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A structural modeling to understand the relationship among food safety knowledge, attitude, and self-reported HACCP practices in restaurant employees in Bangladesh

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25 **A structural modeling to understand the relationship among food safety knowledge, attitude, and**
26 **self-reported HACCP practices in restaurant employees in Bangladesh**

27

28 **Abstract**

29 *Background:* Nowadays most people have their meals outside of their homes and largely depend on the
30 restaurants' made food. Consequently consumers exposed themselves to risk and become vulnerable to
31 illness caused by food. Unsafe food preparation and handling by restaurants' workers have made food
32 safety a concern for public health. The study was aimed to examine the relationships among food safety
33 knowledge, attitude, and hazard analysis critical control point (HACCP) practices in restaurant employees
34 in Bangladesh.

35 *Methods:* A total of 360 employees from 120 restaurants participated in a face-to-face interview through a
36 structured questionnaire comprising four sections: demographic characteristics, food safety knowledge,
37 attitudes and practices. The mean scores for each survey item were calculated and used in structural
38 equation modeling (SEM), designed to assess interrelationships among the three sections related to food
39 safety.

40 *Results:* Participants obtained a correct average score of 53.32% in food safety knowledge, with the
41 highest and lowest correct scores in good hygiene practices (GHPs) and HACCP practices, respectively.
42 The highest score in the attitude section belonged to "self-improvement", followed by "food safety
43 concern". A negative correlation was observed between knowledge with practices, knowledge with
44 attitudes, and a positive correlation was observed between practices with attitudes. A significant positive
45 correlation was observed between HACCP practices with shelf improvement ($r = 0.54, p < 0.05$) and the
46 knowledge toward food poisoning with GHP practices ($r = 0.55, p < 0.05$). Self-improvement and food
47 safety concern are negatively correlated with food poisoning, GHP, and HACCP practice.

48 *Conclusions:* This study demonstrated that the restaurant employees in Bangladesh often have lack of
49 knowledge regarding food safety and HACCP. There is an immediate need for education and training
50 among restaurant employees in order to improve knowledge and attitude on safe HACCP practice.

51 **Keywords:** Food safety, Knowledge, Attitude, Behavior, Structural equation modeling

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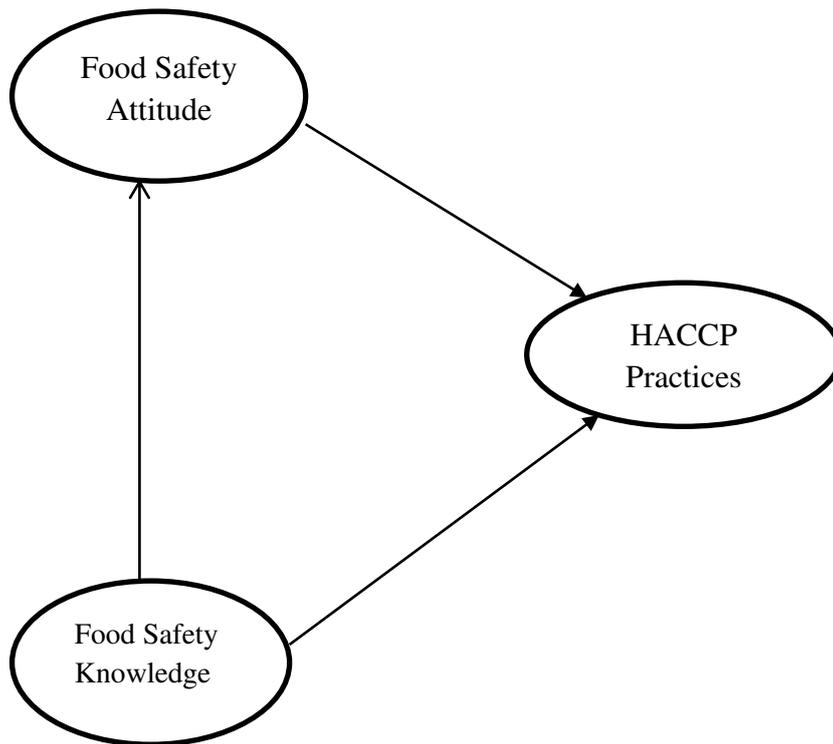
56 **Background**

57 Nowadays, food safety is a major concern worldwide, and millions of people become sick, while hundreds
58 of thousands die every year because they consume unsafe food (1). More than one-third of the total
59 population in developing countries are affected by foodborne illnesses every year (2). A recent estimate
60 has reported that about 30 million people in Bangladesh suffer from foodborne diseases each year (3). The
61 burden of foodborne diseases in Bangladesh is increasing and occurs primarily due to food contamination
62 in restaurants from unhygienic practices (4-6).

63 As food contamination and adulteration currently have become serious public health concerns in
64 Bangladesh, the fight against them has become tough. Therefore, the country's government
65 established the Bangladesh food safety authority (BFSA) in 2014. But now BSFA has faced
66 numerous problems with a regular monitoring system to assess food contamination and its impact
67 on public health, which is now a matter of concern. Recently, BFSA has adopted a restaurant
68 grading system to help consumers. The BFSA provides colored stickers, namely, green, blue,
69 yellow, and orange, to the restaurants based on the food quality, purity, cleanliness, waiters'
70 health, decoration and kitchen conditions (7). Food contamination could occur and contribute to
71 foodborne diseases by employees if they fail to adhere to proper food handling practices in their respective

72 places (8). The most common foodborne disease in Bangladesh is diarrhea, which can cause death at some
73 point. Data from the International Centre for Diarrhoeal Disease Research, Bangladesh (ICDDR, B)
74 show that an average of 501 people are admitted to hospitals because of diarrhea every day (9).
75 The common causes of food poisoning are cross-contamination, insufficient heating, keeping food at room
76 temperature for extended periods, infected food handlers, using contaminated materials, and inadequately
77 cleaned equipment (10, 11). Hazard analysis critical control point (HACCP) is an internationally
78 recognized system managed by the international food safety community to reduce the risk of food safety
79 hazards (12). HACCP is a system which identifies, evaluates, and controls hazards that are significant for
80 food safety, and it is based on prevention rather than mainly relying on end-product testing. HACCP
81 allows a detailed examination of every process to identify the potential hazards and determine whether
82 they can be controlled (13). Running the HACCP system in restaurants, whether small or large, is not an
83 easy task due to the lack of knowledge, attitudes, focus, trained human resources, technological
84 equipment, and adequate finances (14). Food handlers need the skills and knowledge to handle foods
85 safely. Some studies show that training improves knowledge, but a relationship that exists between
86 knowledge, attitude, and practice is necessary, as knowledge alone is not sufficient to cause a change in
87 practices (15, 16); however, other reports demonstrate that training can improve food handling practices
88 (17, 18). It is also suggested that the individual's attitude and behavior are not related to knowledge (19).
89 In Bangladesh, there is a lack of information regarding knowledge, attitude, and practice (KAP) among the
90 restaurant employees, though the KAP survey has been conducted in restaurants in many countries to
91 confirm the HACCP practices. Recently, the government of Bangladesh has gained certification for large-
92 scale food service providers. Hence, it is essential to understand the present status of KAP among the
93 restaurant employees to offer suggestions to foodservice industry executives and government officials on
94 how to improve the enforcement of HACCP-based food safety systems. Concerning the aforementioned
95 lacunae, this study aims to investigate and evaluate the relationships among knowledge, attitude, and

96 HACCP practices in restaurant employees in Bangladesh. Thus, we expected to establish a liaison between
97 the issues affecting food safety knowledge, attitude, and HACCP practices using structural equation
98 modeling (SEM). Fig 1 shows the hypothesized interrelationships between these factors in the present
99 study. Moreover, because food safety is one of the current key issues in Bangladesh, it is also expected
100 that the findings of this study will contribute significantly toward developing a restaurant HACCP plan as
101 well as a policy to supply safe food to the country.



118 **Fig. 1** Model development

120 **Methods**

121 *Study design and participants*

122 In this study, the respondents were selected using quota sampling. The study was conducted among the
123 part-time and full-time restaurant employees in Sylhet city situated in the northeastern part of

124 Bangladesh, where a large number of tourists visit every year (20, 21). The draft versions of the original
125 English questionnaires were translated into Bangla, the national language of Bangladesh. A pilot study was
126 conducted in March 2019 among fifty participants to assess the clarity of the questions, identify response
127 options, and gauge the likely interview length. We used pilot test results, item analysis, factor analysis, and
128 other recommendations to revise the questionnaire by consulting with experts and volunteers following a
129 series of meetings. A total of 360 restaurant employees from 120 restaurants participated in the study
130 conducted from September to October 2019. Participants were full-time and part-time employees working
131 in restaurants in the Sylhet division, Bangladesh. Respondents were interviewed on a one-to-one and a
132 face-to-face basis and were given enough time to answer the questionnaire. The study data were collected
133 through questionnaires. The study data were collected through questionnaire and all the steps is followed
134 by the guidelines of the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE)
135 (22).

136 *Measures*

137 The questionnaire included four sections. Section one encompassed the participants' demographic
138 information such as gender, age, work experience (years), education, marital status, the employees'
139 department, and supervision of the participant. Section two included 32 yes-no questions to assess food
140 safety knowledge. Questions were divided into three categories: food poisoning, GHP standards, and
141 HACCP standards. For section two, each correct answer was given 1 point, and the wrong answer scored 0
142 points. Pa. The reliability index (KR-20) was 0.60 for food safety knowledge.

143 Sections three and four addressed food safety attitudes and HACCP practices, respectively. Data was
144 collected from a series of items in which scores calculated using a 5-point Likert-type scale ranging from 1
145 (strongly agree) to 5 (strongly disagree). We addressed our initial questions in section three by performing
146 item and factor analysis. Item analysis weighed performance test items based on the assumption that the
147 overall test feature reflects the attributes of its factor's items. The item analysis indexes such as mean,

148 standard deviation, corrected item-total correlation, skewness, and item discrimination were evaluated.
149 Exploratory factor analysis (EFA) deals with the relationships among the observed values in terms of their
150 basic factors. In this study, we used the varimax rotation EFA method, with a minimum eigenvalue of 1.0
151 used for factor extraction.

152 The food safety attitude questionnaire included 14 questions across two paradigms, such as self-
153 improvement (6 items) and food safety concern (8 items), and Cronbach's α for the two constructs ranged
154 from 0.710 to 0.83, indicating good reliability. In the HACCP practices section, we finalized five questions
155 following the item analysis. Cronbach's α for all scales was 0.816.

157 *Statistical analysis*

158 We performed the analysis as per the proposed properties like SEM and a LISREL (Linear structural
159 relations) procedure followed by correlation matrices and standard deviations to test the hypothesized
160 model (23). All routes in the projected model were found, reflecting a causal link among variables and
161 latent constructs. To measure the model fit, we performed several measures. As the conventional χ^2 fit test
162 is used to test accurate fit, we refused it due to its inapplicability for this study. We chose to use χ^2/df
163 ((24), the root mean square error of approximation (RMSEA) (25, 26), the comparative fit index (CFI)
164 (27), the Tucker-Lewis index (TLI) (27), standardized root mean square residual (SRMR), and the
165 coefficient of determination (CD) instead (28).

166 **Results**

167 *Descriptive studies*

168 All the participants were male and between ages 20–39 years. More than half of the respondents (52.78%)
169 were married, and most (75%) had 1–6 years of work experience. Most (80.56%) of participants were high
170 school or college graduates, and (75%) of employees were not supervised. About 75% of respondents were
171 serving the food (Table 1).

172 **Table 1 Participant demographic characteristics.**

Variable	Item	Number	Percent (%)
Gender	Male	360	100
	Female	0	0
Age	Under 19	0	0
	20-24	100	27.78
	25-29	120	33.33
	30-34	110	30.56
	35-39	30	8.33
	40-44	0	0
	45-49	0	0
	Over50	0	0
Nationality	Bangladeshi	360	0
	Others	0	0
Marital Status	Single	170	47.22
	Married	190	52.78
	Divorce	0	0
Work experience(years)	Under 1	0	0
	1-3	140	38.89
	4-6	130	36.11
	7-9	60	16.67
	10-12	10	2.78
	13-15	10	2.78
	Over 16	10	2.78
Education	No formal education	0	0
	Primary school	70	19.44
	High school	200	55.56
	College	70	19.44
	University	20	5.56
Department	Cooking	50	13.89
	Cleaning and washing dishes	10	2.78
	Serving food	270	75.00
	Preparation of food ingredients	0	0
	Others	30	8.33
Does a supervisor check your work?	Yes	90	25.00
	No	270	75.00

174 *Descriptive statistics of measurement items*

175 We considered food poisoning, GHP, and HACCP practices in the food safety knowledge section (Table
 176 2). The results demonstrated that the average score for this section was 53.32%. The GHP was comprised
 177 of the highest average score (64.53%), and the HACCP encompassed the lowest average score (37.65%).
 178 Food safety knowledge scored as 57.78. The items “have you heard the name hazard analysis critical
 179 control point (HACCP)” and “do you familiar with the principle of HACCP” earned a score of zero.

180 **Table 2 Percentage of correct responses on food safety knowledge (N=360)**
 181

Construct	Item	Correct (%)
Food poisoning	Food poisoning occurs if it is not cooked or reheated thoroughly	72.22
	Food poisoning occurs if it is not stored correctly—for example, it has not been frozen or chilled	69.44
	Food poisoning occurs if it is left out for too long	69.44
	Food poisoning occurs if it is handled by someone who is ill or has not washed their hands	63.89
	Food poisoning occurs due to cross-contamination.	50.00
	Food poisoning occurs more frequently in summer than winter	63.89
	<i>Clostridium botulinum</i> is caused by improper vacuum and packing.	47.22
	<i>Bacillus cereus</i> is caused by the improper cooking and cooling of rice	41.67
	<i>Vibrio parahaemolyticus</i> is found in waters where shellfish are harvested	50.00
	People with infected cuts should cover their wounds and avoid touching food	50.00
Total		57.78
Good hygiene practices	Food handlers must wear clean and appropriate uniforms and follow dress codes, including removing jewelry from hands	75.00
	Clean the fridge and freezer regularly	52.78
	Steam clean The Cooker Hood	27.78
	Nails must be trimmed and clean, without nail polish	75.00
	Staff must wear hats, covering all the hair	80.56
	A hat must be put on before entering the kitchen so as not to transfer microorganisms on food by coming or fixing hair in the kitchen	75.00
	Rubber gloves must be worn during dishwashing	69.44
	Smoking should be forbidden in the kitchen and adjacent areas.	91.67
	Use hot dry sterilization at 110 C for over 30 min to clean utensils	47.22
	Wash knives and cutting boards only at the end of each business day	80.56
Wear perfume or aftershave while preparing food	77.78	

	Packaged raw ingredients can be placed directly on the floor	44.44
	The holding temperature is above 50 °C. and the refrigerator temperature is below 10 °C	41.67
Total		64.53
HACCP	You heard the name “Hazard analysis critical control points	0.00
	“HACCP” the best method to control food safety in the world	11.11
	You familiar with the principles of HACCP	0.00
	HACCP emphasizes prevention rather than inspection	44.44
	HACCP is a method to manage critical questions in advance to achieve prevention objectives	50.00
	HACCP addresses final product quality, not preparation procedures	52.78
	HACCP effectively uses human and material resources and may decrease food processing costs	63.89
	Microbiological hazards cannot be included in HACCP	52.78
	It is essential to keep track of and to record every step of food production in the HACCP system	63.89
Total		37.65
Average Percentage of GHP, Food Poisoning, HACCP		53.32

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Table 3 represents the score of food safety attitude. We considered self-improvement and food safety concerns in this section. The self-improvement construct earned the highest average score (2.78), followed by the food safety concern (2.71). Table 4 represents that the mean score for HACCP practices was 3.09.

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185

Table 3 Mean values of participants’ food safety attitude scores.

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Construct	Item	Mean	S.D.
Self-improvement	You read more journals about food safety to increase your food sanitation knowledge	2.75	1.23
	You think attending a sanitation seminar would change your sanitation behavior	2.14	1.22
	You think attending a sanitation seminar would increase your sanitation knowledge and ideas	2.06	.95
	You think Learning more about food safety through training courses is important to you	3.06	1.31

	You think you do not need to attend a food safety seminar because you think you have sufficient knowledge about food safety	3.67	1.26
	You attend a cooking or service competition to increase your professional knowledge	3.03	1.32
Total		2.78	0.53
Food safety concern	Government is responsible for preventing food poisoning	2.5	1.13
	Consumers are responsible for preventing food poisoning	2.39	.96
	Maintaining a clean cooking environment is a good way to control food safety	2.36	1.13
	Self-checking food safety is important to restaurants and institutions	2.58	1.23
	Food safety is more important than taste	2.53	1.18
	Food safety knowledge is important to ensure that food is prepared in a safe manner	2.78	1.22
	Food poisoning is not a serious matter	3.72	1.23
Total		2.71	0.55

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188 **Table 4 HACCP Practice for the employees.**

Item	Mean	S.D.
I have a plan to achieve my HACCP goal.	3.17	1.18
I respect HACCP plan goals	3.72	1.03
I usually follow the HACCP plan to maintain food safety.	2.56	1.05
Knowledge of food sanitation helps to perform my job correctly	3.11	1.28
I try hard to maintain food sanitation standards	2.86	1.25
Total	3.09	0.79

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191 *Structural model*

192 The relationships between food safety knowledge, attitude, and HACCP practices are presented in Table 5.
 193 The results indicate that food safety knowledge was negatively correlated with attitude and HACCP
 194 practices; however, the attitude was positively correlated with HACCP practices, and there was a
 195 significant positive correlation ($p < 0.05$) between HACCP practices and shelf improvement. The
 196 knowledge toward food poisoning and GHP practices was significantly correlated ($p < 0.05$), but there was
 197 no significant relationship between food poisoning and HACCP practices. Lastly we found self-
 198 improvement and food safety concern are negatively correlated with food poisoning, GHP, and HACCP
 199 practice.

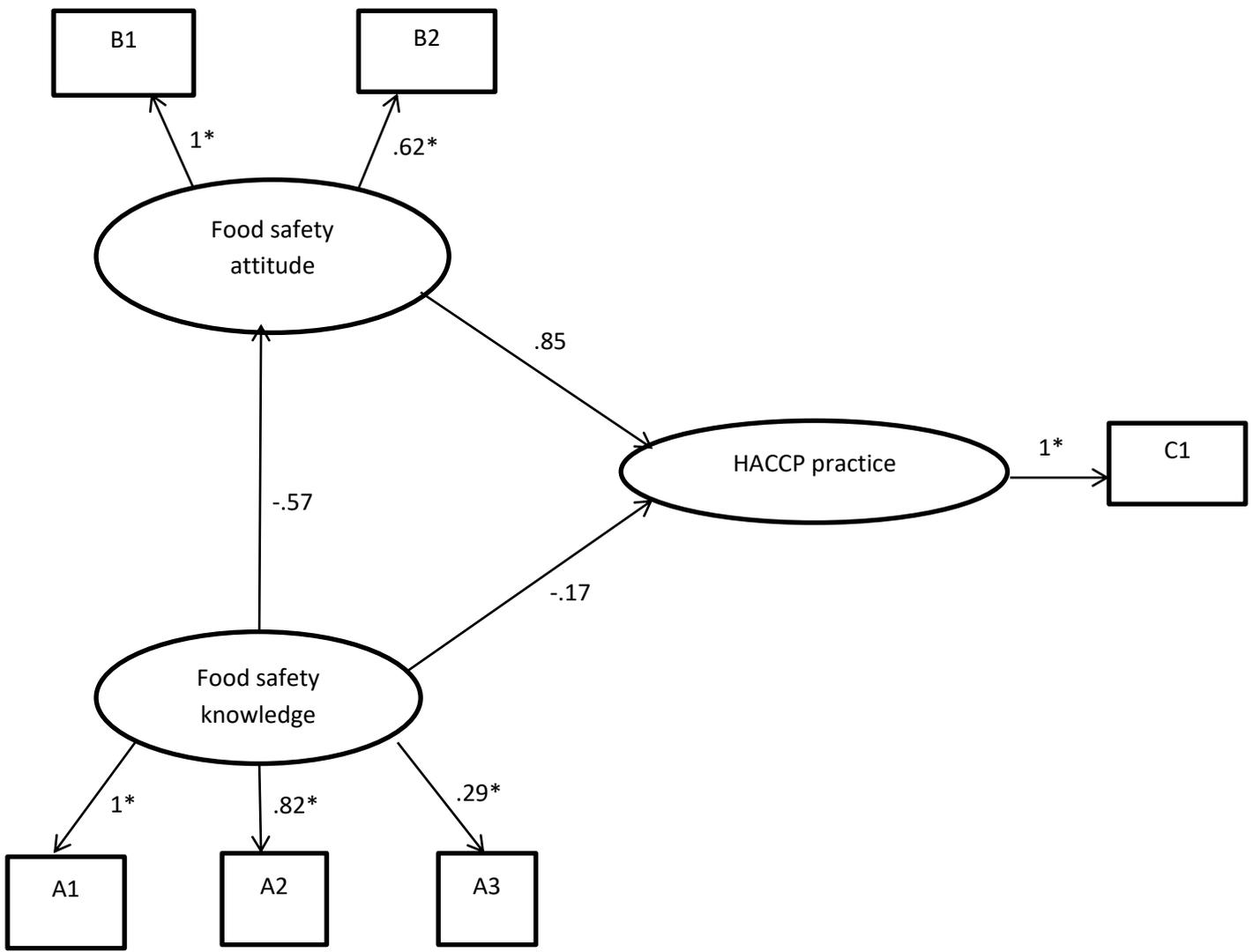
200 **Table 5 Relationships among participant food safety knowledge, attitude, and HACCP practices of the participants**
 201 **(N=360)**

Construct	Knowledge			Attitude		
	Food poisoning	GHP	HACCP	Self-improvement	Food safety concern	HACCP practices
Food Safety knowledge						
Food poisoning	1.0000					
GHP	0.5518*	1.0000				
HACCP	0.2899	0.2297	1.0000			
Food safety attitude						
Self improvement	-0.2815	-0.0762	-0.2521	1.0000		
Food safety concern	-0.2536	-0.2970	-0.1280	0.3155	1.0000	
HACCP practices	-0.2322	-0.2408	-0.207	0.5388*	0.2041	1.0000

202 *Correlation is significant at $p < 0.05$ level (2-tailed).

203
 204 We used structural equation modeling to illustrate the relationship among food safety knowledge, attitude,
 205 and HACCP practices, as presented in Fig. 2. Analytical results indicated a negative relationship between
 206 food safety knowledge and attitude and between food safety knowledge and HACCP practices. The SEM
 207 was used to investigate the fit indices and variance-explained estimates. Table 6 presents a variety of
 208 indices used to evaluate the model's overall value, indicating a good model fit.

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A1: Food poisoning knowledge; A2: GHP knowledge; A3: HACCP knowledge; B1: Self-improvement attitude, B2: Food safety concern; C1: HACCP implementation

Fig. 2 Model of Food safety Knowledge, Attitude, and HACCP Practice

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Table 6 Goodness-of-fit indices for the measurement model.

Fit indices	χ^2 (Chi-square)	DF	χ^2/DF	RMSEA	CFI	TLI	SRMR	CD
Measurement	6.196	7	0.885	0.00	1.00	1.06	0.06	0.78
Accepted value			<3 ^a	<0.08 ^b	$\geq 0.90^c$	>0.90 ^d	<0.08 ^e	0-1 ^f

Chi-square/DF (χ^2/DF), ^a(29)

DF=Degree of freedom

RMSEA=Root mean square error of approximation. ^b(30)

CFI=Comparative fit index. ^c(31)

TLI=Tucker-Lewis index. ^d(27)

SRMR=Standardized root mean squared residual. ^e(32)

CD=Coefficient of determination. ^f(28)

The model for food safety knowledge, attitude, and HACCP practices were verified by SEM, and the goodness of fit of the model was evaluated. In this study, the χ^2 for the measurement of model fit was 6.196 with 7 degrees of freedom (df). Theoretically, when the assumption was made, χ^2 was insignificant, and an χ^2/df ratio of < 5 was acceptable, but the ratio of < 3 was preferred (24). The χ^2/df ratio for the measurement model in this study was 0.89, indicating a good fit for the sample (24). Our model was also evidently a good fit, according to the root mean square error of approximation (RMSEA), the comparative fit index (CFI), Tucker-Lewis index (TLI), standardized root mean squared residual (SRMR), and the coefficient of determination (CD) values. Our results showed that RMSEA and SRMR were 0.0001 and 0.06, respectively, and in both cases, the value was < 0.08 (25-27). Moreover, CFI and TLI showed the

253 values of 1 and 1.06, respectively, indicating that both cases were good CFI (their values were greater than
254 0.90) (27). The value close to 1 indicates a good fit according to CD, and in our study, it appeared as 0.78
255 (28). As shown in Table 6, the requirements were fulfilled; thus the hypothesized model in this study was a
256 good fit and acceptable.

257

258 **Discussion**

259 This research provides information and an outline of many complex questions about the knowledge,
260 attitudes, and practices of the employees working in restaurants in Bangladesh. This study revealed that
261 food handlers had above average knowledge regarding food poisoning and good hygiene practices, but the
262 knowledge of HACCP practices was below the average. There is a lack of information regarding the
263 HACCP practices in Bangladesh, although they are important for industry. The HACCP system provides a
264 high degree of food safety assurance – many enormities by the traditional approaches over that exist for
265 foodservice operations ((33). It appears that employees had almost zero knowledge about the principles of
266 HACCP. Therefore, intensified efforts need to be made to implement the HACCP system in foodservice
267 operations.

268 Although training may demonstrate increased knowledge, it does not always result in a change in HACCP
269 practices and attitude. Restaurants must decide which food safety system best suits their specific situation
270 and how the system should be implemented. Besides, GHP implementation is difficult for restaurants, as
271 high-quality food is necessary to earn and maintain consumer trust and loyalty. However, although in this
272 study, the level of GHP knowledge concerning food poisoning and HACCP knowledge among restaurant
273 employees is high, it is indeed not at a satisfactory level. Therefore, the country and employers should
274 focus on resolving the prevalent low-level basic GMP, food poisoning, and HACCP knowledge.
275 Therefore, periodic evaluation of food handlers' knowledge and the food safety training materials should

276 be made. Many studies revealed that introducing the HACCP system in the restaurants improves the
277 quality of food (34-36).

278 Our study found the positive correlations between self-improvement and food safety concerns and between
279 HACCP practices and attitude. These results are similar to an earlier study by Ko (10). The score of
280 HACCP practices was only 0.79. Many researchers have concluded that training is important to improve
281 standards of food hygiene, positively change the behavior of employees, and prevent foodborne diseases
282 (18, 37, 38). A combination of positive knowledge and attitude is necessary to improve food handling
283 safety (39).

284 Fig. 2 demonstrates the standardized path coefficients for the structural model under investigation,
285 determining the strength of the direct relationship between constructs. Our results showed a negative
286 relationship between food safety knowledge (food poisoning, GHP, and HACCP) and food safety attitude
287 (self-improvement and safety concern), implying that though the respondents have the knowledge related
288 to food safety, they do not apply it to change their behavior (Fig. 2). This situation can improve through
289 legislative governance of food safety guidelines by the local governments like the city corporation as well
290 as the Bangladesh Food Safety Authority. In Bangladesh, there is no well-established food safety
291 governance and monitoring system for the restaurant food. Besides, employee training may increase food
292 safety knowledge and hygienic awareness and potentially improve HACCP practices.

293 All restaurant managers, supervisors, and operators have important roles in the implementation of the
294 HACCP system. Fletcher et al. reported that the staff working in large hotels should have sufficient
295 knowledge about HACCP plans, HACCP principles, and related standard operating procedures (40).
296 Indeed, to improve knowledge transfer, feedback, self-control, and individual commitment to HACCP,
297 training program along with legislation play essential roles (41, 42). The results of this study were in
298 agreement with the findings obtained by Lim, Chye (29), in which knowledge had a negative relationship
299 with both attitude and practices.

300 **Limitation of the study**

301 This study focused on employees working in restaurants located in Sylhet Division. Expanding the scope
302 of recruitment would help improve the generalizability of the study's results. Moreover, self-reported data
303 used in this study may reflect participants' biases.

304 **Conclusion**

305 This study demonstrates that food safety knowledge had a negative relationship with both attitude and
306 HACCP practices; however, the attitude had a positive relationship with HACCP practices. Moreover, this
307 study revealed that if an individual has a fair level of food safety knowledge, it does not necessarily turn
308 into a positive attitude or a tendency to practice HACCP. Therefore, a piece of legislation to follow the
309 food safety guidelines is of great importance along with the establishment of strong monitoring and a
310 frequent training program for the country.

312 Abbreviations

313 HACCP: Hazard Analysis Critical Control Point

314 SEM: Structural Equation Modeling

315 GHPs: Good Hygiene Practices

316 BFSA: Bangladesh Food Safety Authority

317 *ICDDR, B*: International Centre for Diarrhoeal Disease Research, Bangladesh

318 KAP: Knowledge, Attitude, and Practice

319 EFA: Exploratory Factor Analysis

320 LISREL: Linear Structural Relations

321 RMSEA: Root Mean Square Error of Approximation (25, 26)

322 CFI: Comparative Fit Index

323 TLI: Tucker-Lewis Index

324 SRMR: Standardized Root Mean Square Residual

325 CD: Coefficient of Determination

326

327 Declarations

328 *Ethics approval and consent to participate:* The data collection procedure for this was carried out with the
329 approval of the Office of Research Compliance of Shahjalal University of Science and Technology
330 (SUST), Bangladesh review board (No. FET/M/19/014). Before the interview, written informed consent
331 was obtained from individual respondents, and this was followed by an oral and written explanation given
332 by the interviewers. The respondents were informed of the voluntary nature of the survey, the potential
333 risks involved in participation, the purpose of the gathered data (assessment of health needs and planning
334 food services), and the confidentiality of the results of the individual interview.

335 *Consent for Publication:* Before interviewing the survey team orally explains the aim of the study and no
336 personal information will be included during the publication.

337 *Availability of data and materials:* The datasets used and/or analyzed during the current study are
338 protected by the SUST research center and available from the corresponding author on reasonable request.

339 *Competing interest:* None of the authors have any commercial or financial involvement in connection with
340 this study that represent or appear to represent any conflicts of interest.

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342 *Authors' contributions:* This work was carried out in collaboration among the all authors. Authors MJH
343 and RU performed the data collection and wrote the first draft of the manuscript. GMRI designed the
344 study, supervised the work, and assisted in reviewing manuscript draft.

345 *Acknowledgement:* The authors are thankful to all the participant involved this study.

346 *Authors' Information:*

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355 Technology (SUST), Sylhet, Bangladesh.

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Figures

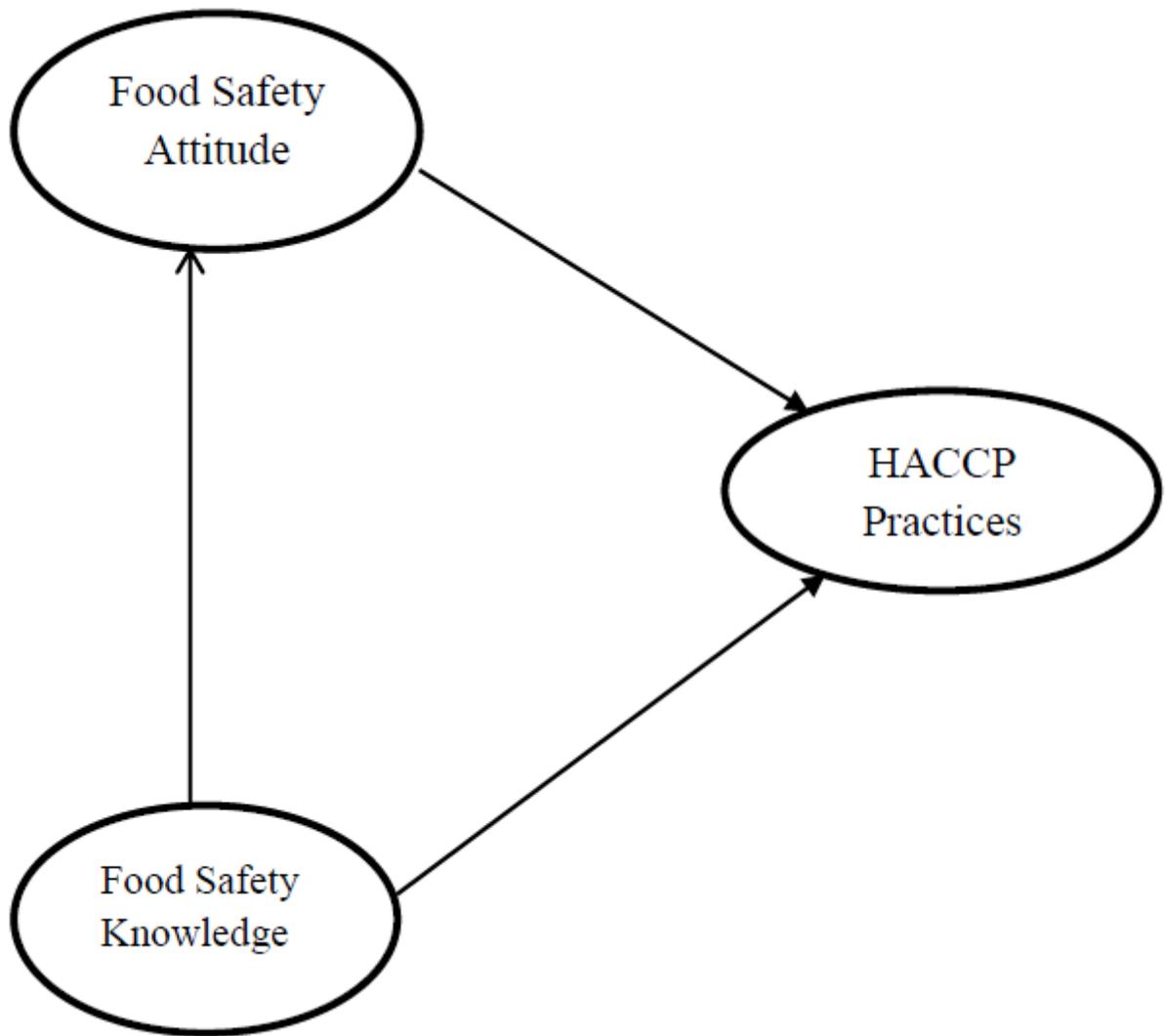
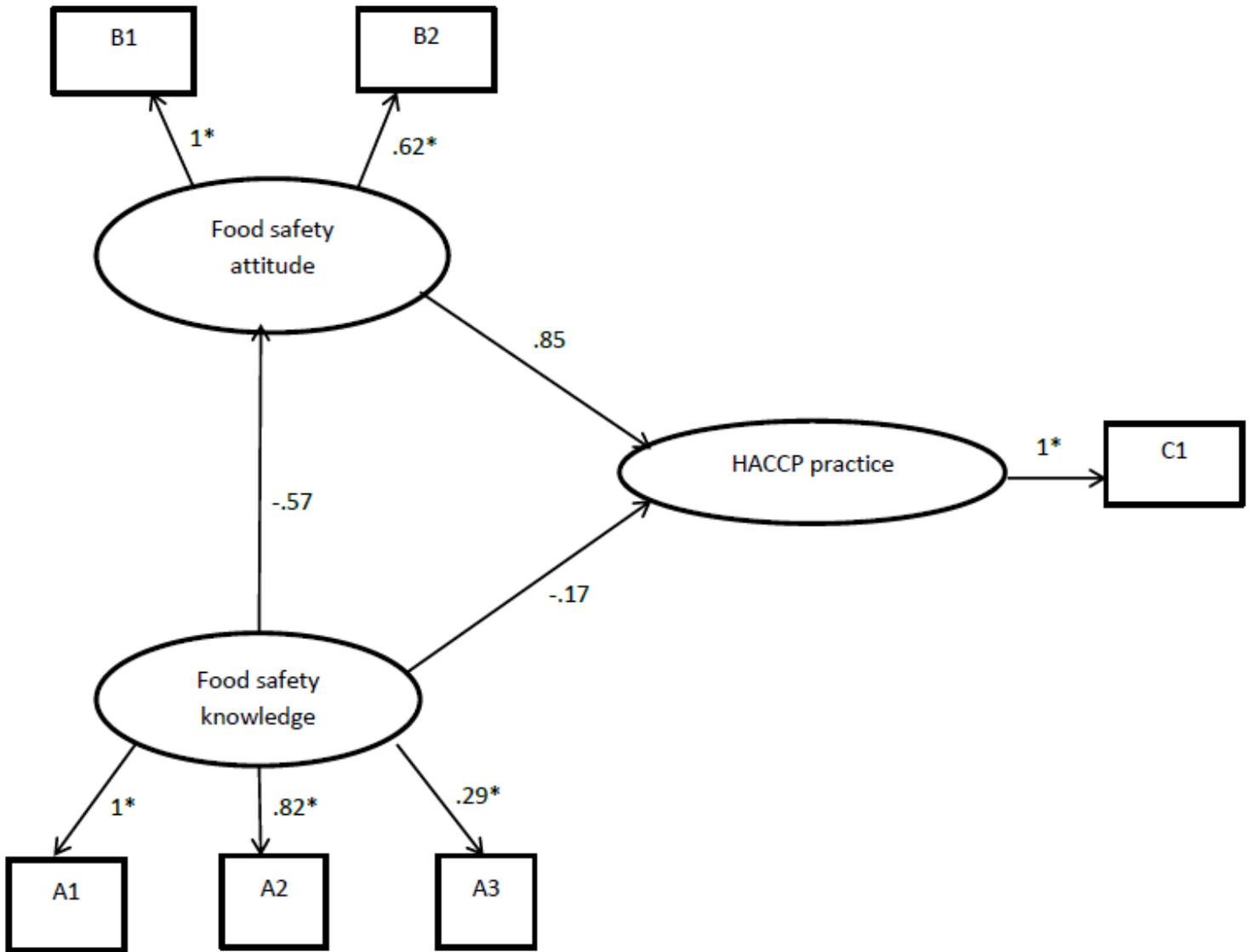


Figure 1

Model development



A1: Food poisoning knowledge; A2: GHP knowledge; A3: HACCP knowledge; B1: Self-improvement attitude, B2: Food safety concern; C1: HACCP implementation

Figure 2

Model of Food safety Knowledge, Attitude, and HACCP Practice