

## Evaluation of microbial safety knowledge, attitude and practice of street food vendors and consumers in Can Tho City, Vietnam

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### Abstract

Street foods have become much more popular in Vietnam. However, the information on the safety of street food sold in Vietnam and food knowledge safety as well as awareness of both Vietnamese vendors and consumers is very limited. The aim of this study was to evaluate the level of knowledge, attitude, and practice in food safety of street food consumers and vendors who volunteered to participate in the study in Can Tho city, Vietnam. This study was conducted in two parts. In the first part, 838 food consumers and 598 food handlers were interviewed via a questionnaire to assess their food safety knowledge and attitude. The second part focused on the observation of the food handling practice of the vendors by means of a checklist. Results indicated that consumers and vendors generally exhibited average food safety knowledge and attitude levels. The consumers and vendors were determined to have higher levels of food safety attitude than knowledge, whilst trained consumers and vendors had better food safety knowledge and attitude compared to untrained consumers and vendors. The observation study showed that the majority of the vendors had unhygienic practice i.e. handled food with bare hands (84.5%), handled money while serving food (92.3%) and without washing hands after handling money (93.3%), etc. These results justify the need for training the vendors about food safety knowledge and practice and further additional studies of street foods and their potential risk of foodborne illness.

## 1. Introduction

Street foods are defined as ready-to-eat food and beverages prepared and/or sold by vendors and handlers especially in streets and similar public places for immediate consumption or consumption at a later stage without further processing or preparation (FAO, 2013). It was estimated that there are 2.5 billion people who consumed street food all around the world daily (FAO, 2007). Street foods are highly appreciated by consumers due to their flavors, attractive, diverse, convenient, low cost, cultural and social heritage links (Ekanem, 1998; Chukuezi, 2010; Aluko *et al.*, 2014; da Silva *et al.*, 2014).

However, street food vendors are very often poor, uneducated and show little concern towards the safe handling of foods (Mensah *et al.*, 2002; Lues *et al.*, 2006). Consequently, some serious concerns do exist about the safety of street food (Muinde and Kuria, 2005; Rheinländer *et al.*, 2008; FAO, 1995). The concerns have been realized as street-vended foods are associated with

poor microbiological quality and potential cause of outbreaks around the world (Dawson and Canet, 1991; Bryan *et al.*, 1992; Aluko *et al.*, 2014).

To date, the food safety knowledge, attitude, and practice of food handlers (including street food vendors) in several countries have been reported in several studies. Food safety and sanitary practice at car parks in Nigeria showed only 16.9% of vendors always wash hands after using the toilet and only 3.8% always refrigerate leftover cooked food; 61.9% of the vendors had no formal training about food safety (Aluko *et al.*, 2014). In addition, observation street food vendors in Port-au-Prince, Haiti found that flies and animals were around the street food stall (60%) and no accessibility to potable water (65%) (Samapundo *et al.*, 2015). It is explained that poor quality of raw materials, improper food preparation, lack of awareness about food safety, etc. are possibly the most common cause of food poisoning outbreaks (Liu *et al.*, 2014). However, for vendors theoretical training is not related to the attitude and practice of food handlers (da Cunha *et al.*, 2014).

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In addition, the consumer's knowledge and attitude toward food safety differ according to demographic and socio-economic factors. Consumers were however determined to have a lower level of food safety knowledge than vendors (Samapundo *et al.*, 2015). Although the specific regulations for street food vendors including locations, facilities, environment around the stall and personal hygiene have been issued by the Ministry of Health in their revised Law of food safety in 2012 (30/2012/TT-BYT). Until now, there is no formal study on the food safety knowledge, attitude and practice of vendors and consumers of street foods, particularly in Can Tho city.

As other developing countries, Vietnam is largely known for its delicious and diverse street foods which do not only serve the eating habits of urban residents, especially in low and medium-income areas in Can Tho city but also attract the curiosity of tourists. There are about 5000 street food vendors in Can Tho city (population of 1.2 million and 1408 km<sup>2</sup>). The street food in Can Tho city accounts for up to 95% of urban consumer purchases (mainly by more than 60 thousand students studying in universities located in Can Tho city); 51% consuming for the main dish daily and 82% for breakfast (based on a local report). Despite the alarming food poisoning outbreaks due to consuming street foods, at the moment very few studies are available about the level of food safety knowledge, attitude, and practice of both vendors and consumers of street foods in Can Tho city, the biggest city in Mekong Delta of Vietnam. Therefore, this study is aimed to evaluate the level of food safety knowledge and attitude of both the vendors and consumers, and to assess the food safety practice of the vendors in order to raise the safety awareness of street foods in Vietnam.

## 2. Materials and methods

### 2.1 Sample size

The study was conducted in five districts (i.e. Ninh Kieu, Cai Rang, O Mon, Phong Dien and Binh Thuy) in Can Tho city, Vietnam from November 2016 to October 2018. In the study, 838 street food consumers and 598 vendors were involved in the survey. Besides, 677 street food vendors were observed to check their food handling practice.

### 2.2 Food safety knowledge and attitude surveys

The questionnaire used to assess the food safety knowledge and attitude of street food vendors and consumers were based on previous studies by Angelillo *et al.* (2001), Bolton *et al.* (2008), Ansari-Lari *et al.* (2010), Soares *et al.* (2012) and Samapundo *et al.* (2015). The questionnaire was translated into

Vietnamese and pre-tested with 30 people to ensure its clear and properly structured content. All questions were standardized before the adoption of the final version for the survey. The questionnaire was classified into three main sections including demographic information, food safety knowledge, and food safety attitude.

The demographic section included gender, age, educational level, location, income, employment status, food safety training for both consumers and vendors and additionally the length of time spent in vending and types of vending by the vendors. The food safety knowledge section (including 18 questions) was designed to assess the awareness of the vendors and consumers to food poisoning pathogens, food hygiene, cross-contamination, personal hygiene, proper cleaning, etc. The food safety attitude questionnaire (including 16 questions) was organized to test how much consumers and vendors understand about food safety. The vendors operating around industrial zones, schools, universities, parks and busy street pavements in five districts were selected for the survey. The consumers in and around these areas which are frequented the most by local inhabitants of Can Tho city were asked to voluntarily participate in the survey. When the participants are not clear enough to fill in the questionnaire themselves, they were aided by the researchers during the survey.

These sections of knowledge and attitude were designed with three possible answers: "true", "false" and "do not know". Each correct answer considered as one point whilst no point was given for incorrect answers or when the respondent indicated that they did not know the answer. The score was then converted to 100 based on a maximum possible score of 18 and 16 points for knowledge and attitude, respectively. Scores less than 50 were considered as poor level, scores between 50 and 75 were considered as average (adequate) level whilst scores higher than 75 were considered as a good level of food safety knowledge as well as attitude.

### 2.3 Food handling observation checklist

A checklist was used to assess the food safety practice of street food vendors. The checklist was a combination of different checklists used in previous studies by Samapundo *et al.* (2015), Samapundo *et al.* (2016), Muinde and Kuria (2005), Chukuezi (2010) and some minor changes following the Law of food safety issued by Ministry of Health in 2012 (30/2012/TT-BYT) were made before adoption for the final version. The checklist contained five main sections: i) information on facilities ii) the environment around the stall iii) personal hygiene iv) food storage (cool/refrigeration storage at the vending sites) and v) utensils (the use of soap and clean water). The absence or presence of each component of

the checklist was recorded. The selection of participants for this part of the study was based on the same methodology as for the selection of vendors for the food safety knowledge and attitude surveys.

#### 2.4 Statistical analysis

The data obtained from the surveys and the checklists were computed by Microsoft Excel version 2013 (Microsoft, U.S.A.). The data set was then exported from Excel to SPSS Statistics version 20 (SPSS Inc., Chicago, U.S.A.) for further statistical analysis based on an  $\alpha = 0.05$ . For comparisons of the scores, cut-off points of  $<50$ ,  $50-75$  and  $>75$  were used.

### 3. Results and discussion

#### 3.1 Demographic characteristics

The demographic characteristics of the 838 consumers who participated in this study showed that there was 535 female (63.8%) and 303 males (36.2%). The mean age of the participants was  $26.4 \pm 10.35$  years. The age of consumers ranged from 15 to 67 years old. With regards to the level of education attained, almost (84.1%) of the consumers had a high school or higher education. Half of the respondents were located at Ninh Kieu district (52.1%), the biggest district in Can Tho city. Most of the consumers were students (51.8%) and employed (42.6%). The income of consumers each month was below or equal to 3 million VND (66.2%), indicating that most of the consumers that participated in this study are students while only 6.9% of the consumers had income above 8 million VND. In addition, the majority of the consumers who participated in this study (77.9%) did not have any food safety training.

Of the 598 vendors who participated in this study, the majority of them were women (84.1%). This is a reflection that the street food stalls were mostly manned by women. In most South Asian cultures, women play a major role in food handling and cooking. Specifically, women in poor economics can get income by means of vending street foods. These findings are in agreement with other studies with women vendors of 72.5% in Ho Chi Minh City, Vietnam (Samapundo *et al.*, 2016), 75.9% in Accra, Ghana (Kunadu *et al.*, 2016) and 87.5% in Port-au-Prince, Haiti (Samapundo *et al.*, 2016). The mean age of the vendors was  $41.3 \pm 12.21$  years with a wide age range of 16 to 83 years. Over 70% of vendors in this study had at least secondary education, this showed a better educational status among Vietnamese vendors compared with other findings reported in Haiti (Samapundo *et al.*, 2015) where 65% had primary education while 25% had secondary education. 44.5% of the vendors have income below or equal 3, 48% have income between 3 and 8, and only 7.5% have income

above 8 million VND per month. The majority (65.9%) of the vendors in this study did not have any food safety training. Other studies have reported even higher levels of untrained street food vendors including those in Ghana (Kunadu *et al.*, 2016), in Brazil (Rebouças *et al.*, 2017) and Haiti (Samapundo *et al.*, 2015). Almost half (49.3%) of the vendors have below five years of experience in vending foods and 9.9% have above 20 years of experience. The main vending type was stationary (84.6%).

#### 3.2 Food safety knowledge of consumers and vendors

The results of the survey which was carried out to determine the effect of sex, age, education, location, income, employment status, and food safety training on food safety knowledge of the consumers are shown in Table 1. The consumers had a mean food safety knowledge score of  $63 \pm 16$ , indicating average knowledge of food safety. About 16.3% (137/838) of the consumers had an inadequate level of food safety knowledge (scores  $<50$ ) whilst 24.2% (203/838) of the consumers had a good level of food safety knowledge (scores  $>75$ ). No significant difference ( $p > 0.05$ ) was found between the food safety knowledge of female and male consumers. However, food safety knowledge was significantly different ( $p < 0.05$ ) with age groups of 15-20 years compared to others ( $>20$  years). The food safety knowledge of consumers was dependent on education level ( $p < 0.05$ ). The food safety knowledge of consumers located in Ninh Kieu district was significantly higher than those in Cai Rang district ( $p < 0.05$ ) whereas those in both Ninh Kieu and Cai Rang did not differ significantly from the other districts ( $p > 0.05$ ). As mentioned above, most of the consumers were students and employed as well as half of the consumers were located in Ninh Kieu district; as a result, the students and employed consumers had a higher level of food safety knowledge than unemployed consumers ( $p < 0.05$ ). No significant difference was observed among income levels ( $p > 0.05$ ). In similarity to the trend observed for employment status, the consumers who were trained on food safety had a significantly higher score than those untrained ( $p < 0.05$ ), i.e. 69 and 61 respectively. In contrast to our findings, other studies have indicated that an increase in food safety knowledge occurs with age and that women have higher levels of food safety knowledge compared to men (Bruhn and Schutz, 1999). These findings were in good agreement with those reported by Samapundo *et al.* (2015) and Samapundo *et al.* (2016) where it was indicated that no statistical difference ( $p > 0.05$ ) was found in the food safety knowledge of consumers based on gender in Port-au-Prince, Haiti and Ho Chi Minh City, Vietnam.

Table 1. Effect of sex, age, education, location, income, employment status and food safety training on the food safety knowledge of consumers (n=838)

Characteristics	Number of respondents (%)			Mean score±SD	Range
	<50	50-75	>75		
<b>Sex</b>					
Female	83 (9.9)	313 (37.4)	139 (16.6)	63±16 <sup>a</sup>	11-100
Male	54 (6.4)	185 (22.1)	64 (7.6)	62±16 <sup>a</sup>	6-100
<b>Age (years)</b>					
15-20	58 (6.9)	147 (17.5)	40 (4.8)	58±15 <sup>b</sup>	17-94
21-30	54 (6.4)	230 (27.4)	103 (12.3)	64±17 <sup>a</sup>	6-100
31-40	18 (2.1)	57 (6.8)	34 (4.1)	65±17 <sup>a</sup>	22-100
41-50	4 (0.5)	30 (3.6)	22 (2.6)	69±14 <sup>a</sup>	33-94
>50	3 (0.4)	34 (4.1)	4 (0.5)	64±16 <sup>a</sup>	39-100
<b>Education</b>					
Illiterate	0 (0)	5 (0.6)	0 (0)	61±8 <sup>ab</sup>	50-67
Primary school	9 (1.1)	8 (1)	5 (0.6)	58±19 <sup>ab</sup>	22-89
Secondary school	21 (2.5)	64 (7.6)	21 (2.5)	60±7 <sup>b</sup>	11-94
High school	32 (3.8)	107 (12.8)	34 (4.1)	61±16 <sup>b</sup>	17-100
Higher education	75 (8.9)	314 (37.5)	143 (17.1)	64±16 <sup>a</sup>	6-100
<b>Location</b>					
Ninh Kieu	64 (7.6)	252 (30.1)	121 (14.4)	64±16 <sup>a</sup>	11-100
Cai Rang	26 (3.1)	96 (11.5)	30 (3.6)	61±17 <sup>b</sup>	17-100
O Mon	19 (2.3)	44 (5.3)	17 (2)	59±18 <sup>ab</sup>	6-89
Phong Dien	10 (1.2)	46 (5.5)	17 (2)	64±16 <sup>ab</sup>	11-100
Binh Thuy	18 (2.1)	60 (7.2)	18 (2.1)	62±15 <sup>ab</sup>	33-100
<b>Income (million VND per month)</b>					
≤3	96 (11.5)	335 (40)	124 (14.8)	62±16 <sup>a</sup>	11-100
>3-8	33 (3.9)	127 (15.2)	65 (7.8)	64±17 <sup>a</sup>	6-100
>8	8 (1)	36 (4.3)	14 (1.7)	64±16 <sup>a</sup>	28-100
<b>Employment status</b>					
Student	72 (8.6)	259 (30.9)	103 (12.3)	63±16 <sup>a</sup>	22-100
Employed	54 (6.4)	206 (24.6)	97 (11.6)	64±16 <sup>a</sup>	6-100
Unemployed	11 (1.3)	33 (3.9)	3 (0.4)	56±17 <sup>b</sup>	11-89
<b>Food safety training</b>					
Yes	10 (1.2)	106 (12.6)	69 (8.2)	69±14 <sup>a</sup>	11-100
No	127 (15.2)	392 (46.8)	134 (16)	61±16 <sup>b</sup>	6-100
Total	137 (16.3)	498 (59.4)	203 (24.2)	63±16	6-100

Mean values with the same superscript letter within the column of the same characteristics are not significantly different at the level of 5%.

The results of the survey done to determine the effect of sex, age, education, location, income, food safety training, length of time spent vending, and types of vending on food safety knowledge of the vendors are shown in Table 2. Approximately 24.4% (146/598) of the vendors who participated in the study had a good level (score of >75), 57% (341/598) had an average level (scores between >50 and <75) and 18.6% (111/598) had an inadequate level of food safety knowledge (scores of <50). Amongst the studies that have used the same scoring methods, the mean food safety knowledge score of the street food vendors in Can Tho was found to be higher than that of food handlers from Ho Chi Minh City, Vietnam (Samapundo *et al.*, 2016) and Haiti (Samapundo *et al.*, 2015). There were no significant differences ( $p>0.05$ ) in food safety knowledge on the basis of gender, age, educational level attained, income,

and length of time spent vending. The same findings have also been observed in Brazil (Aquad *et al.*, 2019) and Haiti (Samapundo *et al.*, 2015) where no statistical difference was found between the food safety knowledge of the vendors based on gender, age, and the educational level attained. In this study, significant differences occurred between the food safety knowledge levels of vendors who had received food safety training and those who had not ( $p<0.05$ ), with the untrained vendors attaining lower scores (60±16) compared to trained vendors (67±15). It indicated that the training of vendors may have a positive influence on their food safety knowledge. The food safety knowledge of food vendors also had significant difference ( $p<0.05$ ) among studied districts, the lowest score was seen in Cai Rang and Binh Thuy districts where there are no universities or colleges, more frequent vendors may be of low income and low

Table 2. Effect of sex, age, education, location, income, food safety training, length of time spent vending and types of vending on the food safety knowledge of vendors (n=598)

Characteristics	Number of respondents (%)			Mean score±SD	Range
	<50	50-75	>75		
<b>Sex</b>					
Female	94 (15.7)	291 (48.7)	118 (19.7)	62±16 <sup>a</sup>	17-100
Male	17 (2.8)	50 (8.4)	28 (4.7)	63±17 <sup>a</sup>	22-89
<b>Age (years)</b>					
15-20	3 (0.5)	8 (1.3)	4 (0.7)	60±16 <sup>a</sup>	28-83
21-30	19 (3.2)	66 (11)	34 (5.7)	64±16 <sup>a</sup>	22-94
31-40	23 (3.8)	92 (15.4)	42 (7)	65±15 <sup>a</sup>	28-94
41-50	30 (5)	100 (16.7)	32 (5.4)	62±15 <sup>a</sup>	28-94
>50	36 (6)	75 (12.5)	34 (5.7)	60±17 <sup>a</sup>	17-100
<b>Education</b>					
Illiterate	4 (0.7)	3 (0.5)	4 (0.7)	63±24 <sup>a</sup>	22-94
Primary school	30 (5)	67 (11.2)	30 (5)	61±16 <sup>a</sup>	28-94
Secondary school	38 (6.4)	115 (19.2)	41 (6.9)	61±16 <sup>a</sup>	17-100
High school	19 (3.2)	105 (17.6)	38 (6.4)	65±14 <sup>a</sup>	28-94
Higher education	20 (3.3)	51 (8.5)	33 (5.5)	63±16 <sup>a</sup>	22-89
<b>Location</b>					
Ninh Kieu	45 (7.5)	178 (29.8)	69 (11.5)	63±15 <sup>b</sup>	22-94
Cai Rang	36 (6)	47 (7.9)	21 (3.5)	58±18 <sup>c</sup>	22-94
O Mon	4 (0.7)	50 (8.4)	28 (4.7)	68±13 <sup>a</sup>	39-94
Phong Dien	13 (2.2)	42 (7)	21 (3.5)	62±17 <sup>bc</sup>	17-89
Binh Thuy	13 (2.2)	24 (4)	7 (1.2)	59±17 <sup>c</sup>	33-100
<b>Income (million VND per month)</b>					
≤3	48 (8)	155 (25.9)	63 (10.5)	62±15 <sup>a</sup>	17-100
>3-8	55 (9.2)	162 (27.1)	70 (11.7)	62±16 <sup>a</sup>	22-94
>8	8 (1.3)	24 (4)	13 (2.2)	65±17 <sup>a</sup>	33-89
<b>Food safety training</b>					
Yes	10 (1.2)	106 (12.6)	69 (8.2)	69±14 <sup>a</sup>	11-100
No	127 (15.2)	392 (46.8)	134 (16)	61±16 <sup>b</sup>	6-100
<b>Length of time spent vending (years)</b>					
<5	47 (7.9)	172 (28.8)	76 (12.7)	63±16 <sup>a</sup>	22-100
5-<10	27 (4.5)	78 (13)	38 (6.4)	63±15 <sup>a</sup>	28-94
10-<20	27 (4.5)	53 (8.9)	21 (3.5)	60±17 <sup>a</sup>	28-94
>20	10 (1.7)	38 (6.4)	11 (1.8)	60±16 <sup>a</sup>	17-94
<b>Types of vending</b>					
Stationary	89 (14.9)	288 (48.2)	129 (21.6)	63±16 <sup>a</sup>	17-94
Mobile	22 (3.7)	53 (8.9)	17 (2.8)	59±17 <sup>b</sup>	28-100
Total	111 (18.6)	341 (57)	146 (24.4)	62±16	17-100

Mean values with the same superscript letter within the column of the same characteristics are not significantly different at the level of 0.05%

level of education. Stationary vendors (score of 63) who have food safety knowledge score significantly higher ( $p < 0.05$ ) than mobile vendors (score of 59). Most of the stationary vendors may be trained about food safety and it is partly due to the majority of stationary vendors (84.6%) participated in this study. Similar studies were reported by Chukuezi (2010) and Odonkor *et al.* (2011) studies conducted on street foods in Nigeria and Ghana, respectively.

### 3.3 Food safety attitude of consumers and vendors of street food

The results of the survey to determine the food safety attitude of the consumers are shown in Table 3. The

consumers had a mean food safety attitude score of 72, which indicated that they generally had an average awareness of food safety. The range of scores was between 19 and 100. With regards to the distribution of scores, it can be seen in Table 3 that 60.3% (505/838) of the consumers had an average food safety attitude and 34.5% (289/838) had a very good food safety attitude. No statistical difference ( $p > 0.05$ ) was found between the food safety attitude of the consumers based on gender and income. However, statistically significant differences ( $p < 0.05$ ) occurred between the food safety attitude of consumers based on their age, educational level, location, employment status, and food safety training.

Table 3. Effect of sex, age, education, location, income, employment status and food safety training on the food safety attitude of consumers (n=838)

Characteristics	Number of respondents (%)			Mean score±SD	Range
	<50	50-75	>75		
<b>Sex</b>					
Female	20 (2.4)	322 (38.4)	193 (23)	73±13 <sup>a</sup>	19-100
Male	24 (2.9)	183 (21.8)	96 (11.5)	71±14 <sup>a</sup>	19-100
<b>Age (years)</b>					
15-20	16 (1.9)	160 (19.1)	69 (8.2)	69±14 <sup>b</sup>	19-94
21-30	16 (1.9)	224 (26.7)	147 (17.5)	74±13 <sup>a</sup>	19-100
31-40	7 (0.8)	65 (7.8)	37 (4.4)	72±13 <sup>ab</sup>	44-100
41-50	2 (0.2)	31 (3.7)	23 (2.7)	74±12 <sup>a</sup>	44-94
>50	3 (0.4)	25 (3)	13 (1.6)	73±11 <sup>ab</sup>	44-94
<b>Education</b>					
Illiterate	0 (0)	4 (0.5)	1 (0.1)	73±14 <sup>ab</sup>	56-94
Primary school	2 (0.2)	12 (1.4)	8 (1)	71±14 <sup>ab</sup>	44-88
Secondary school	7 (0.8)	74 (8.8)	25 (3)	69±13 <sup>b</sup>	19-94
High school	15 (1.8)	114 (13.6)	44 (5.3)	69±14 <sup>b</sup>	25-100
Higher education	20 (2.4)	301 (35.9)	211 (25.2)	74±13 <sup>a</sup>	19-100
<b>Location</b>					
Ninh Kieu	24 (2.9)	237 (28.3)	176 (21)	73±13 <sup>a</sup>	19-100
Cai Rang	5 (0.6)	105 (12.5)	42 (5)	71±12 <sup>bc</sup>	25-94
O Mon	10 (1.2)	48 (5.7)	22 (2.6)	68±16 <sup>c</sup>	25-94
Phong Dien	3 (0.4)	47 (5.6)	23 (2.7)	71±14 <sup>abc</sup>	31-100
Binh Thuy	2 (0.2)	68 (8.1)	26 (3.1)	73±11 <sup>ab</sup>	38-94
<b>Income (million VND per month)</b>					
≤3	30 (3.6)	335 (40)	190 (22.7)	72±13 <sup>a</sup>	19-100
>3-8	11 (1.3)	137 (16.3)	77 (9.2)	72±13 <sup>a</sup>	31-100
>8	3 (0.4)	33 (3.9)	22 (2.6)	73±12 <sup>a</sup>	44-94
<b>Food safety training</b>					
Yes	10 (1.2)	106 (12.6)	69 (8.2)	69±14 <sup>a</sup>	11-100
No	127 (15.2)	392 (46.8)	134 (16)	61±16 <sup>b</sup>	6-100
<b>Employment status</b>					
Student	19 (2.3)	261 (31.1)	154 (18.4)	72±13 <sup>a</sup>	19-100
Employed	20 (2.4)	212 (25.3)	125 (14.9)	72±13 <sup>a</sup>	25-100
Unemployed	5 (0.6)	32 (3.8)	10 (1.2)	67±14 <sup>b</sup>	38-94
<b>Food safety training</b>					
Yes	6 (0.7)	93 (11.1)	86 (10.3)	75±13 <sup>a</sup>	25-100
No	38 (4.5)	412 (49.2)	203 (24.2)	71±13 <sup>b</sup>	19-100
Total	44 (5.3)	505 (60.3)	289 (34.5)	72±13	19-100

Mean values with the same superscript letter within the column of the same characteristics are not significantly different at the level of 5%.

Consumers who only had higher education were determined to have higher scores than those who went to high and secondary school ( $p < 0.05$ ) however no statistical difference was observed about their food safety attitude when compared to those who had primary school or illiterate ( $p > 0.05$ ). A higher educational level would have a positive effect on food safety attitude (Samapundo *et al.*, 2016; Ma *et al.*, 2019). In contrast, cooking and household tasks would gain the experiences and attitude for consumers who are less educated. However, the educational level has been determined to have no bearing on the food safety knowledge and attitude of consumers in Handan, China (Ma *et al.*,

2019).

The results of the survey to determine the food safety attitude of the vendors are shown in Table 4. The mean food safety attitude score of the vendors was 73 and the scores ranged from 25 to 100. Only 2.2% of the vendors had an inadequate food safety attitude (scores  $< 50$ ); whilst 97.8% had at least an average food safety attitude (scores of  $\geq 50$ ). Even a lower proportion of the vendors (32.3%) had good food safety attitude compared to consumers (34.5%). No statistical difference ( $p > 0.05$ ) was found in the food safety attitude of the vendors based on gender, age, level of education, income, length of time spent and types of vending. These findings

Table 4. Effect of sex, age, education, location, income, food safety training, length of time spent vending and types of vending on the food safety attitude of vendors (n=598)

Characteristics	Number of respondents (%)			Mean score±SD	Range
	<50	50-75	>75		
<b>Sex</b>					
Female	9 (1.5)	334 (55.9)	160 (26.8)	73±11 <sup>a</sup>	25-100
Male	4 (0.7)	58 (9.7)	33 (5.5)	73±12 <sup>a</sup>	31-100
<b>Age (years)</b>					
15-20	1 (0.2)	9 (1.5)	5 (0.8)	73±11 <sup>a</sup>	44-88
21-30	7 (1.2)	72 (12)	40 (6.7)	73±14 <sup>a</sup>	31-100
31-40	0 (0)	107 (17.9)	50 (8.4)	73±9 <sup>a</sup>	50-100
41-50	1 (0.2)	109 (18.2)	52 (8.7)	73±10 <sup>a</sup>	38-100
>50	4 (0.7)	95 (15.9)	46 (7.7)	72±11 <sup>a</sup>	25-94
<b>Education</b>					
Illiterate	1 (0.2)	8 (1.3)	2 (0.3)	68±13 <sup>a</sup>	38-81
Primary school	1 (0.2)	91 (15.2)	35 (5.9)	72±11 <sup>a</sup>	31-100
Secondary school	4 (0.7)	128 (21.4)	62 (10.4)	73±10 <sup>a</sup>	25-94
High school	2 (0.3)	113 (18.9)	47 (7.9)	74±10 <sup>a</sup>	38-100
Higher education	5 (0.8)	52 (8.7)	47 (7.9)	74±13 <sup>a</sup>	31-100
<b>Location</b>					
Ninh Kieu	6 (1)	186 (31.1)	100 (16.7)	74±11 <sup>a</sup>	31-100
Cai Rang	4 (0.7)	74 (12.4)	26 (4.3)	70±11 <sup>b</sup>	38-100
O Mon	1 (0.2)	53 (8.9)	28 (4.7)	74±10 <sup>a</sup>	38-94
Phong Dien	2 (0.3)	47 (7.9)	27 (4.5)	72±12 <sup>a</sup>	25-100
Binh Thuy	0 (0)	32 (5.4)	12 (2)	75±9 <sup>a</sup>	50-94
<b>Income (million VND per month)</b>					
≤3	8 (1.3)	168 (28.1)	90 (15.1)	73±12 <sup>a</sup>	25-94
>3-8	5 (0.8)	196 (32.8)	86 (14.4)	73±10 <sup>a</sup>	38-100
>8	0 (0)	28 (4.7)	17 (2.8)	74±9 <sup>a</sup>	56-94
<b>Food safety training</b>					
Yes	0 (0)	127 (21.2)	77 (12.9)	75±9 <sup>a</sup>	50-100
No	13 (2.2)	265 (44.3)	116 (19.4)	72±11 <sup>b</sup>	25-100
<b>Length of time spent vending (years)</b>					
<5	8 (1.3)	185 (30.9)	102 (17.1)	74±11 <sup>a</sup>	31-100
5-<10	2 (0.3)	101 (16.9)	40 (6.7)	72±10 <sup>a</sup>	44-94
10-<20	1 (0.2)	64 (10.7)	36 (6)	73±10 <sup>a</sup>	38-94
>20	2 (0.3)	42 (7)	15 (2.5)	72±11 <sup>a</sup>	25-88
<b>Types of vending</b>					
Stationary	10 (1.7)	336 (56.2)	160 (26.8)	73±11 <sup>a</sup>	25-100
Mobile	3 (0.5)	56 (9.4)	33 (5.5)	72±12 <sup>a</sup>	38-94
Total	13 (2.2)	392 (65.6)	193 (32.3)	73±11	25-100

Mean values with the same superscript letter within the column of the same characteristics are not significantly different at the level of 5%.

agreed with that of Auad *et al.* (2019) in Brazil. However, it was determined that food vendors who had received training in food safety had better food safety attitude than untrained vendors ( $p<0.05$ ). It is reported that trained food handlers have higher food safety attitude compared to untrained food handlers (McIntyre *et al.*, 2013; Auad *et al.*, 2019) while another study has reported that no significant differences occur between trained and untrained vendors (Baş *et al.*, 2006).

It can be seen the detail responses of the consumers and vendors to the food safety knowledge questionnaire in Table 5 and 6, respectively. The majority of the consumers did not know that *Salmonella* spp. (55.7%), hepatitis A virus (63.8%) and *Staphylococcus aureus*

(63.6%) are responsible for foodborne diseases. As shown in Table 5, almost half (49.7%) of the consumers failed to identify the demographic groups at the greatest risk of foodborne diseases. In contrast, 54.9% of the consumers knew that bloody diarrhea can be transmitted by food. 81.9% of the consumers recognized that AIDS cannot be transmitted by food. 92.2% knew that it is necessary to take leave from work if they had infectious skin diseases and 82.6% knew that microorganisms can be found in the skin, mouth, and nose of healthy handlers. The majority of the consumers were also aware of the critical role of washing hands (97.1%) and proper cleaning of utensils (97.7%) with regards to the prevention of foodborne diseases. 95.4% knew that the

use of gloves is important in reducing the risk of contamination. More than half (53.5%) of the consumers were aware that eating and drinking in the workplace lead to an increase in the risk of foodborne disease.

In comparison to the consumers, the majority of the vendors (Table 6) did not know that hepatitis A (63.2%),

*Salmonella* (65.4%) and *S. aureus* (70.2%) were foodborne pathogens. In agreement with this finding, vendors in Brazil and Haiti also failed to identify these foodborne pathogens (Soares et al., 2012; Samapundo et al., 2015). However, most of the vendors (57.2%) knew that bloody diarrhea can be transmitted through food.

Table 5. Assessment of the food safety knowledge of street food consumers (n=838)

Statement	Correct, n (%)	Wrong, n (%)	Do not know, n (%)
1. Washing hands before work reduce the risk of food contamination	814 (97.14)	13 (1.55)	11 (1.31)
2. Using gloves while handling food reduces the risk of food contamination	799 (95.35)	19 (2.27)	20 (2.39)
3. Proper cleaning and sanitization of utensils prevent the risk of food contamination	819 (97.73)	11 (1.31)	8 (0.95)
4. Eating and drinking in the workplace increase the risk of food poisoning	449 (53.58)	213 (25.42)	176 (21)
5. Food prepared in advance stored at room temperature after four hours in increases the risk of food poisoning	506 (66.95)	131 (15.63)	201 (23.99)
6. Reheating cooked foods can contribute to food poisoning	561 (66.95)	160 (19.09)	117 (13.96)
7. Washing utensils with detergent leaves them free of microbial contamination	205 (24.46)	547 (65.27)	86 (10.26)
8. Children, healthy adults, pregnant women and older individuals are at equal risk for food poisoning	421 (50.24)	276 (32.94)	141 (16.83)
9. Typhoid fever can be transmitted by contaminated food and water	417 (49.76)	146 (17.42)	275 (32.82)
10. AIDS can be transmitted by food	686 (81.86)	85 (10.14)	67 (8)
11. Bloody diarrhea can be transmitted by food	460 (54.89)	169 (20.17)	209 (24.94)
12. Abortion in pregnant women can be induced by food-borne disease	315 (37.59)	208 (24.82)	315 (37.59)
13. <i>Salmonella</i> is among the food-borne pathogens	371 (44.27)	39 (4.65)	428 (51.07)
14. Hepatitis A virus is among the food-borne pathogens	303 (36.16)	130 (15.51)	405 (48.33)
15. <i>Staphylococcus aureus</i> is among the food-borne pathogens	305 (36.4)	42 (5.01)	491 (58.59)
16. Swollen cans may contain the microorganism	555 (66.23)	98 (11.69)	185 (22.08)
17. The skin, nose and mouth of healthy handlers are free of microbes	692 (82.58)	62 (7.4)	84 (10.02)
18. During infectious disease of the skin, it is necessary to take leave from work	773 (92.24)	37 (4.42)	28 (3.34)

Table 6. Assessment of the food safety knowledge of street food vendors (n=598)

Statement	Correct, n (%)	Wrong, n (%)	Do not know, n (%)
1. Washing hands before work reduce the risk of food contamination	585 (97.83)	7 (1.17)	6 (1)
2. Using gloves while handling food reduces the risk of food contamination	564 (94.31)	21 (3.51)	13 (2.17)
3. Proper cleaning and sanitization of utensils prevent the risk of food contamination	585 (97.83)	4 (0.67)	9 (1.51)
4. Eating and drinking in the workplace increase the risk of food poisoning	318 (53.18)	163 (27.26)	117 (19.57)
5. Food prepared in advance stored at room temperature after four hours in increases the risk of food poisoning	346 (57.86)	113 (18.9)	139 (23.24)
6. Reheating cooked foods can contribute to food poisoning	458 (76.59)	98 (16.39)	42 (7.02)
7. Washing utensils with detergent leaves them free of microbial contamination	109 (18.23)	456 (76.25)	33 (5.52)
8. Children, healthy adults, pregnant women and older individuals are at equal risk for food poisoning	265 (44.31)	235 (39.3)	98 (16.39)
9. Typhoid fever can be transmitted by contaminated food and water	346 (57.86)	108 (18.06)	144 (24.08)
10. AIDS can be transmitted by food	461 (77.09)	83 (13.88)	54 (9.03)
11. Bloody diarrhea can be transmitted by food	342 (57.19)	129 (21.57)	127 (21.24)
12. Abortion in pregnant women can be induced by food-borne disease	256 (42.81)	162 (27.09)	180 (30.1)
13. <i>Salmonella</i> is among the food-borne pathogens	207 (34.62)	26 (4.35)	365(61.04)
14. Hepatitis A virus is among the food-borne pathogens	220 (36.79)	70 (11.71)	308 (51.51)
15. <i>Staphylococcus aureus</i> is among the food-borne pathogens	178 (29.77)	33 (5.52)	387 (64.72)
16. Swollen cans may contain the microorganism	407 (68.06)	73 (12.21)	118 (19.73)
17. The skin, nose and mouth of healthy handlers are free of microbes	532 (88.96)	28 (4.68)	38 (6.35)
18. During infectious disease of the skin, it is necessary to take leave from work	527 (88.13)	41 (6.86)	30 (5.02)



Compared to the consumers, a higher proportion of the vendors (77.1%) knew that AIDS could not be transmitted by food. 88.1% of the vendors also knew that it is necessary to take leave from work during an infectious disease of the skin. Vendors (89%) knew that microbes could be found on the skin, in the nose, and mouth of healthy handlers while 57.2% of the vendors did not know that abortion could be induced by foodborne diseases. About 81.8% wrongly believed that washing utensils with detergent would leave them free of contamination. Most of the vendors were aware of the importance of washing hands (97.8%), proper cleaning (97.8%) and the use of gloves (94.3%) in the prevention of foodborne diseases. About 55.7% of the vendors were not able to identify children, pregnant women and the elderly as being at equal risk of foodborne diseases. The majority of the vendors (68.1%) responded correctly that swollen cans may be a possible host of microorganisms. Vendors (57.9%) knew that food prepared in advance and stored at room temperature after four hours increases the risk of foodborne disease. Slightly more vendors than consumers knew that the reheating of cooked foods can contribute to food poisoning (76.6% vs. 67%) and slightly more consumers than vendors knew that the preparation of food in advance could lead to food poisoning (67% vs. 57.9%).

The food safety attitude response of the consumers and vendors are shown in Table 7 and 8, respectively.

Half of the consumers (62.5%) wrongly believed that a well-cooked food is free of microbial hazards and that the ideal place to store raw meat was the bottom shelf of the refrigerator (61.9%). Most of the consumers (83.7%) thought that eggs should be washed as soon as possible after purchase and 62.8% thought that chicken should not be thawed in a bowl of cold water. About 50.9% of consumers incorrectly understand that defrosted foods can be refrozen. Almost all of them (94.6%) were able to identify wearing masks as an important practice to reduce the risk of food contamination. The low percentage of correct answers (36.8%) was observed for the question concerning whether or not well-cooked food is free of microbial hazards. In agreement with the findings of other studies conducted in Ghana, South Africa and Haiti (Lues *et al.*, 2006; Donkor *et al.*, 2009; Samapundo *et al.*, 2015), most of the street food vendors (94.5%) who participated in this study were aware of the importance of separating cooked and raw foods to prevent contamination.

### 3.4 Observed food handling habits

Figure 1 shows the characteristics of the observed stalls. Based on the observation of facilities, 72.7% of vendors prepared food on-site. The finding was similar to previous studies conducted in Ho Chi Minh City, Vietnam (Samapundo *et al.*, 2016) and in China (Ma *et al.*, 2019) where the vendors prepared food on site. The stalls did not have access to potable water (53%),

Table 7. Assessment of food safety attitude of street food consumers (n=838)

Statement	Correct, n (%)	Wrong, n (%)	Do not know, n (%)
1. Well-cooked foods are free of microbial hazards	398 (47.49)	384 (45.82)	56 (6.68)
2. Proper hand hygiene can prevent food-borne diseases	782 (93.32)	38 (4.53)	18 (2.15)
3. Can a closed can/jar of cleaning product be stored together with closed cans and jars of food products	655 (78.16)	110 (13.13)	73 (8.71)
4. Raw and cooked foods can be stored them together due to the equal risk of food contamination	737 (87.95)	48 (5.73)	53 (6.32)
5. It is necessary to check the temperature of refrigerators periodically to reduce the risk of foodborne disease	730 (87.11)	63 (7.52)	45 (5.37)
6. Defrosted foods can be refrozen	411 (49.05)	315 (37.59)	112 (13.37)
7. The health status of workers don't need to be evaluated before employment	746 (89.02)	38 (4.53)	54 (6.44)
8. The best way to thaw a chicken is in a bowl of cold water	312 (37.23)	402 (47.97)	124 (14.8)
9. Wearing masks is an important practice to reduce the risk of food contamination	793 (94.63)	22 (2.63)	23 (2.74)
10. Wearing gloves is an important practice to reduce the risk of food contamination	796 (94.99)	25 (2.98)	17 (2.03)
11. Wearing caps is an important practice to reduce the risk of food contamination	537 (64.08)	201(23.99)	100 (11.93)
12. The ideal place to store raw meat in the refrigerator is on the top shelf	319 (38.07)	374 (44.63)	145 (17.3)
13. Eggs must be washed immediately after delivery	136 (16.23)	625 (74.58)	77 (9.19)
14. Dish towels can be a source of food contamination	737 (87.95)	54 (6.44)	47 (5.61)
15. Knives and cutting boards should be properly sanitized to prevent cross contamination	812 (96.9)	16 (1.91)	10 (1.19)
16. Food handlers who have abrasions or cuts on their hands should not touch foods without gloves	757 (90.33)	32 (3.82)	49 (5.85)

Table 8. Assessment of food safety attitude of street food vendors (n=598)

Statement	Correct, n (%)	Wrong, n (%)	Do not know, n (%)
1. Well-cooked foods are free of microbial hazards	220 (36.79)	351 (58.7)	27 (4.52)
2. Proper hand hygiene can prevent food-borne diseases	565 (94.48)	28 (4.68)	5 (0.84)
3. Can a closed can/jar of cleaning product be stored together with closed cans and jars of food products	447 (74.75)	127 (21.24)	24 (4.01)
4. Raw and cooked foods can be stored them together due to the equal risk of food contamination	565 (94.48)	22 (3.68)	11 (1.84)
5. It is necessary to check the temperature of refrigerators periodically to reduce the risk of foodborne disease	536 (89.63)	13 (2.17)	49 (8.19)
6. Defrosted foods can be refrozen	289 (48.33)	258 (43.14)	51 (8.53)
7. The health status of workers don't need to be evaluated before employment	526 (87.96)	24 (4.01)	48 (8.03)
8. The best way to thaw a chicken is in a bowl of cold water	236 (39.46)	300 (50.17)	62 (10.37)
9. Wearing masks is an important practice to reduce the risk of food contamination	566 (94.65)	21 (3.51)	11 (1.84)
10. Wearing gloves is an important practice to reduce the risk of food contamination	565 (94.48)	19 (3.18)	14 (2.34)
11. Wearing caps is an important practice to reduce the risk of food contamination	438 (73.24)	96 (16.05)	64 (10.7)
12. The ideal place to store raw meat in the refrigerator is on the top shelf	214 (35.79)	305 (51)	79 (13.21)
13. Eggs must be washed immediately after delivery	101 (16.89)	456 (76.25)	41 (6.86)
14. Dish towels can be a source of food contamination	554 (92.64)	26 (4.35)	18 (3.01)
15. Knives and cutting boards should be properly sanitized to prevent cross contamination	592 (99)	4 (0.67)	2 (0.33)
16. Food handlers who have abrasions or cuts on their hands should not touch foods without gloves	563 (94.15)	25 (4.18)	10 (1.67)

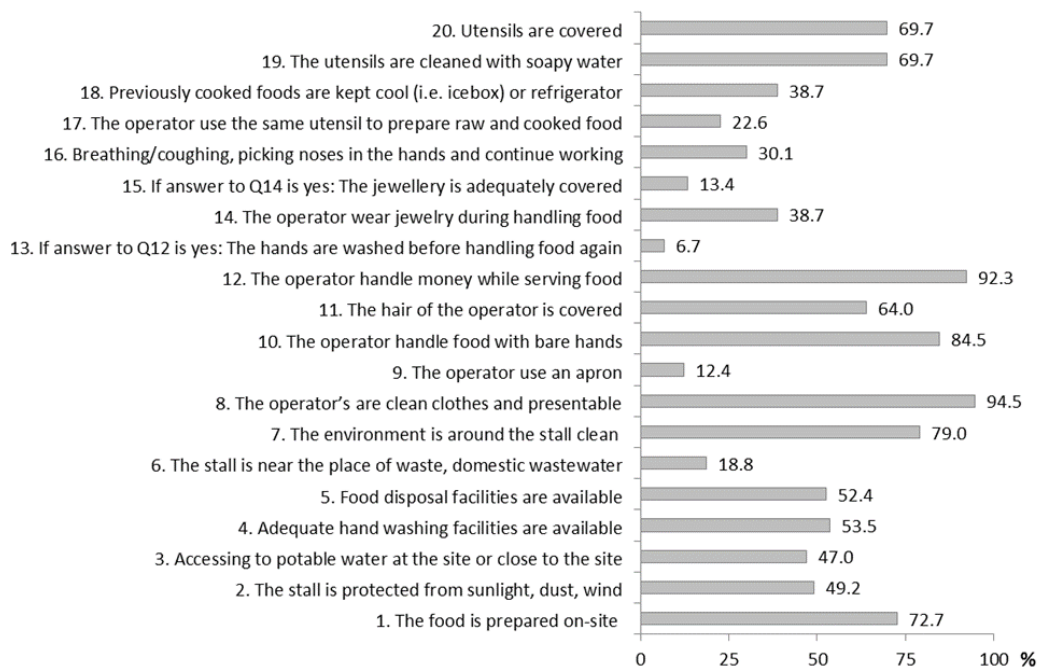


Figure 1. Hygiene practices of street food vendors in Vietnam (n = 677)

adequate handwashing (46.5%) and food disposal facilities (47.6%). Because of the lack of adequate food disposal facilities, street vendors tend to dispose of their waste in the street. Consequently, the flies and insects, potential vectors of pathogens, would be attracted and thus spread out contamination. This study is in agreement with those studies performed in Ghana (Mensah *et al.*, 2002), Uganda (Muyanja *et al.*, 2011) and Kenya (Muinde and Kuria, 2005), which found that

potable water was not readily available at street vending sites. Therefore, vending sites can contribute to street food contamination with microorganisms (Tambekar *et al.*, 2011). 50.1% of the stalls were not protected from the sun, dust, and wind. Dust potentially carries pathogens and therefore it may become a vector for their transmission to prepared foods. These findings are in agreement with the observations studied in Uganda, Sudan, Nigeria, and Kenya (Muinde and Kuria, 2005;

Abdalla *et al.*, 2009; Chukuezi, 2010; Muyanjanja *et al.*, 2011). About 79% (535/677) of the stalls had a clean environment i.e. far from rubbish, wastewater, toilet facilities, and open drains. In contrast, Muinde and Kuria (2005) reported that only 15% of street food had a clean environment around the stall in Kenya. According to the FAO, the place of food preparation should be kept clean at all times and should be far from any source of contamination such as rubbish, wastewater, dust, and animals (FAO, 1995).

In addition to facilities and environment around the stalls, the personal hygiene of vendors will have a positive impact on the safety of street food. Results showed that only 12.4% of the vendors wore an apron when handling, preparing and serving of food and 64% of their hair was covered when handling, preparing, and serving of food. Other studies in various developing countries have also observed that a low percentage of street food vendors use aprons and gloves while handling, preparing, and serving food (Subratty *et al.*, 2004; Muinde and Kuria, 2005; Lues *et al.*, 2006; Chukuezi, 2010; Samapundo *et al.*, 2015). Omemu and Aderoju (2008) also reported varying cleaning practice among food vendors, with the majority of them usually ignoring personal hygiene.

In agreement to the observations that have been made in Kenya (Muinde and Kuria, 2005), Nigeria (Omemu and Aderoju, 2008; Chukuezi, 2010) and Haiti (Samapundo *et al.*, 2015), 84.5% of the vendors in Can Tho handled food with bare hands and 92.3% handled money while serving the food; however, only 6.7% washed their hands thereafter. Accordingly to Khairuzzaman *et al.* (2014), foods and ingredients may be subjected to cross-contamination from unwashed hands. It has also been reported by European Commission (1997) that food handlers should avoid handling food with bare hands and handling money at the same time. Additionally, according to the WHO, food should be preferably handled with clean tongs, forks, spoons or disposable gloves (FAO/WHO, 1999). In this study, 30.1% of the operators were breathing or coughing in their hands, picking their noses with their hands and continued working without washing their hands. 39% of the food operators wore jewelry and only 13.4% covered the jewelry adequately. This action is considered as a source of contamination because food handlers should have, good appearance, healthy body, clean clothes, hygienic hands, short nails, no jewelry and without beard or mustache (Trafialek *et al.*, 2018).

It was observed that cooked food products were not kept cool (61.3%). This is an important finding as inadequate cooling is one of the key factors that contribute to the occurrence of food poisoning outbreaks.

It has been reported that storing raw materials at ambient temperature (29-32°C) encouraged the growth of foodborne pathogens which may pose risks to consumers (Badrie *et al.*, 2004). In the stalls, the utensils were washed clean in soapy water (69.7%) and covered (69.7%). This practice of washing the dishes seems to be common in other countries such as the Philippines and South Africa (Azanza *et al.*, 2000; Lues *et al.*, 2006).

#### 4. Conclusion

This study aims to improve the food safety status of street food through the evaluation of food safety knowledge and attitude of both vendors and consumers to street foods, and the practice of food vendors in Can Tho city, Vietnam. Results indicated that consumers and vendors generally exhibited an average food safety knowledge and attitude. Although Vietnam's street food regulations were adopted in 2012, the present study shows this had not yet transformed the practice of food vendors. Therefore, there is an urgent need to organize formal training in food hygiene and food safety. To control the risk of foodborne disease or foodborne outbreak, an effort should be made to improve the environmental conditions and infrastructure i.e. providing clean protected structures, potable water and waste disposal facilities. Also, the high frequency of checklist about the hygienic practice of street food vendors can be planned in order to strengthen the safety of street food.

#### Conflict of interest

The authors declare no conflict of interest.

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