

Food safety practices in female food handlers in catering services, Wuhu City, China

¹*Chen, Y. J., ²Song, J. G., ²Ding, S. S., ²Shi, W. and ²Chen, G. D.

¹Department of Polyclinics, Nanjing Forestry University, Nanjing 210037, Jiangsu Province, China

²School of Public Health, Wannan Medical College, Wuhu 241002, Anhui Province, China

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Abstract

Poor food safety (FS) practices play a role in transmission of food-borne diseases. However, factors responsible for poor food-handling practices in catering services are not entirely understood. By way of questionnaire, the present work investigated the food-handling practices of females in catering businesses in Wuhu City, Anhui Province, China. Of 424 interviewees, 122 (28.8%) self-reported having poor FS practices such as infrequent separation of animal- and plant-based foods and seafood during cleaning (75.5%), frequent indoor storage of perishable foods at temperatures between 8 and 60°C (59.0%), infrequent separation of raw materials in containers or the tools used during storage and processing (56.4%), and infrequent refrigeration of cold dishes (44.8%). Demographic factors associated with poor FS practices included age, average monthly income, work experience, and FS training. Respondents aged 18 - 49 years or with no FS training were more likely to report poor FS practices than individuals ≥ 50 years or with FS training. Respondents with an average monthly income ranging US\$ 414 - 966 and individuals with 5 - 6 years of work experience were less likely to report poor FS practices than respondents with a monthly income < US\$ 414 or < 1 year of work experience. Supervision and training of female caterer FS practices will reduce the incidence of food-borne diseases in catering services.

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Introduction

Food-borne disease (FBD), a major cause of morbidity and mortality, is a significant public health issue worldwide, especially in developing countries. The World Health Organization (WHO) estimates that consuming unsafe foods leads to 600 million cases of FBD globally, resulting in 420,000 deaths annually (WHO, 2015). In the United States of America, approximately 8,131 outbreaks of FBD caused 131,525 outbreak-associated illnesses, and led to 145 deaths between 2009 and 2018 (Dewey-Mattia *et al.*, 2018). In Brazil, approximately 7,630 FBD outbreaks between 2007 and 2017 were recorded in the National Epidemiological Surveillance System of Food-borne Diseases, resulted in 134,046 cases of FBD, 19,394 hospitalisations, and 127 deaths (Draeger *et al.*, 2018). In 2000, almost 1,338,772 cases of FBD caused 20,759 hospitalisations in England and Wales, and resulted in 480 deaths (Adak *et al.*, 2002). Approximately 26,847 FBD cases occurred in Taiwan from 2014 - 2018 (Yu *et al.*,

2021). FBD also poses a serious threat to human health in China (Li *et al.*, 2018), with the National Food-borne Disease Outbreaks Surveillance System reporting 5,493 outbreaks in 2021, resulting in 32,334 cases and 117 deaths (Li *et al.*, 2022).

FBD is caused by ingesting food contaminated with bacteria, viruses, or toxic and harmful substances. *Salmonella*, *Escherichia coli*, *Vibrio parahaemolyticus*, *Staphylococcus aureus*, *Clostridium perfringens*, *Bacillus cereus*, *Listeria*, and *Norovirus* are the most common pathogenic microorganisms responsible for FBD in many countries, including China (Draeger *et al.*, 2018; Li *et al.*, 2018; 2022; Yu *et al.*, 2021). Poorly enforced regulatory standards, inadequate food processing facilities, low awareness of food safety (FS), drinking unclean water, poor personal hygiene, and unsafe food-handling practices are primarily responsible for both food contamination by microorganisms and FBD (Gould *et al.*, 2013; Zhao *et al.*, 2022).

Foods provided by catering services and restaurants contribute to FBD outbreaks (Angelo *et*

*Corresponding author.
Email: 57903241@qq.com

al., 2017; Wu *et al.*, 2018; Han *et al.*, 2022). Outbreaks associated with these services are mainly attributed to poor FS practices such as incorrect preservation, unhygienic handling, inadequate cleaning of utensils, improper storage temperature and time, and cross-contamination (Gould *et al.*, 2013; Mellou *et al.*, 2019; Yu *et al.*, 2021; Zhao *et al.*, 2022). Many factors (*e.g.*, health professional supervision, routine medical check-ups, liquid waste management, knowledge and attitude of food handling, FS training, water storage equipment, gender, age, educational status, average monthly income, and work experience as a food handler) are associated with poor FS practices (Tessema *et al.*, 2014; Azanaw *et al.*, 2019; Reta *et al.*, 2021; Tuglo *et al.*, 2021; Tamiru *et al.*, 2022).

In China, FBD outbreaks caused by foods provided by catering services are a major FS concern. Although the number of male professional chefs far exceeds that of females, female food handlers are becoming increasingly dominant in catering services, particularly in small restaurants, school canteens, and fast-food restaurants. Most are engaged in food rough processing, cutting and mixing, food storage, serving food, and tableware disinfection. Accordingly, female food handlers in catering services are playing an increasingly important role in managing FS. However, the FS practices of female food handlers have been minimally researched. To reduce the impact of FBD on consumer health, the China State Administration of Market Supervision issued the Food Safety Operation Specifications for Catering Services in 2018, and used this to supervise and standardise caterer FS practices. However, it is unknown if implementing these standards has affected caterer FS practices. Accordingly, the present work investigated the FS practices and those demographic factors that affect them of female food handlers in catering services in a Chinese city.

Materials and methods

Catering locations and samples

A questionnaire-based cross-sectional survey was performed from March to December 2022, in Wuhu City, Anhui Province, China. Survey respondents, all full-time workers, worked at 11 school collective canteens and 132 communal restaurants, each of which had a food sanitation license (also known as a “Catering Service License”, issued every two years). Questionnaire respondents

working for > 3 months and engaging in food processing (*i.e.*, picking out and cleaning usable food), cooking, serving food, and cleaning/disinfection of tableware in these canteens and restaurants were recruited and interviewed. Respondents had a health check-up certificate (a national regulation, to ensure FS and hygiene for consumers, and to avoid issues such as infectious diseases and malnutrition). In total, 433 respondents accepted and completed the interview. Among them, nine that suffered from diarrhoea for other reasons were excluded, leaving 424 valid respondents.

Questionnaire

The questionnaire was designed based on the Food Safety Operation Specifications for Catering Services, and revised by the State Administration of Market Supervision of China, on June 22, 2018. Questionnaire content, structure, and design were first evaluated by a five-expert panel, then pre-tested among 20 food handlers in catering services. The final questionnaire included two sections: (A) six questions to collect socio-demographic information; and (B) 20 questions on FS practices. Section A questions required respondents to categorise their (1) age (year) (18 - 29 = 1; 30 - 39 = 2; 40 - 50 = 3; and $\geq 50 = 4$); (2) education (primary school or lower (*e.g.*, almost illiterate) = 1; junior high school = 2; high school = 3; and junior college or above = 4); (3) average monthly income (US\$) (< 414 = 1; 414 - 690 = 2; 691 - 966 = 3; and $\geq 967 = 4$); (4) work experience (years) (< 1 = 1; 1 - 2 = 2; 3 - 4 = 3; 5 - 6 = 4; 7 - 8 = 5, and $\geq 9 = 6$); (5) catering unit type (collective canteens = 1; and restaurants = 2), and whether they had or had not had FS training (yes = 1; and no = 2). Section B required respondents to answer series of yes/no questions (Table 1, questions 1 - 10; and Table 2, questions 11 - 20). FS practices were considered typical if they were followed > 70% of the time. For questions 1 - 8, 10 - 12, and 14 - 16, reporting “no” was an incorrect response, while reporting “yes” was a correct response. For questions 9, 13, and 17 - 20, reporting “yes” was an incorrect response (“no” was correct); an incorrect response was scored “1,” and a correct response was scored “0” (for a total possible score of 20 points). Each food handler's score was calculated. Food handlers who scored > 30% of the total score were considered to follow poor FS practices, and those who scored $\leq 30\%$ of the total score were considered to follow good FS practices.

Table 1. Proportions of respondents with different demographic characteristics answered “no” or “yes” to food safety practices questions (%).

Food safety practices	Age (year)				Education				Income (USD)			Work experience (year)						
	18-30	30-40	40-50	> 50	Primary school and below	Junior high school	High school	Junior college and above	< 414	414 - 966	967 - 691	< 1	1 - 2	3 - 4	5 - 6	7 - 9	> 9	
Total	96	120	144	64	43	151	123	107	40	209	63	112	88	104	72	32	48	80
No	1.0	7.5	4.2	1.6 ^a	0.0	4.6	4.1	4.7 ^b	0.0	1.4	1.6	11.6 ^a	3.4	9.6	1.4	0.0	4.2	1.3 ^a
Often wash hands with soap or hand sanitizer before handling food																		
No	8.3	13.3	5.6	0.0 ^a	11.6	9.9	7.3	2.8 ^b	20.0	3.8	12.7	7.1 ^a	0.0	7.7	11.1	25.0	0.0	10.0 ^a
Often check for any deterioration of food before handling it																		
No	70.8	76.7	75.7	79.7 ^b	62.8	80.1	78.9	70.1 ^a	70.0	74.6	76.2	78.6 ^b	72.7	76.9	76.4	71.9	72.9	78.8 ^b
Often use 3-compartment sinks to separately clean different types of raw food materials																		
No	56.3	60.0	55.6	51.6 ^b	60.5	55.0	54.5	58.9 ^b	57.5	53.6	61.9	58.0 ^b	54.5	57.7	54.2	53.1	66.7	53.8 ^b
Often use separate containers/tools to store/process different raw food materials																		
No	14.6	14.2	13.2	14.1 ^b	16.3	16.6	13.8	9.3 ^b	17.5	10.0	4.8	25.0 ^a	11.4	23.1	6.9	18.8	10.4	11.3 ^a
Often separately refrigerate raw food materials, semi-finished products, and finished products																		
No	27.1	24.2	19.4	26.6 ^b	37.2	27.2	14.6	23.4 ^a	40.0	20.6	12.7	29.5 ^a	18.2	48.1	0.0	18.8	25.0	20.0 ^a
Often removing non-edible parts of aquatic products outside a specific room for food processing																		
No	37.5	25.8	28.5	29.7 ^b	32.6	31.8	29.3	27.1 ^b	55.0	14.4	25.4	52.7 ^a	36.4	47.1	25.0	12.5	14.6	21.3 ^a
Often disinfected tableware (bowls, dishes, cups, chopsticks, knives, forks, and spoons)																		
No	2.1	9.2	8.3	4.7 ^b	2.3	7.3	6.5	7.5 ^b	12.5	7.7	0.0	6.3 ^b	3.4	7.7	5.6	6.3	6.3	10.0 ^b
Often store raw and cooked food in the same container																		
Yes	44.8	37.5	41.0	25.0 ^b	39.5	41.7	33.3	39.3 ^b	35.0	41.1	28.6	40.2 ^b	39.8	34.6	44.4	43.8	47.9	28.7 ^b
Often separately refrigerate raw plant food, animal food, and marine products																		
No	19.8	14.2	18.1	9.4 ^b	9.3	17.9	14.6	17.8 ^b	12.5	13.9	15.9	21.4 ^b	15.9	17.3	22.2	9.4	10.4	15.0 ^b

^a*p* < 0.05; ^b*p* > 0.05.

Table 2. Proportions of respondents with different demographic characteristics answering “no” or “yes” to food safety practices questions (%).

Food safety practices	Age (year)				Education				Income (USD)			Work experience (year)						
	18-30	30-40	40-50	≥ 50	Primary school and below	Junior high school	High school	Junior college and above	< 414	414 - 690	691 - 966	≥ 967	< 1	1 - 2	3 - 4	5 - 6	7 - 9	≥ 9
Total	96	120	144	64	43	151	123	107	40	209	63	112	88	104	72	32	48	80
Often immediately refrigerate cold dishes prepared in advance for later consumers																		
No	43.8	54.2	43.1	32.8 ^a	44.2	42.4	43.1	50.5 ^b	27.5	50.2	47.6	39.3 ^a	45.5	40.4	54.2	40.6	56.3	36.3 ^b
Often use plastic wrap to cover food before refrigerating them																		
No	21.9	16.7	11.8	12.5 ^b	14.0	15.9	18.7	12.1 ^b	37.5	10.5	0.0	25.9 ^a	13.6	27.9	2.8	37.5	6.3	10.0 ^a
Often store perishable foods at 8 - 60°C in the indoor environment after cooking and before eating																		
Yes	44.8	58.3	63.9	70.3 ^a	53.5	58.3	60.2	60.7 ^b	52.5	62.2	58.7	55.4 ^b	59.1	54.8	61.1	53.1	68.8	58.8 ^b
Often thoroughly process foods and cook them well																		
No	14.6	20.0	14.6	20.3 ^b	23.3	17.9	14.6	15.9 ^b	22.5	19.1	17.5	10.7 ^b	17.0	19.2	11.1	15.6	18.8	18.8 ^b
Often immediately process raw food materials thawed using a microwave oven																		
No	15.6	34.2	14.6	7.8 ^a	18.6	22.5	18.7	15.9 ^b	17.5	20.6	14.3	20.5 ^b	14.8	24.0	11.1	21.9	37.5	13.8 ^a
Often reheat cooked perishable foods stored at 8 - 60°C for more than 2 h before eating																		
No	30.2	30.0	31.3	34.4 ^b	25.6	28.5	37.4	29.9 ^b	35.0	30.6	25.4	33.9 ^b	29.5	41.3	34.7	18.0	25.0	25.0 ^b
Often use packaged food beyond its shelf-life																		
Yes	33.3	1.7	5.6	1.6 ^b	11.6	10.6	10.6	8.4 ^b	37.5	5.3	0.0	15.2 ^a	19.3	0.0	11.1	31.3	0.0	10.0 ^a
Often use food additives beyond their scope and limit																		
Yes	33.3	1.7	6.3	0.0 ^a	11.6	10.6	10.6	8.4 ^b	37.5	5.7	0.0	14.3 ^a	18.2	0.0	11.1	31.3	2.1	10.0 ^a
Often use unlabelled pre-packaged food																		
Yes	33.3	0.0	5.6	0.0 ^a	9.3	9.9	10.6	7.5 ^b	37.5	4.3	0.0	14.3 ^a	18.2	0.0	11.1	25.0	0.0	10.0 ^a
Often use recycled food as a raw material to reprocess food																		
Yes	12.5	6.7	3.5	4.7 ^a	7.0	7.9	5.7	5.6 ^b	12.5	3.8	7.9	8.9 ^b	2.3	8.7	12.5	0.0	4.2	7.5 ^b

^a*p* < 0.05; ^b*p* > 0.05.

Data collection

Data were collected by five investigators, each pre-trained by the questionnaire designer to standardise their face-to-face interview techniques. Investigators contacted the manager or directors prior to interviewing respondents to obtain consent for interviews; respondents were informed about survey objectives, provided informed verbal consent prior to each interview, and had each question explained to them. Interviews were performed at respondent workplaces.

Statistical analysis

Data were analysed using SPSS software V.22.0 (SPSS Inc., Chicago, Illinois, USA). Frequencies were calculated to describe qualitative data. Respondent responses were compared with demographic characteristics using chi-square tests. Bivariable logistic regression analysis was performed to analyse factors associated with FS practices, and to determine odds ratios (*OR*) and 95% confidence intervals (95% *CI*). A *p*-value < 0.05 was considered

statistically significant. For logistic regression analysis, age, education, average monthly income, work experience, and FS training were treated as independent variables, and FS practices (good = 0, and poor = 1) as dependent variables.

Results

Demographic characteristics of respondents

Of 424 respondents that completed the questionnaire, 264 (62.3%) were aged 30 - 50 years, and 64 (15.1%) aged ≥ 50 years; 374 (64.7%) respondents had secondary education, 43 (10.1%) had primary school or below (almost illiterate) education, and 107 (25.2%) had completed junior college or above. Average monthly income of 64.2% of respondents ranged US\$ 414 - 966. Approximately 54.7% of respondents had > 2 years of work experience as a food handler in restaurants, and approximately 94.3% of them had attended a FS training course. Further demographic characteristics are detailed in Table 3.

Table 3. Demographic data of female food handlers in catering service locations (*n* = 424).

	Variable	Frequency	Percentage (%)
Age (year)	18 -	96	22.6
	30 -	120	28.3
	40 -	144	34.0
	≥ 50	64	15.1
Education	Primary school and below	43	10.1
	Junior high school	151	35.7
	High school	123	29.0
	Junior college and above	107	25.2
Average monthly income (USD)	< 414	40	9.4
	414 - 690	209	49.3
	691 - 966	63	14.9
	≥ 967	112	26.4
Work experience (year)	< 1	88	20.8
	1 - 2	104	24.5
	3 - 4	72	17.0
	5 - 6	32	7.5
	7 - 8	48	11.3
Catering unit type	≥ 9	80	18.9
	Collective canteen	179	42.2
	Restaurant	245	57.8
Food safety training	Yes	400	94.3
	No	24	5.7

Inappropriate FS practices

The proportions of respondents reporting inappropriate FS practices are shown in Figure 1. The highest proportion of inappropriate practices involved infrequent separation of animal- and plant-based foods, and seafood (75.5%), storing perishable foods at 8 - 60°C in indoor environments (59.0%),

and infrequent use of separate containers/tools to store/process different food materials (56.4%). Of all respondents, 44.8% reported infrequently storing cold dishes in the refrigerator, and fewer (6.5% of respondents) used recycled food as a raw material to reprocess food, or infrequently disinfected tableware (6.6%).

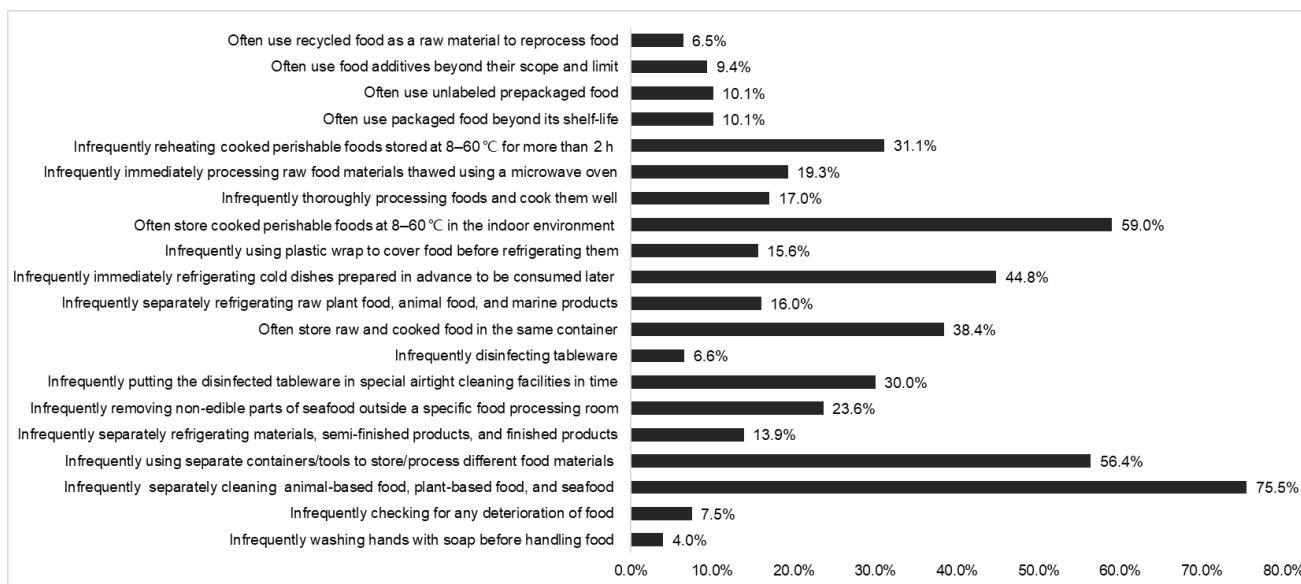


Figure 1. Distribution of improper food safety practices among respondents.

Distribution of FS practices

The proportion of respondents who reported infrequent, separate cleaning of different raw food materials (*e.g.*, meat, vegetables, fruits, and aquatic products) was significantly ($p < 0.05$) higher among educated to junior high school level (80.1%, 30/151) workers when compared with other groups in the same categories (Table 1). The proportion of respondents that reported infrequently removing inedible parts of seafood outside a specific room for food processing was significantly ($p < 0.05$) higher among workers with primary school and below (37.2%, 16/43) education, income < US\$ 414 (40.0%, 16/40), and 1 - 2 years (48.1%, 50/104) of work experience. The proportion of respondents that infrequently put disinfected tableware in special airtight facilities in a timely manner were significantly ($p < 0.05$) higher among workers earning < USD\$ 414 (55.0%, 22/40) per month, and with 1 - 2 years (47.1%, 49/104) of work experience.

The proportion of respondents who did not routinely refrigerate cold dishes immediately after preparation was significantly ($p < 0.05$) higher among workers aged 30 - 40 years (54.2%, 65/120), and monthly income range of USD\$ 414 - 690 (50.2%,

105/209) compared with other workers in the same categories (Table 2). The proportion of respondents who self-reported that they did not routinely store perishable foods appropriately (leaving them in an indoor environment at 8 - 60°C) was significantly ($p < 0.05$) higher for workers aged ≥ 50 years (70.3%, 45/64) than for other age groups. More details on the distribution of FS practices for each respondent category are presented in Tables 1 and 2.

Poor FS practices

The distribution of poor FS practices for each category of respondents is detailed in Table 4. Differences between age, average monthly income, work experience, and FS training were statistically significant ($p < 0.001$). Among all 424 respondents, 122 (28.8%) had poor FS practices and 302 (71.2%) had good FS practices. The proportion of respondents with poor FS practices was highest among workers aged 18 - 30 years (45.8%, 44/96), with an average monthly income < USD\$ 414 (47.5%, 19/40), with more limited work experience (1 - 2 years, 43.3%), and who had not participated in FS training (58.3%, 14/24).

Table 4. Levels of food safety practices for each category/group of respondents and logistic regression analysis of factors associated with food safety practices.

Variable	Food safety practices		<i>p</i>	Exp (B) (95% CI)	<i>p</i>
	Good (<i>n</i> , %)	Poor (<i>n</i> , %)			
Total	302 (71.2)	122 (28.8)			
Age (year)					
18 - 29	52 (54.2)	44 (45.8)	< 0.001	3.911 (1.598 - 9.572)	0.003
30 - 39	89 (74.2)	31 (25.8)		3.436 (1.296 - 9.109)	0.013
40 - 49	106 (73.6)	38 (26.4)		2.441 (1.014 - 5.736)	0.047
≥ 50	55 (85.9)	9 (14.1)		Ref	Ref
Education					
Primary school or below	30 (69.8)	13 (30.2)	0.440	-	-
Junior high school	101 (66.9)	50 (33.1)		-	-
High school	90 (73.2)	33 (26.8)		-	-
Junior college and above	81 (75.7)	26 (24.3)		-	-
Average monthly income (USD)					
< 414	21 (52.5)	19 (47.5)	< 0.001	Ref	Ref
414 - 690	163 (78.0)	46 (22.0)		0.269 (0.07 - 0.748)	0.012
691 - 966	57 (90.5)	6 (9.5)		0.094 (0.026 - 0.343)	<0.001
≥ 967	61 (54.5)	51 (45.5)		0.730 (0.245 - 2.177)	0.572
Work experience (year)					
< 1	58 (65.9)	30 (34.1)	0.001	Ref	Ref
1 - 2	59 (56.7)	45 (43.3)		1.588 (0.777 - 3.245)	0.205
3 - 4	58 (80.6)	14 (19.4)		0.603 (0.267 - 1.364)	0.225
5 - 6	25(78.1)	7 (21.9)		0.222 (0.065 - 0.751)	0.016
7 - 8	35 (72.9)	13 (27.1)		1.002 (0.392 - 2.564)	0.996
≥ 9	67 (83.7)	13 (16.3)		0.463 (0.155 - 1.381)	0.167
Catering unit type					
Collective canteens	123 (68.7)	56 (31.3)	0.392	-	-
Restaurants	179 (73.1)	66 (26.9)		-	-
Food safety training					
Yes	292 (73.0)	108 (27.0)	0.001	Ref	Ref
No	10 (41.7)	14 (58.3)		3.425 (1.167 - 10.055)	< 0.001

Factors associated with poor FS practices

Average monthly incomes of US\$ 414 - 690 and 691 - 966, and work experience of 5 - 6 years, compared with incomes < USD\$ 414 and < 1 year of work experience, respectively, correlated negatively with poor FS practices (Table 4). Ages 18 - 29, 30 - 39, and 40 - 49 years, and a lack of FS training, compared with those aged ≥ 50 years, and those with FS training, correlated positively with poor FS practices.

Discussion

Safe food handling practices can reduce the risk of food contamination, and prevent FBD transmission. The present work reports the demographic factors associated with FS practices among female food handlers in catering services in Wuhu City. Among respondents, 28.8% had poor FS practices—below the 36.4% reported by Tuglo *et al.* (2021) for female food handlers cooking street food

in the Volta Region, Ghana; 50.2% for female street vendors in Gondar City, northwest Ethiopia (Azanaw *et al.*, 2022); 73.6% (286/394, 94% of whom were female) of food handlers in various food establishments in the Bole sub-city, Addis Ababa, Ethiopia (Abdi *et al.*, 2020); and 59.9% (249/416, 91.9% of whom were female) of workers in restaurants, cafes, hotels, butchers, and juice houses in northwest Ethiopia (Chekol *et al.*, 2019). These differences in proportions may be attributable to variation in study designs, the research population, FS practice questions, and criteria to determine FS performance.

The present work reports food-handling practices issues such as infrequent cleaning of different types of food materials with three-compartment sinks (of 424 respondents, 75.7% of them did not frequently use the three-compartment sink; of 151 respondents with a junior high school education, 80.1% of them also did not frequently use this three-compartment sink), infrequent use of separate containers/tools to store/process different material foods (56.4%), infrequent refrigeration of cold dishes (of 424 respondents, 44.8% of them usually failed to refrigerate pre-prepared cold dishes in a timely manner; of 120 respondents aged 30 - 39 years, and 72 respondents with 3 - 4 years of work experience, 54.2% of them usually failed to refrigerate these pre-prepared cold dishes in a timely manner), and frequent storage of perishables at 8 - 60°C (of 424 respondents, 59.0% of them often left perishable foods at 8 - 60°C in the indoor environment after cooking and before eating; of 64 respondents aged ≥ 50 years, 70.3% of them did so) to be most common among respondents. According to the Code of Practice for Food Safety in Catering Services issued by the State Administration for Market Regulation in 2018, vegetables and fruits should be washed separately from other food ingredients such as meat and aquatic products. Failure to do so increases the risk of cross-contamination. Similarly, cross-contamination risks increase when containers/tools for processing/storing foods are not used separately during food preparation or storage. The code also stipulates that perishable food should be stored at a lower ($< 8^{\circ}\text{C}$) temperature, or a higher ($> 60^{\circ}\text{C}$) temperature if the timing between cooking and consumption exceeds 2 hours. The increase in number of microorganisms on food stored at low temperatures (*e.g.*, $< 5^{\circ}\text{C}$) is significantly lower than that on food stored at room temperature (Adhikari *et*

al., 2018). Strains of *Cronobacter* spp. perish within 10 - 20 minutes at 55°C , and 2 - 5 minutes at temperatures exceeding 60°C (Ueda, 2017). Therefore, storing food at inappropriate temperatures (*e.g.*, $> 8^{\circ}\text{C}$ or $< 60^{\circ}\text{C}$) facilitates microbial growth, and increases FS risks. Since food cross-contamination and inappropriate storage temperatures are the main reasons for outbreaks of FBD (Jung, 2018; Yuan *et al.*, 2021), these findings suggest that strengthen supervision of the daily operation of restaurants and increased training of female food handlers would improve food-handling practices.

Understanding how demographic factors affect food-handling practices is necessary to identify and implement appropriate remedial FS supervision, management, and education. The present work reports age to correlate with poor FS practices, with poor practices apparent in 45.5% of food handlers aged 18 - 29 years (1.8 \times higher than for the 30 - 39 years age group (25.8%), 1.7 \times that of the 40 - 49 years age group (26.4%), and 3.2 \times that of the ≥ 50 years age group (14.1%)). Younger food handlers are also more likely to use unsafe food practices. Compared with food handlers aged ≥ 50 years, the likelihood of poor FS practices among workers aged 18 - 29, 30 - 39, and 40 - 49 years increases by 3.9 \times , 3.4 \times , and 2.4 \times , respectively. Older food handlers may have a greater awareness of food practices, and how poor practices can deleteriously affect consumer health. They tend to be more careful, cautious, and responsible when handling food. Younger food handlers, however, may lack the prerequisite awareness of FS responsibility to improve FS quality, and thereby reduce the incidence of FS issues—a finding consistent with research by Reta *et al.* (2021), but not supported by Lema *et al.* (2020), Keleb *et al.* (2022), and Alemu *et al.* (2023), all of whom reported no correlation between age and food handling practices. This inconsistency may be caused by regional differences in research populations, changes in questionnaire content, differences in standards for determining poor FS practices, and changes in segmentation of age groups.

The present work reports a lower average monthly income to be related to poor FS practices. Compared with food handlers with monthly incomes $< \text{US\$ } 414$, the odds of poor FS practices in food handlers with incomes ranging $\text{US\$ } 414 - 690$ was 26.9% less likely, and further reduced to 9.4% among food handlers with a monthly income of $\text{US\$ } 691 - 966$. These results indicated that food handlers who

had a lower income were more likely to practice unsafe food-handling skills. All respondents were full-time workers in the present work, where market wages range of US\$ 485 – 1,177 (CNY 3,500 – 8,500), with a minority earning < US\$ 415 (CNY 3,000) or > US\$ 1,246 (CNY 9,000) (exchange rates 13 November 2024) (Wuhu Municipal Human Resources and Social Security Bureau, 2023). Salary is related to many factors [e.g., size of the catering unit, restaurant revenue, work experience, cooking proficiency, and job type (cooking, tableware disinfection, and cutting and mixing)]. Compared with higher-income food handlers, those earning less may be unable to afford training on food hygiene, contributing to lower levels of FS knowledge (Al Banna *et al.*, 2021). The result was consistent with studies in Volta Region, Ghana (Tuglo *et al.*, 2021), Bahir Dar City, northwest Ethiopia (Alemu *et al.*, 2023), and Dangila town, northwest Ethiopia (Tessema *et al.*, 2014). However, in Gondar City, northwest Ethiopia, income level was unrelated to food handler FS practices (Azanaw *et al.*, 2019).

Lack of work experience has previously been associated with poor FS practices. In a student cafeteria of Woldia University, north-eastern Ethiopia, food handlers with ≤ 1 year of work experience (*vs.* more experienced food handlers) were 3 \times more likely to use poor food hygiene practices (Abegaz, 2022). In Fiche Town, North Shewa Zone, Ethiopia (Teferi *et al.*, 2021), food handlers with > 10 years of work experience were 3.11 \times more likely to use good food-handling practices than those with < 1 year of work experience. In Mettu and Bedelle towns, southwest Ethiopia (Tamiru *et al.*, 2022), the odds of food handlers with 2 - 4 and 5 - 7 years of work experience using unsafe food practices decreased by 96.8% and 88.5%, respectively, when compared with workers with < 2 years of work experience. The present work reports the probability of workers with 5 - 6 years of work experience using poor food-handling practices to be 77.8% less likely compared with those with < 1 year of work experience, consistent with previous studies (Alemayehu *et al.*, 2021; Reta *et al.*, 2021; Teferi *et al.*, 2021; Abegaz, 2022; Tamiru *et al.*, 2022). While work experience from continuous practices should improve food handler proficiency and behaviour, this was not the case in North Dayi District, Ghana (Tuglo *et al.*, 2021); Amhara Regional State, northwest Ethiopia (Alemu *et al.*, 2023); Gondar, Ethiopia (Engdaw *et al.*, 2023); or Dhaka and Chattogram, Bangladesh (Al

Banna *et al.*, 2022). It should be noted, however, that inconsistent regions, food handlers [e.g., for Tuglo *et al.* (2021), they were working in the street delis; for Alemu *et al.* (2023), food service industries; for Engdaw *et al.* (2023), food and drink service establishments; and for Al Banna *et al.* (2022), hospital kitchens], and work experience categories [e.g., for Tuglo *et al.* (2021), these were < 3, 3 - 10, 10 - 20, and > 20 years; for Alemu *et al.* (2023), < 5 and ≥ 5 years; for Engdaw *et al.* (2023), < 1, 1 - 2, and > 2 years; and for Al Banna *et al.* (2022), < 5, 5 - 10, and > 10 years] were used in each of these studies.

Training may improve knowledge levels and convert attitudes toward FS, thereby improving FS practices. A lack of FS training significantly correlated with poor food-handling practices, with 58.3% of respondents with no training having poor FS practices. The probability of a worker using poor food-handling practices was 3.4 \times lower in workers with FS training than those without it. Adane *et al.* (2018) suggested that trained food handlers in street food shops and food establishments were 6.7 \times more likely to have good level of food hygiene practices than those without training. Tuglo *et al.* (2021) reported street-cooked food handlers who had completed FS training to be 5.97 \times more likely to perform good food hygiene practices than those who had not. Alemu *et al.* (2023) reported a stronger correlation between a lack training in FS and poor FS practices, with the likelihood of poor food hygiene practices being 7.96 \times higher in untrained food handlers than in trained food handlers. Additionally, the likelihood of having good food hygiene practices was 2.05 \times (Alemayehu *et al.*, 2021), 1.79 (Reta *et al.*, 2021), and 2.11 \times (Abegaz, 2022) higher in trained food handlers than in untrained food handlers—all lower than 3.4 \times reported herein. FS training can improve food handler knowledge of FS practices, and enable them to better understand and fulfil their FS responsibilities. Despite 94% of our respondents having had FS related training, we noted that 28.8% of them still performed poorly in FS practices. This suggested that ongoing and periodic FS training should be provided to ensure that food-handlers have the requisite knowledge and skills to comply with FS standards.

Limitations

The present work had two study limitations. First, the data on food-handler FS practices were obtained *via* self-reporting rather than direct

observation. As such, respondents may have reported expectations rather than actual practice, which may adversely affect determination of causal relationships between FS practices and demographic factors. Second, since respondents were selected from a limited area, the findings may not be representative of female food handlers working in catering services throughout China. Further studies using quantitative and qualitative methods may yield more comprehensive results and verify these findings.

Conclusion

Inappropriate food handling practices such as incorrect cleaning of food ingredients, improper storage of perishable food and cold dishes, and improper use of containers for storing foods, are common among female food handlers working in catering services. Predominant factors associated with poor food handling practices included age, average monthly income, work experience, and former FS training. We recommend that female food handlers, especially young and inexperienced ones working in catering services, should be trained in FS to improve their food handling practices.

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