

Journal Article

An understanding the food safety knowledge among food science students in Iraq

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This article is published by Emerald. The definitive version of this article is available at:
<https://www.emerald.com/insight/content/doi/10.1108/NFS-01-2022-0011/full/html>

Recommended citation:

Muhyaddin, S. and Sabir, I. (2022), 'An understanding the food safety knowledge among food science students in Iraq', *Nutrition & Food Science*, 13 May 2022. doi: 10.1108/NFS-01-2022-0011

1 An understanding the Food Safety Knowledge among Food Science Students in Iraq

5 **Abstract:**

7 Purpose

8 Food-borne diseases can be prevented with the knowledge of food safety. Food-related
9 infirmity especially in developing economy perspective such as Iraq can be addressed
10 effectively with adequate food safety knowledge. So, this study aimed to analyse the food
11 safety knowledge of Iraqi students studying in food science programs.

13 Design/methodology/approach

14 Four aspects of food safety namely the food poisoning, personal hygiene, temperature control
15 and cross contamination and cleaning were considered to understand the food safety
16 knowledge of Iraqi students. A survey of 105 Iraqi food technology students was conducted
17 to know their food safety knowledge. A structured questionnaire was made involving
18 multiple choice scales. Among the alternatives, one alternative was right and all other
19 alternatives were wrong. Respondents were asked to pick the correct answer amongst the
20 given alternatives. Correct answer given by the respondent was considered a measure of food
21 safety knowledge.

24 Findings

25 Findings of the study revealed that students had insufficient knowledge about various
26 dimensions of food safety. Students had knowledge about the food poisoning ($p<0.001$)
27 Students had partial understanding about personal hygiene wherein they had knowledge
28 about handwashing practices ($p<0.001$) and food-handling practices ($p<0.001$). Respondents
29 had knowledge about role of freezing in bacterial growth ($p<0.001$). Students only had
30 knowledge about separation of cooked and uncooked food ($p<0.001$), indicating partial
31 understanding about cross contamination and cleanliness. Both age and gender of the student
32 didn't have relationship with their food safety knowledge. The results implied that instructors
33 and tutors should stress upon the socio-cultural facets to facilitate the food safety knowledge.
34 Educators should also emphasize upon the application and laboratory demonstration of food
35 safety knowledge rather than over-emphasizing the theoretical part.

37 Originality

39 It is important to study food technology students regarding their food safety knowledge due
40 to their projected future roles as students are stipulated to perform the role of managers, food
41 handlers, trainers, experts and caterers in the future in food industry. These students are more
42 likely to influence the food safety orientations of society at large than the students belonging
43 to other educational programs. Hence, this study offered a review of food safety knowledge
44 of food technology students.

46 Key Words: Food Safety Knowledge, Food Technology Students, Food Poisoning, Personal
47 Hygiene, Food Borne Diseases.

49 1. Introduction

50 Food safety deals with the assurance that preparation, handing, serving and consumption of
51 the food would not cause harm to the individuals (WHO, 2020). Food safety has become an
52 important matter of concern for several stakeholders given the increasing number of medical
53 issues resulting from food borne diseases and ever-increasing mortality rates globally. Recent
54 estimate of WHO (World Health Organization) pegs the global mortality number at 4, 20,
55 000 people per year due to consumption of contaminated food (World Health Organization,
56 2020). So, knowledge of food safety becomes essential to comprehend not only for the policy
57 makers and regulators, but also for the consumers to limit the effect of food-borne diseases.
58 Ozilgen (2011) asserts that various stages including the preparation, transforming, treating
59 and disposing of food have the probability of contamination. Improper handling of food at
60 any of the stages might cause the outbreak of the food-borne of the disease. Moreover, factors
61 such as personal hygiene of the food handlers and knowledge about important parameters
62 including the temperature, cutting surfaces, cleansing material, cross-contamination and
63 cleanliness also affect the food safety (Gursoy, 2019). Several researchers asserted that
64 consumers had inadequate food safety knowledge that ultimately led towards food-borne
65 diseases (Da Costa, Akutsu, Gallo and Araújo, 2016). Knowledge of food safety not only
66 increases the consumers' knowledge and education by offering relevant food-safety related
67 insights, but also has the capability to avert the advance of food-borne diseases (Leib and
68 Pollans, 2019). So, understanding knowledge of food safety becomes imperative in a
69 developing country perspective such as Iraq.

70

71

72 Although gulf countries including Iraq have very limited published data on food borne
73 diseases; still their concern for food safety is a well-established public health agenda (World
74 Health Organisation, 2020). Decades old military conflicts have left the food infrastructure of
75 the Iraq in a very troubled state; that Iraqi government is aiming to restore by emphasizing on
76 food safety culture in the country. The country has also realized the importance of
77 educational institutes especially the universities in fostering the food safety knowledge and
78 has started offering various food safety courses (WHO EMRO | Food safety | Programmes |
79 Iraq, 2019). Studies conducted by researchers like Mahmoud and Ghanem (2016) and
80 Banawas (2019) highlighted the inadequate food safety provided by the educational institutes
81 wherein researchers also fostered the belief that inclusion of food safety in the curriculum
82 would not only enhance the understanding of the students about the food safety practices, but
83 also result in application of hygienic food practices and reduction in food poisoning issues.

84

85 Food safety knowledge has been area of interest for researchers across the globe with diverse
86 set of respondents like chefs, mangers, employees, food vendors and the general public
87 (Howells et al. 2008; McCarthy et al. 2007; Angelillo et al. 2001). However, lesser number of
88 researchers chose students as the primary respondents. Majority of the studies conducted with
89 student respondents report lack of food safety knowledge amongst students (Smigic, Lazarov,
90 and Djekic, 2020; Osaili et al. 2011; Mahmood et al. 2018; Byrd-Bredbenner et al. 2007;
91 Smigic, Lazarov and Djekic, 2020). Researchers also opined student were engaged in risky
92 health behaviours (Garayoa et al. 2005). In their food safety-oriented study conducted with
93 Jordanian female students, Osaili et al. (2011) contended that only one third students
94 possessed the food safety knowledge regarding its various aspects such as cross-
95 contamination, optimal food temperature, food-borne diseases, and origin of food-borne
96 micro-organisms especially the pathogens. The study also validated a relationship between
97 educational qualifications of the students with food safety awareness. Other researchers also
98 observed the relationship of various demographic variables namely the age, experience,

99 gender and educational qualifications with the food safety awareness (Iqbal, Choiriyah, and
100 Setyorini, 2018; Osaili et al. 2011). McNeilly and Raming (2018) highlighted the limited
101 knowledge of students about personal hygiene in their student centric study. Muhammad,
102 Nurul Aziz and Inma Yunit (2018) while studying the food safety knowledge of students in
103 Indonesian context observed that students had poor knowledge about food storage. Obande
104 and Young (2020) concluded that students had improper knowledge of ideal temperature
105 required for storage.

106
107 However, majority of the studies **had** been conducted with student respondents of different
108 courses such as medical science, humanities, hospitality, health and nutrition etc. Very few
109 studies **focused** upon food technology students. It is important to study food technology
110 students regarding their food safety knowledge due to their projected future roles as students
111 are stipulated to perform the role of managers, food handlers, trainers, experts and caterers in
112 the future in food industry. Their food safety understanding will have a remarkable impact on
113 food borne diseases. These students are more likely to influence the food safety orientations
114 of society at large than the students belonging to other educational programs. **So, the primary
115 objective of our study aimed to understand the food safety knowledge among food science
116 students in Iraq. There were limited number of food safety studies in emerging countries like
117 Iraq especially with food safety students; forming another pressing reason to conduct this
118 study. Second objective of the study dealt with understanding the association between the
119 knowledge of food safety and demographics of the students. The exploration of food safety
120 knowledge of food technology student would highlight their understanding towards various
121 dimensions of food safety and would have important implications for students, universities,
122 food industry and regulators.**

123 124 **2. Materials and methods**

125 2.1. Subjects' selection and recruitments

126
127 The study was designed to understand the food safety knowledge of students belonging to
128 food technology programs in Iraq. The Ethical approval for this survey was considered by
129 Cardiff School of Sport and Health Sciences under the Cardiff Metropolitan University Ethics
130 Framework. It was approved on 23/01/2020 with reference number of PGT-2517. In order to
131 conduct the study, a survey of 105 students attending Food Science and Technology
132 programs in Iraq was conducted. **Participants in the study were included using non-
133 probability sampling. Convenience sampling technique was used by the researcher to recruit
134 the participants. Participants were informed about the objectives of the study before
135 completion of the survey. Their participation in the study was voluntary and were allowed to
136 leave the research at any point of time without assigning the reason.**

137 138 2.2. Questionnaire

139
140 Study of available literature helped researcher to identify the four main domains of food
141 safety knowledge, researched the most by the well-known researchers. The areas **were** food
142 poisoning, personal hygiene, temperature control and cross contamination and cleaning. The
143 present study also considered these four aspects to understand the food safety knowledge of
144 Iraqi students. A structured questionnaire was made after taking substantial cues from the
145 accessible literature. Various statements were framed catering to each dimension of food
146 safety. Structured questionnaire involving multiple choice scales, were employed in the study
147 wherein respondents were supposed to pick the correct answer amongst the given

148 alternatives. Among the alternatives, one alternative was right and all other alternatives were
149 wrong. Correct answer given by the respondent was considered a measure of food safety
150 knowledge. The questionnaire was validated by initially administered to only 16 food
151 technology students and appropriate changes were made to the questionnaire based upon the
152 initial testing of the questionnaire. Thornhill, Saunders and Lewis (2009) advocate the initial
153 testing of the questionnaire with few respondents to eliminate the uncertainty and making the
154 questionnaire understandable for the target respondents. The final scale included a total of 20
155 questions referring to the diverse aspects of food safety.

156
157

158 Food Safety Knowledge Scale

159

160 The final questionnaire was sent (to distribute) using online mode using Qualtrics web
161 services from 8th of July 2020 to 17th of August 2020. Questionnaire was sent to 500 food and
162 technology students wherein they were required to fill the questionnaire measuring food
163 safety knowledge. After the stipulated time of research, a total of 117 filled questionnaires
164 were obtained. After dealing with missing responses, total 105 respondents were considered,
165 which also constitutes the final sample size for the present study.

166

167 2.3. Statistical analysis

168

169 Statistical Package for the Social Sciences version 25.0 (SPSS) was used to analyse the data.
170 Frequency tables were used to report the descriptive results of the study related to various
171 aspects of food safety knowledge. Correct option for each statement was coded as 1 and all
172 incorrect answers were coded as 0 as adopted by Choiriyah and Setyorini (2018) in their food
173 safety study conducted with nutrition students in Indonesia. This resulted in only two
174 possible outcomes namely the correct and incorrect answers. In order to see the statistical
175 significance of the results, one sample binomial test was employed at 5% level of
176 significance. The most common non-parametric test of association i.e., Chi-square, was
177 applied as test of significance to see the relationship between students' demographics and
178 food safety knowledge.

179 3. Results

180

181 3.1. Demographic characteristics of study participants

182

183 Data for the study were obtained from the respondents including both female and male
184 respondents associated with diverse age brackets. The female respondents composed 55% of
185 the sample whereas male respondents represented 45% of the sample. Respondents belonging
186 to 25-49 years age bracket were slightly over represented in the sample as they constituted
187 58% of the sample in comparison to 42% representation by the respondents belonging to 18-
188 24 years age bracket.

189

190 Both the variables namely age and gender were included in the study to see the relationship
191 of chosen variables with the food-safety knowledge. The results of association have been
192 displayed later in the study.

193

194 3.2 Food Safety Knowledge

195

196 As discussed in the literature review, the most common dimensions dealing with knowledge
197 of food safety used by majority of the researchers **were** personal hygiene, food poisoning,
198 cross-contamination and cleaning and temperature control. The section below gives the
199 details of student knowledge about each aspect of food safety knowledge.

200

201 3.2.1 Food Poisoning

202 Food poisoning dimension of food safety was measured with the help of five questions.
203 Students' knowledge about food poisoning has been displayed in Table I. This can be seen
204 from the Table I for none of the statement, complete understanding was not obtained.
205 Respondents had an average knowledge related to the symptoms of food poisoning (FP3)
206 and origin of bacteria leading towards food poisoning (FP4). 79% students had correct
207 knowledge of most common food poisoning symptom i.e. Diarrhoea. However, it was
208 remarkable to note that 21% respondents were having incorrect understanding about the
209 most common food poisoning symptoms and believed that constipations, rashes, and
210 headache were the most prominent indications for food poisoning. 71% respondents
211 possessed correct knowledge about origin of bacteria leading towards food poisoning at the
212 manufacturing sites and were aware about the fact that hygiene level of food handlers,
213 uncooked food and insects were the most common sources of bacteria. However, students
214 didn't possess correct knowledge about the activities of food-related bacteria at body heat
215 temperature. 49% students accurately acknowledged that activity of food-related bacteria
216 by asserting that such bacteria develop rapidly at body heat temperature. Students could not
217 correctly determine the characteristic temperature facilitating the development of bacteria
218 i.e. food-borne pathogens. Only 22% students correctly picked up the 4 °C option as typical
219 temperature for the growth of food-borne bacteria in comparison to 49% of the respondents
220 choosing 25°C as the typical temperature. Students also exhibited average understanding
221 about the most common method of examining the food item or potential contamination due
222 to food-poisoning bacteria. A good majority of the students i.e. 68% assumed that activities
223 such as smelling, tasting, and looking at food; **could** help an individual in examining the
224 food item against probable contamination due to food- poisoning bacteria. Merely 35%
225 students knew that such activities were not the most effectual examination methods for
226 plausible food-poisoning.

227 **One sample binomial test was applied to examine the statistical significance of the results.**
228 **This can be observed from the Table I significant results ($p < 0.001$) were obtained for all the**
229 **statements except FP5, but student could give correct answers for only two aspects of food**
230 **poisoning namely the symptoms and origin of bacteria. So, it was contemplated that food**
231 **technology students in Iraq had partial understanding about food-poisoning aspect of food**
232 **safety.**

233 3.2.2 Personal Hygiene

234

235 Six statements were used to measure the personal-hygiene dimension of food safety.
236 Students' knowledge about personal hygiene has been displayed in Table II. Complete
237 understanding was not obtained for any of the statement. However, Table II displays the
238 results that students possessed average understanding about hand-washing practices (PH1)
239 and food-handling practices (PH4). A good majority of the students i.e. 73% students
240 acknowledged that hands must be washed after handling raw food, caressing hair and using
241 the toilet. The results exhibit satisfactory hand-washing practices among food and
242 technology students. Another good majority of the students i.e., 66% acknowledged that
243 wearing make-up, earrings, and finger-rings must be avoided while handling foods in
244 manufacturing sites. However, students didn't exhibit adequate understanding about the
245 circumstances involving injuries like finger cuts in manufacturing settings. A little more
246 than majority i.e., 52% students correctly answered that an individual can keep on working
247 and handle the food-items after covering finger-cut injuries with noticeable plaster.
248 However, there were 36% students who believed that individuals with finger-cut injuries
249 should neither handle the food-items nor enter the kitchen premises. There were 7% of the
250 students who believed that raw food might be handled with a finger-cut injury. 5% students
251 didn't possess knowledge about circumstances involving finger-cut injuries. Less than 50%
252 of the students i.e., 42% had adequate understanding about the food items causing
253 *Salmonella* contamination wherein they acknowledged that meat and chicken were the
254 prominent food items associated with such contamination. A little more than majority i.e.,
255 56% students believed that other food items such as fishes, dairy objects and eggs were
256 primarily accountable for *Salmonella* contamination. 2% students didn't possess any
257 knowledge about the food-items causing *Salmonella* contamination.

258 Students possessed really low understanding about catering kitchen. There were only 5%
259 students who believed that one must wear a special clothing or protective jacket while
260 entering in the kitchen area. 95% of students didn't have correct understanding about wearing
261 protective jackets. They either didn't simply possess any understanding about protective
262 wears in the kitchen area or believed that shoes and gloves should be worn along with
263 protective wear while entering kitchen. Students also didn't have adequate level of
264 understanding about the circumstances involving food-poisoning of employees. Less than
265 majority i.e., 45% of the students understood the fact that an individual must not enter in the
266 kitchen area if he/she suffers from cold and diarrhoea. However, 43% students considered
267 entering kitchen area as appropriate for a person having cold and diarrhoea if latter covers
268 his/her face and doesn't handle the raw food directly. 12% students remained unsure about
269 such situations and didn't possess any understanding about handling such circumstances.

270

271 One sample binomial test was applied to ascertain the statistical significance of the results
272 obtained. This can be observed from the Table II that although significant results ($p < 0.001$)
273 were obtained statements PH1 and PH5 of personal-hygiene. However, students could
274 correctly answer only questions dealing with handwashing practices. So, on the basis of
275 significant results obtained, it can be stated that food technology students in Iraq had partial
276 understanding about personal-hygiene aspect of food safety knowledge.

277
278
279

3.2.3 Temperature Control

280 Three statements were used to measure students' knowledge about temperature control.
281 Table III displays the students' knowledge about temperature control. Complete
282 understanding was not observed for any of the statement. Students were found to have
283 understanding about optimal freezing temperature (TC1) and role freezing plays in curbing
284 the spread of bacteria (TC2). Ideal temperature of a refrigerator is known to be 5°C or
285 below. 64% food technology students possessed this information as per current study. 66%
286 of the students also knew about the fact that freezing stops the bacterial growth in food.
287 However, 34% students possessed wrong information about the role of freezing towards
288 bacterial growth wherein 18% students thought that bacteria grow at a slower rate due to
289 freezing, 12% students believed that freezing results in death of bacteria and 4% students
290 believed that freezing of food results in bacterial growth.

291 However, students didn't possess enough knowledge about the optimal temperature of hot
292 food. Only 48% students were aware of the fact that optimal temperature for hot food is
293 above 63°C. 41% students wrongly identified the ideal temperature for hot food. There were
294 11% students who didn't know about the ideal temperature for hot food.

295 **One sample binomial test was applied to determine the statistical significance of the results**
296 **attained. This can be observed from the Table III that significant results ($p < 0.001$) were**
297 **obtained only for one statement i.e., TC2, dealing with role of freezing in bacterial growth.**
298 **So, on the basis of significant results obtained, it can be stated that food technology students**
299 **in Iraq possessed partial understanding about temperature-control aspect of food safety**
300 **knowledge.**

3.2.4 Cross Contamination and Cleaning

301

302 Students' knowledge about Cross Contamination and Cleaning was studied with the help of
303 six statements. Table IV displays the results of students' knowledge about cross
304 contamination and cleaning. Complete understanding was not obtained for any of the
305 statement. Students were found possessing knowledge only about separation of cooked and
306 uncooked food (CC1). 65% students had the understanding that uncooked and cooked foods
307 should be segregated to prevent the bacterial transfer. Students lacked in their knowledge
308 about the optimal cutting platforms, disinfecting the kitchen surface, disinfecting hands after
309 handling food and usage of different kitchen knives. Only 19% students held the knowledge
310 that kitchen surfaces should be cleaned with the help of disinfectants as latter is the best
311 cleaning agent for eradicating bacteria. Majority of the students resorted to traditional
312 cleaning methods such as using boiled water (considered appropriate by 42%), detergent
313 (considered suitable by 21%) and scrub brush (considered right by 9%). However, there
314 were 8% of the students who didn't know about the best method to disinfect the kitchen
315 surface. Only 12% of the students in the study acknowledged that plastic was the best
316 cutting surface. Rest others remained misinformed about the optimal cutting surfaces and
317 considered glass (chosen as ideal cutting surface by 32%), steel (preferred by 31%) and
318

319 wood (considered appropriate by 21%). There were 3% students who didn't know about the
320 best cutting surface.

321 Students didn't possess adequate knowledge about handling the cutting surfaces. 34% of the
322 students correctly answered that cutting surface must be cleaned with hot water, soap and
323 disinfectant after cutting raw chicken and meat. Majority students i.e., 58% thought that
324 cutting surfaces must be either cleaned with hot water and soap or replaced after usage. 4%
325 students believed mopping cutting platform with wipes and disinfectant an ideal practice.
326 There were 5% students who didn't have any knowledge about handling cutting surfaces.
327 Students were found possessing inadequate knowledge related to knives' usage. Less than
328 majority i.e., 37% of the students had the knowledge that ideally separate knives must be
329 used if one wishes to cut vegetables after cutting chicken and raw meat. Majority of the
330 students i.e., 56% believed that there was no harm in using the same knife after washing it.
331 There were 7% of the students who didn't know anything about use of knife after cutting
332 chicken and meat. Students were also found possessing little knowledge about disinfecting
333 hands after dealing with cooked foods. Less than majority students i.e., 33% correctly
334 identified that hands should be cleaned with hot water, soap and disinfectant. 45% students
335 wrongly identified that cleaning hands with hot water and soap was adequate. 12% of the
336 students believed that wiping hands with napkins was an adequate practice after handling
337 cooked food. 8% students thought cleaning hands with cold water and soap made a healthy
338 hand disinfecting practice. 2% students in the study had no knowledge about the ideal hand
339 disinfecting practice after handling cooked food items.

340
341 **One sample binomial test was used to conclude the statistical significance of the results.**
342 **This can be observed from the Table IV significant results ($p < 0.001$) were obtained for**
343 **three statements of cross-contamination and cleaning. However, students had correct**
344 **knowledge about only one aspect dealing with segregation of uncooked and cooked food**
345 **items. So, on the basis of significant results obtained, it can be ascertained that food**
346 **technology students in Iraq had partial understanding related to cross contamination and**
347 **cleaning aspect of food safety knowledge.**

348 **Overall, results of the study** revealed that students didn't possess complete knowledge about
349 any dimension of food safety. Statistical results were found significant for two dimensions
350 namely the food poisoning and cross contamination and cleaning. However, descriptive
351 results for both the factors revealed that majority respondents correctly answered only two
352 questions of food poisoning dealing with symptoms of food poisoning and sources of food
353 poisoning. Students also correctly answered the question related to separation of cooked and
354 uncooked food under the cross contamination and cleaning dimension of food safety. Partial
355 statistical significance was obtained for other factors namely the personal hygiene and
356 temperature control. Descriptive statistics revealed that students correctly answered
357 questions dealing with hand washing and food handling practices of personal hygiene.
358 Students also possessed knowledge about the freezing temperature and its role in checking
359 bacterial growth. So, it can be concluded that students had knowledge about the symptoms

360 and sources of food poisoning. Food science students were also aware of the fact that cooked
361 and uncooked food should be kept separate. Students also possessed knowledge about
362 personal hygiene practices especially about washing hands and avoiding putting make-up
363 and wearing jewellery in manufacturing setting. Students had knowledge about the optimal
364 refrigerator temperature and role of freezing in bacterial growth. So, the results of the study
365 **revealed** that students of food science program in Iraq had partial knowledge of food safety.

366 3.3 Students' Demographics and Food Safety Knowledge

367

368 The present study also wished to ascertain the relationship if any between the food safety
369 knowledge and students' demographics i.e., age and gender. As both the variables dealt with
370 categorical variables, the most common test of association i.e., chi-square test, was applied to
371 determine the relationship between two variables. As stated earlier, this study **considered** the
372 four aspects of food safety knowledge; the relationship of student demographics was
373 observed individually with each aspect. Table V presents the results of association between
374 food safety knowledge and students' demographics.

375 This can be inferred from Table V that no association was found between the gender of the
376 student and food safety knowledge. Insignificant results of association were obtained for all
377 four aspects of food safety. Age of the students, was also not found significant for any of any
378 other aspect of food safety. The study concluded that students' gender had no association
379 with food-safety knowledge wherein both male and female food technology students didn't
380 differ in their possession of knowledge towards food safety. Age of the students also didn't
381 associate significantly with the food safety knowledge of food technology students.

382

383 4. Discussion of the Findings

384 The study concluded that food science students in Iraq didn't possess complete knowledge
385 about the food safety. However, amongst all the food safety's aspects, they had
386 comparatively superior knowledge about food poisoning. Students displayed good level of
387 understanding about the origin of food poisoning bacteria and symptoms of food poisoning.
388 However, their understanding about the personal hygiene and cross contamination was not
389 really motivating. Osaili et al. (2011) in their student centric study **offered** different results
390 from this study wherein they **claimed** the students to be more knowledgeable about the cross-
391 contamination and least knowledgeable about food-borne pathogens. The difference in results
392 of both the studies **could** be understood by looking at the sample composition of both the
393 studies whereby Osaili et al. (2011) based their results on the basis of homogenous sample
394 comprising of female students from Jordan only whereas present study **catered** to the more
395 heterogeneous sample comprising of both female and male student respondents. Moreover, as
396 Osaili et al. (2011) only considered female respondents in their study and they were assigned
397 to kitchen cleaning duties since their childhood; this also **accounted** for their enhanced
398 understanding about the cross-contamination of the food.

399

400 79% food science students in Iraq displayed good level of knowledge about the symptoms of
401 food poisoning. 71% food technology students also accurately recognized the origin of food
402 poisoning bacteria in the manufacturing settings. The results **corroborated** well with the

403 earlier study conducted by **Mahmood et al. (2018)** whereby it was validated in the study that
404 majority students in Malaysia, possessed knowledge of food poisoning. The present study
405 also confirmed the fact that food technology students in Iraq have good level of personal
406 hygiene awareness wherein 73% food technology students acknowledged the importance of
407 hand-washing practices and 66% students knew about evading make up and jewellery in
408 manufacturing sites. Study conducted by Smigic, Lazarov and Djekic (2020) also
409 acknowledges superior knowledge of hand-washing practices by students wherein **95%** of the
410 students claimed washing their hands after using toilets. The difference in less number of
411 students possessing personal hygiene knowledge (i.e., **95% vs. 73%** in present study) **could**
412 be explained by the fact that present study aimed to determine the importance of hand
413 washing after using toilets, touching hair and raw food, rather than simply using toilets.
414 Students' knowledge about hand washing practices could be attributed to the learning of the
415 students' related to personal hygiene practices particularly washing and cleaning hands since
416 their childhood.

417
418 The study also **highlighted** the fact that food science students had knowledge about freezing
419 temperature and the role freezing **played** in curbing the growth of bacteria. 64% students in
420 the present study knew about ideal refrigerator temperature and 66% students knew about the
421 role freezing plays in curbing bacterial growth. The findings of the present study **differed**
422 from the earlier study undertaken by **Smigic, Lazarov and Djekic (2020)** wherein a lesser
423 percentage of students i.e., **13%**, were found possessing the information about ideal
424 refrigeration temperature. The results also **differed** from the study conducted by Ovca,
425 Jevšnik and Raspor (2014) wherein students possessed inadequate knowledge about role of
426 temperature on microorganism growth. However, the findings of the present study
427 **corroborated** well with the recent study conducted by Obande and Young (2020) wherein
428 majority students i.e. 56% were found possessing the correct knowledge about ideal
429 refrigeration temperature. The enhanced knowledge about the ideal refrigeration temperature
430 and freezing role **could** be attributed to the superior packaging and labelling of food products.
431 The contemporary packaging and labelling of food items contain vital information printed
432 over the food packages; that helps individual knowing the ideal refrigeration temperature.
433 Moreover, curriculum of food technology programs might play a significant role in
434 improving the knowledge about ideal refrigeration temperature.

435
436 Food technology students in Iraq didn't have sufficient understanding about wearing
437 protective wears while entering the kitchen area, circumstances involving food-poisoning and
438 finger injuries of employees. Food technology students in Iraq also lacked in their knowledge
439 about the optimal cutting platforms, disinfecting the kitchen surface, disinfecting hands after
440 handling food and usage of different kitchen knives. Study conducted by Serrem et al. (2021)
441 also studied the finger injury issues in manufacturing settings whereby 86% students knew
442 that that finger cuts could act as a significant basis of food-borne diseases. However, this
443 study dealt with the students' response towards dealing with finger cuts or injuries whereby
444 52% students purported that finger cuts must be enclosed with noticeable plaster. Food
445 technology students in Iraq exhibited very low level of understanding towards wearing
446 protective wears whereby only 5% students acknowledged the significance of wearing such
447 protective wears. The findings of present study were different from the study undertaken by
448 Osaili et al. (2011) whereby 45% students acknowledged the relevance of protective wears in
449 manufacturing settings. Multiple explanations can be given to explain the difference in
450 results. One possible explanation might be the difference in cultural orientations. Culture
451 especially beliefs, customs and traditions might play a substantial role in shaping such

452 practices. Another explanation lies in the teaching pedagogy of the universities wherein one
453 might find the omission of these relevant topics from the curriculum and less emphasis given
454 to such topics by the teachers and trainers. On the whole, it can be concluded that food and
455 technology students in Iraq possessed inadequate knowledge about food safety. The findings
456 of present study **correlated** well with the recent studies conducted by Iqbal, Choiriyah and
457 Setyorini (2018), Jeinie, Nor, Saad and Sharif (2017).

458

459 The present study also wished to determine the relationship of students' demographics with
460 food safety knowledge wherein both age and gender didn't were insignificant in explaining
461 the said association. The findings of present study were consistent with the previous studies
462 conducted by Tegegne and Phyo (2017) and **Marsin and Azis (2021)** wherein both the studies
463 couldn't determine any association between age and knowledge of food safety. However,
464 results of the present study differed from the findings of the study conducted by Alqurashi,
465 Priyadarshini and Jaiswal (2019) wherein they validated the association between the age and
466 food safety knowledge. **The different results of the present study can be explained by
467 appreciating the fact that presents study considered the food safety students whereas
468 Alqurashi, Priyadarshini and Jaiswal (2019) explored the food safety knowledge of service
469 staff, wherein with increasing age, employee experience taught them more knowledgeable
470 about food safety.**

471

472 **5. Conclusion**

473

474 The present study intended to examine the food safety knowledge of food technology
475 students in Iraq. The study also aimed to identify the association of students' demographics
476 with food safety understanding. Students' knowledge was measured towards four aspects of
477 food safety namely the food poisoning, personal hygiene, temperature control and cross
478 contamination and cleaning. **The study concluded that students possessed insufficient
479 understanding about all four aspects of food safety. Complete understanding was not
480 observed for any of the food safety dimension.** Students had comparatively enhanced
481 knowledge of aspects namely the temperature control and food poisoning. Students had
482 comparatively compromised understanding about other two aspects namely the cross
483 contamination and cleanliness and personal hygiene. Students exhibited absolute low level of
484 understanding towards kitchen catering whereby food technology students did not appreciate
485 the relevance of protective wears while entering in the kitchen area. Likewise students'
486 understanding regarding ideal kitchen surface, usage of knives and disinfecting the kitchen
487 platforms was not adequate. Age and gender of the student didn't associate with food safety
488 knowledge. The results of the study conclude the inadequate level of food safety knowledge
489 of food technology students.

490 This study **recognized** the current and future role of the food technology students in affecting
491 the food safety culture in Iraq and advocate for the modern teaching and training practices to
492 offer the essential information to the students. The study **suggested** instructors and tutors to
493 emphasize upon the socio-cultural facets to facilitate the food safety knowledge. **Educators
494 should also emphasize upon the application and laboratory demonstration of food safety
495 knowledge rather than over-emphasizing the theoretical part. Perhaps universities that deliver
496 such programs could seek international cooperation with leading schools worldwide to
497 understand further how they could empower their delivery method within food technology
498 programs.**

499

500 **6. Limitations and Future Directions**

501 The present study **suffered** from multiple limitations demanding specific mention. The study
502 undertook a quantitative methodology and made use of a close-ended questionnaire. As
503 generally the quantitative studies include the self-reported actions or behaviours of the
504 selected respondents; the present study also **offered** its results on the basis of self-reported
505 behaviour of the students. It might be possible to observe the difference between the stated
506 and actual behaviour of the food technology students. Other researchers might use an
507 observational study to obtain more genuine results. They might also think about using
508 qualitative research to get improved insights about the food safety behaviour. The study **used**
509 low level scale i.e. multiple choice questions, which also **formed** one more limitation of the
510 present study. Lower level scale restricts the statistical analysis capabilities and accounts for
511 the complicated interpretation of the results. Other researchers **might employ higher** order
512 scales for enhanced statistical investigation. The study used the non probability sampling
513 technique to collect the relevant information from the sample respondents. Probability
514 sampling is considered superior for better representing the population. So, other researchers
515 are recommended to use probability sampling while conducting the research. Smaller sample
516 size of the study i.e. **105 respondents was another limitation. Study sampling greater number**
517 **of individuals might offer different results.** While studying the association of students'
518 demographics with food safety knowledge, only two demographic factors were used. This
519 **restricted** the complete interpretation of students' demographics. Other researchers must
520 consider a holistic demographic profile of respondents by considering factors such as family,
521 income, education, etc. Socio-cultural background of the students must also be given more
522 attentions and factors like culture, attitude, perception etc. must be studied to know the
523 impact on food safety knowledge of the students.

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Table I
Food Poisoning Knowledge

Dimension of Food Safety	Statement	Response	n (%)	Test of Significance	p value
Food Poisoning (FP)	FP1	Incorrect	56 (53.3)	One Sample Binomial Test	< 0.001
		Correct	49 (46.7)		
	FP2	Incorrect	82 (78.1)		< 0.001.
		Correct	23 (21.9)		
	FP3	Incorrect	22 (20.9)		< 0.001
		Correct	83 (79.1)		
	FP4	Incorrect	30 (28.6)		< 0.001
		Correct	75 (71.4)		
	FP5	Incorrect	68 (64.8)		0.002
		Correct	37 (35.2)		

Note: Bold responses represent the correct answers with n=105
One sample binomial test sig. level was applied to see whether proportion of variable i.e. correct response, in population equals the observed value.

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26 **Table II**

27 Personal Hygiene Knowledge

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Dimension of Food Safety	Statement	Response	n (%)	Test of Significance	p value
Personal Hygiene (PH)	PH1	Incorrect	28 (26.7)	One Sample Binomial Test	< 0.001
		Correct	77 (73.3)		
	PH2	Incorrect	60 (57.1)		0.143
		Correct	45 (42.9)		
	PH3	Incorrect	50 (47.6)		0.626
		Correct	55 (52.4)		
	PH4	Incorrect	36 (34.3)		0.001
		Correct	69 (65.7)		
	PH5	Incorrect	100 (95.2)		< 0.001
		Correct	5 (4.8)		
	PH6	Incorrect	58 (55.2)		0.283
		Correct	47 (44.8)		
<p>Note: Bold responses represent the correct answers with n=105 One sample binomial test sig. level was applied to see whether proportion of variable i.e. correct response, in population equals the observed value.</p>					

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32 **Table III:**

33 Temperature Control Knowledge

Dimension of Food Safety	Statement	Response	n (%)	Test of Significance	p value
Temperature Control (TC)	TC1	Incorrect	38 (36.2)	One Sample Binomial Test	0.005
		Correct	67 (63.8)		
	TC2	Incorrect	36 (34.3)		< 0.001
		Correct	69 (65.7)		
	TC3	Incorrect	55 (52.4)		0.626
		Correct	50 (47.6)		

Note: Bold responses represent the correct answers with n=105

One sample binomial test sig. level was applied to see whether proportion of variable i.e. correct response, in population equals the observed value.

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37 **Table IV**

38 Cross-Contamination and Cleaning Knowledge

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Dimension of Food Safety	Statement	Response	n (%)	Test of Significance	p value
Cross-Contamination and Cleaning (CC)	CC1	Incorrect	37 (35.2)	One Sample Binomial Test	< 0.001
		Correct	68 (64.8)		
	CC2	Incorrect	85 (81.1)		< 0.001
		Correct	20 (18.9)		
	CC3	Incorrect	92 (87.6)		0.002
		Correct	13 (12.4)		
	CC4	Incorrect	69 (65.7)		< 0.001
		Correct	36 (34.3)		
	CC5	Incorrect	66 (62.9)		0.008
		Correct	39 (37.1)		
	CC6	Incorrect	70 (66.7)		0.001
		Correct	35 (33.3)		

Note: Bold responses represent the correct answers with n=105
 One sample binomial test sig. level was applied to see whether proportion of variable i.e. correct response, in population equals the observed value.

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43 **Table V**
 44 Students' Demographics and Food Safety Knowledge
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Statements		Gender		Test of Significance	Age		p value
		Male	Female		18-24	25-49	
		Number	Number		Number	Number	
FP1	Incorrect	40	53	0.315	40	53	0.523
	Correct	7	5		4	8	
FP2	Incorrect	37	45	0.889	33	49	0.515
	Correct	10	13		11	12	
FP3	Incorrect	10	12	0.941	16	6	0.001
	Correct	37	46		28	55	
FP4	Incorrect	16	14	0.264	13	17	0.851
	Correct	31	44		31	44	
FP5	Incorrect	26	42	0.068	29	39	0.834
	Correct	21	16		15	22	
PH1	Incorrect	16	12	0.124	11	17	0.743
	Correct	31	46		33	44	
PH4	Incorrect	17	19	0.714	17	19	0.425
	Correct	30	39		27	42	
PH5	Incorrect	44	56	0.483	42	58	0.930
	Correct	3	2		2	3	
PH6	Incorrect	25	33	0.704	24	34	0.904
	Correct	22	25		20	27	
TC1	Incorrect	14	24	0.219	20	18	0.093
	Correct	33	34		24	43	
TC2	Incorrect	19	17	0.233	15	21	0.972
	Correct	28	41		29	40	
CC1	Incorrect	17	20	0.857	17	20	0.536
	Correct	30	38		27	41	
CC2	Incorrect	35	50	0.128	35	50	0.755
	Correct	12	8		9	11	
CC3	Incorrect	42	50	0.626	40	52	0.385
	Correct	5	8		4	9	
CC4	Incorrect	34	35	0.198	25	44	0.103
	Correct	13	23		19	17	
CC5	Incorrect	29	37	0.825	27	39	0.788
	Correct	18	21		17	22	
CC6	Incorrect	32	38	0.781	26	44	0.162
	Correct	15	20		18	17	

Note: Only the statements with significant results have been displayed.
 Non-parametric test (Chi-square (X²)) was used to analyse the association between the demographic characteristics of participants and food safety knowledge.