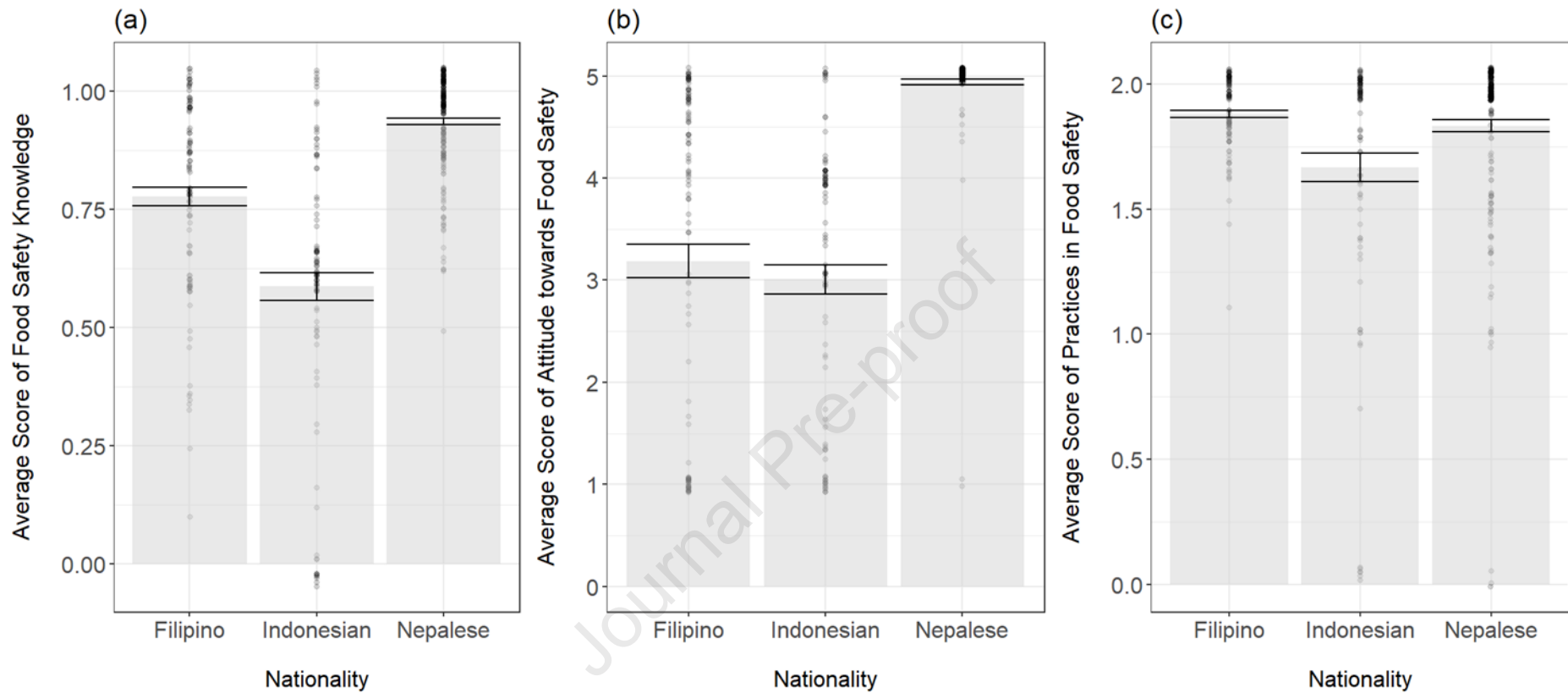
724 **Table 3. Multinomial Regression Model for Nationality.** Selection of the final model was based on the lowest AIC value, lowest delta AIC and
 725 highest AIC weight. ‘Nepalese’ was set as the base/reference category as Nepalese respondents had significantly higher levels of ‘Knowledge’
 726 and ‘Attitude’, based on Dunn’s test and descriptive analyses.
 727

Explanatory Variable	Indonesian		Filipino	
	Coefficient	Standard Error	Coefficient	Standard Error
Intercept	6.169	2.868	-2.941	3.259
Knowledge	-5.444	1.930	-2.446	2.006
Attitude	-1.554	0.427	-1.587	0.425
Gender (Base = Male)	4.745	0.753	2.145	0.785
Education	-0.131	0.484	1.832	0.484
Age	-0.849	0.505	0.566	0.468
Occupation				
Domestic helpers	7.657	84.303	10.909	84.303
Manufacturing	-20.482	9.748 x 10 ⁻⁶	-1.025	1.035
Plantation	-1.032	1.735	-13.689	5.800 x 10 ⁻⁴
Services	-1.706	1.035	-1.776	0.943
Years Working in Malaysia	2.032	0.834	2.003	0.882

728

729

730



731

732 **Figure 6. Comparison of Averaged Food Safety KAP Across Nationalities Based on 403 Respondents.** (a) 'Knowledge' plotted against
 733 Nationality, (b) 'Attitude' plotted against Nationality, (c) 'Practice' plotted against Nationality.

734 **Appendix**

735 **1) Additional Statistical Methodology Details**

736 Selection of the final linear regression model for PSEM was based on the highest adjusted R^2 ,
737 lowest delta AIC, highest AIC weight, and the lowest PRESS statistic. Delta AIC of <2
738 signifies that there is substantial supporting evidence for the candidate model, whereas AIC
739 weights reflect the probability of a model being the best amongst all other possible models
740 [46]. The adjusted R^2 value reflects the goodness of fit of the model and charges a penalty for
741 increasing the number of predictors in a model [47,48]. The PRESS statistic measures the
742 predictive ability of a model, with the lowest value signifying the best model [49]. The selected
743 models were also supported by the stepwise regression procedure with the stepwise selection
744 technique. Predictors were added sequentially, ensuring that each predictor met the preselected
745 significance level ($p\text{-value}<0.05$) until all predictors in the model met this criterion and all
746 those outside did not [48]. All models had a VIF < 5 , indicating the absence of any
747 multicollinearity [51].

748 To assess whether the PSEM fit the data well, the comparative fit index (CFI), Tucker–Lewis
749 index (TLI) and standardized root mean square residual (SRMR) were obtained. TLI allows
750 for comparisons between the proposed and null model whilst CFI, more specifically, measures
751 the improvement in non-centrality between the two models [57]. SRMR assesses the extent to
752 which the sample variance-covariance data fits the PSEM [57].

753

754

755 **2) Additional Results**

756 **Table A1. Top Three Regression Models.** The final regression models used for piecewise
 757 structural equation modelling are highlighted in yellow. Selection of the final model was based
 758 on the highest adjusted R^2 , lowest delta AIC, highest AIC weight, and the lowest PRESS
 759 statistic. The selected models were also supported by the stepwise regression procedure with
 760 the stepwise selection technique. All models had a variation inflation factor (VIF) < 5 ,
 761 indicating the absence of any multicollinearity.

Linear Regression Models	Adjusted R²	Delta AIC	AIC weight	PRESS Statistic	VIF
Response Variable: Knowledge					
Knowledge ~ age + Attitude + Practice + Sex + Understand.Social.Media	0.3929	0.00	0.221	13.52	1.67
Knowledge ~ age + Attitude + Education + Practice + Sex + Understand.Social.Media	0.3926	1.24	0.118	13.57	1.67
Knowledge ~ age + Attitude + Practice + Sex + Occupation + Understand.Social.Media	0.3974	1.30	0.115	13.55	1.70
Response Variable: Attitude					
Attitude ~ Education + Knowledge + Practice + Sex	0.3555	0.00	0.211	544.97	1.57
Attitude ~ Education + Knowledge + Sex	0.3508	1.56	0.097	548.23	1.55
Attitude ~ age + Education + Knowledge + Practice + Sex	0.3539	1.79	0.086	548.28	1.57
Response Variable: Practice					
Practice ~ Attitude + Knowledge + Understand.Social.Media	0.1266	0.00	0.127	50.47	1.15
Practice ~ Attitude + Knowledge + Understand.Social.Media + Education	0.1279	0.46	0.101	50.49	1.15
Practice ~ Attitude + Knowledge + Understand.Social.Media + Sex	0.1260	1.33	0.065	50.59	1.16

762

763 **Table A2. Post Hoc Analysis of PSEM Model.** To assess whether the PSEM fit the data well,
764 the comparative fit index (CFI), Tucker–Lewis index (TLI) and standardized root mean square
765 residual (SRMR) were obtained.

Fit Indices	Model Value	Accepted Value
CFI	1.000	CFI > 0.9
TLI	1.022	TLI > 0.9
SRMR	0.010	SRMR < 0.05

766