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Food safety knowledge, hygiene practices among food handlers, and microbiological quality of animal side dishes in contract catering

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Key words: food handlers, food safety knowledge, hygiene practice, microbiological quality, contract catering.

Contributions: IRP designed the study and was in charge of overall direction and planning, analyzed and interpreted the results, and wrote the paper; RDB designed and supervised the project, and prepared the draft manuscript; FAK, ASH, collected and analyzed the data, and contributed to drafting the manuscript.

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Abstract
Food poisoning is a major concern in catering services in Indonesia, with multiple outbreaks being reported in factories and offices. This study aimed to assess the level of food safety knowledge, personal hygiene practices, and microbiological quality of chicken and egg dishes at three catering companies in the Yogyakarta Special Region of Indonesia, which provide mass catering for workers. From March to July 2019, a cross-sectional study was conducted using validated questionnaires, observation checklists, and microbiological tests to measure the parameters of *Escherichia coli* and *Staphylococcus aureus*. Pearson and Rank-Spearman correlation tests, as well as independent sample *t*-tests, were used for statistical analysis. The study revealed that 75% of the subjects had limited knowledge of food safety, with only 5% having a good understanding. Furthermore, 95% of the subjects had not received any food safety training, resulting in poor hygiene practices among the food handlers. Although there was no significant correlation between food safety knowledge and hygiene practices ($p>0.05$), certain practices, such as appearance and hand washing, were significantly correlated with age. Employment duration was negatively correlated with food safety knowledge ($p=0.027$; $r=-0.494$). While chicken samples were free from *E. coli* and *S. aureus*, one egg sample was found to be contaminated with *E. coli*. The research emphasizes the significance of providing frequent food safety training to food handlers, ideally every year. Additionally, it recommends conducting larger sample studies and collaborating with government agencies for future research.

Introduction

Food poisoning is defined as an illness that occurs when someone gets sick from consuming food that is suspected to contain biological or chemical contamination (Ministry of Health - Republic of Indonesia, 2013). Indonesia experienced 61,119 cases of food poisoning from a population of 715,579 at-risk individuals between 2000 and 2015, leading to an attack rate of 8.5% and a 0.4% case fatality rate, resulting in 291 people losing their lives (Arisanti *et al*., 2018). According to the 2019 Annual Report of the Center for Food and Drug Data and Information in Indonesia, the leading causes of food poisoning were household processed food (265 cases), catering food (97 cases), and street food (43 cases) (Indonesia National Agency of Drug and Food Control, 2020).

Catering services are intricate systems that strive to provide high-quality food products to diverse consumers, but foodborne infections and poisoning remain major concerns (Osimani *et al*., 2016; Doğan and Tekiner, 2021;). Based on a systematic review study, Indonesian factories rank third in frequency of foodborne poisoning after homes and schools (Arisanti *et al*., 2018). There have been reports of food poisoning outbreaks in a garment factory and an office due to contaminated catering buffet food (Prihastuti *et al*., 2018; Wiariyanti *et al*., 2018).

In the catering industry, pathogenic bacteria are often responsible for food poisoning outbreaks (Zaitun *et al*., 2018). Bacteria caused 74.9% of food poisoning outbreaks in Indonesia from 2000 to 2015, with *Escherichia coli*, *Bacillus cereus*, and *Staphylococcus* sp. being the main culprits (Arisanti *et al*., 2018).

The cleanliness of food and food handlers is critical in preventing food poisoning and disease transmission, as any incident can have severe consequences on the quality of catering services (Rahmadhani and Sumarmi, 2017). Encouraging food handlers to maintain personal hygiene and follow good handling practices is crucial to prevent the transmission of pathogens from food handlers to consumers (Smigic *et al*., 2016). Poor hygiene practices and lack of knowledge increase the risk of food and beverage contamination (Salsabela and Abryanto, 2022). A study on a group of food handlers in Indonesia discovered that the knowledge level of food handlers was the biggest contributor to food contamination (Susanna *et al*., 2015).

Microbiological tests are necessary for ensuring food safety, with the Indonesian Ministry of Health (Ministry of Health - Republic of Indonesia, 2011) recommending the use of *E. coli* bacterial counts as a standard test for food quality control. Studies suggest that food handler hygiene affects *E. coli* contamination (Romanda *et al*., 2016; Rahmayani and Simatupang, 2019). Additionally,

Staphylococcus aureus can serve as an important indicator of personal hygiene and the effectiveness of industrial sanitation programs (Zhang *et al*., 2018). Almost all types of food are susceptible to *S. aureus* contamination, especially those high in protein (Soedarto, 2015). Animal side dishes, particularly those containing high nutrient levels, are prone to microbiological contamination because they provide a favorable environment for microorganisms to grow and multiply (Yulistiani, 2010; Fatimah *et al*., 2022). In Europe, animal-derived food products were found to be the main cause of foodborne outbreaks in 2017, with meat and meat products being the most frequently implicated food group, followed by eggs and egg products (European Food Safety Authority, 2018).
This study aimed to examine the correlation between food safety knowledge and hygiene practices among food handlers working for contract catering companies in the Yogyakarta Special Region, Indonesia. It also investigated the microbiological quality of animal side dishes catered in terms of *E. coli* and *Staphylococcus aureus* parameters.

Materials and Methods

Study design, location, and population

This study employed a quantitative approach with a cross-sectional design and was conducted from March to July 2019 at three catering companies operating in the Yogyakarta Special Region, Indonesia. These companies were contracted to provide mass catering for workers, with a minimum of 50 portions per day. Catering A, located in Sleman Regency, provided food for restaurant employees with 80 daily portions. Catering B, also in Sleman Regency, served agricultural equipment employees with 450-480 portions per day for the morning shift and 280-300 portions for the afternoon shift. Catering C, located in Yogyakarta City, served hospital and printing company employees with 300-400 portions per day. Only Catering A did not have a nutritionist, but it had a food service sanitation hygiene certificate from the Health Service Office. All caterers operated from the owner's residence (home-based industries). The research participants consisted of food handlers involved in food preparation, cooking, and serving. Of the 23 food handlers present across the three catering establishments, 20 were willing to participate in the study and completed the questionnaire.

Data collection

The study assessed three variables: food safety knowledge, personal hygiene practices, and microbiological quality of chicken and egg dishes. Subjects completed a questionnaire modified from previous research (Garayoa *et al*., 2011; Sunaryo, 2011) to measure food safety knowledge. The questionnaire included multiple-choice questions on topics such as defrosting methods, appropriate storage and handling, handwashing, cleaning and sanitizing, and food sampling. Scores from the questionnaire were classified into three categories: good (above 75), medium (56-75), or poor (below 56) knowledge levels (Nursalam, 2008).
The food safety knowledge questionnaire was pre-tested on 30 food handlers from 5 catering establishments in Sleman District and Yogyakarta City (Khoirunnisa, 2019). These establishments serve the public in various settings such as offices, schools, meetings, and parties, but were not part of the research locations. Out of 30 participants, the majority (83.33%) worked in the food cooking unit. Only 4 (13.33%) were male, 1 (3.33%) had acquired tertiary education or graduated from a college, and 5 (16.67%) participants received training in food safety, hygiene, and sanitation. The point-biserial correlation method was employed to conduct the validity test, as each question's score was binary, either 1 or 0 (Arikunto, 2013). The validity test identified 16 of the 32 questions as valid research instruments with a correlation coefficient (r) greater than 0.30. The Kuder-Richardson Formula 20 was utilized for the reliability test (Arikunto, 2013), resulting in a high overall reliability coefficient of 0.65 ($0.60 \leq r_{11} < 0.80$) for the 16-item questionnaire.
Researchers evaluated food handlers' hygiene practices at each catering kitchen in March-April 2019 using a 25-item observation checklist adhering to Indonesian food safety regulations (Ministry of Health - Republic of Indonesia, 2011, 2012; Indonesia National Agency of Drug and Food Control, 2012). The checklist encompassed appearance, behavior, and hand-washing habits, with a score of 1

for observed and 0 for not observed. The same checklist has been used in prior research (Khairina *et al.*, 2018).

The microbiological quality of chicken and egg side dishes processed by catering was assessed for *E. coli* and *S. aureus* contamination. These two food ingredients are commonly provided by contract catering and are at high risk of dangerous contamination. Samples were collected twice aseptically from different days and transported in an ice box to the testing laboratory within 30-60 minutes. Microbiological tests were conducted by the Yogyakarta Health and Calibration Laboratory Center using the Pour Plate Colony Counting method. The testing materials included 0.9% NaCl, Tryptone Bile X-glucuronide Agar, Petri dishes, test tubes, pipettes, and incubators. Samples were analyzed immediately if submitted in the morning, or within 24 hours if submitted in the afternoon or evening. The microbiological examination results were expressed in colonies per gram (cfu/g) and followed the Food and Drug Supervisory Agency regulation number 13 of 2019. An acceptable result for the *E. coli* test would be less than 10^1 colonies per gram, whereas an unsatisfactory outcome would be more than 10^1 colonies/g. For the *S. aureus* test, less than 10^2 colonies/g was satisfactory, and more than 10^2 colonies/g was unsatisfactory (Indonesia National Agency of Drug and Food Control, 2019).

Data analysis

The study used descriptive statistics to analyze the demographics, food safety knowledge, and hygiene practices of food handlers, along with the microbiological quality of animal side dishes. Statistical analyses were performed using the Pearson correlation test for normally distributed data and the Rank-Spearman correlation test for data that were not normally distributed. Additionally, the independent samples *t*-test was utilized to analyze the relationship between demographic characteristics such as level of education, catering origin, work unit, and training history with the food safety knowledge and hygiene practices of the subjects.

Results and Discussion

All 20 participants in the study were female and did not have a tertiary education (Table 1) (Khoirunnisa, 2019). The majority of the participants (65%) worked in Catering C, were over 40 years old (95%), had completed high school (45%), and had never received any food safety training (95%). Food handlers in this study had different characteristics compared to a catering service in Surakarta, Indonesia, which had 18 handlers. The majority of them were male (61.1%) and aged below 40 years (100%) (Marfuah *et al*., 2023).

Food safety knowledge and hygiene practices among food handlers

Table 2 shows that 75% of the subjects had a low level of knowledge about food safety, while only 5% had a good level of knowledge (Khoirunnisa, 2019). The overall personal hygiene practice score was 12.50±2.01, reaching only 50% of the maximum score of 25, indicating poor implementation of food handlers' hygiene practices.

Most subjects in this study were able to answer questions about kitchen requirements and cooking utensils but struggled with topics like defrosting frozen food, refrigerator and freezer temperatures, and bacterial growth temperatures. The research findings differ from those of previous studies. A survey of 15 catering companies in Apulia, Italy found that only 8% of kitchen operators lacked knowledge of food storage temperatures (Disanto *et al*., 2020). In contrast, a study in Malaysia showed that food handlers had excellent knowledge of food storage temperatures and food storage (Siau *et al*., 2015). This variation could be attributed to differences in the characteristics of the research subjects, such as the percentage of respondents who attended food handler training. Government regulations require food handlers in catering services to have a food sanitation hygiene course certificate (Ministry of Health - Republic of Indonesia, 2011). However, not all caterers in Indonesia have these certificates, and there is minimal participation in food sanitation hygiene courses or training activities. In this study, 95% of the subjects were not trained in food safety (Table 1) (Khoirunnisa, 2019).

Food handlers had a 50% personal hygiene practice score, indicating poor practices. The highest average score for hygiene practices was in behavior during work, while the lowest was in good hand-washing practices. Subjects fully carried out nail appearances, not smoking, and not eating while working, whereas the least performed actions were wearing a mask, not talking excessively while preparing food, and following proper hand-washing steps. This finding aligns with a study among employees of small food companies in Ambon City, Indonesia, which revealed that 57.7% of the respondents had a low level of knowledge and failed to follow safe food handling practices (Sihombing *et al*., 2018).

In this study, food handlers did not use required personal protective equipment due to discomfort, leading to customer complaints about finding hair in the food. Customer satisfaction in contract-based food service businesses is influenced by food quality, cleanliness, menu, and overall environment (Ko, 2010). Furthermore, food handlers can transmit pathogens, leading to disease outbreaks. Therefore, proper hand washing, wearing protective gear, and refraining from smoking and chatting while preparing food are essential (Ministry of Health - Republic of Indonesia, 2011; Ismail *et al*., 2016).

In Table 3, there was no significant relationship found between food safety knowledge and individual hygiene practices or the four components of hygiene practices ($p>0.05$). Table 3 also includes bivariate analysis results for food safety knowledge, individual hygiene practices, and demographic characteristics such as age and duration of employment.

The study found no significant relationship between food safety knowledge and hygiene practices which is consistent with prior research in Yogyakarta (Suryani *et al*., 2019) and Jakarta (Putri and Susanna, 2021) but contradicts other studies (Sihombing *et al*., 2018; Firdani, 2022). Food handlers' education level and training experience significantly correlated with their food handling practices in the studies of Sihombing *et al*. (2018) and Firdani (2022), but not in the present study.

The mean difference test showed no significant differences in individual knowledge and practice scores based on education level, catering origin, work unit, and food safety training ($p>0.05$, data not shown). This contrasts with research in Turkey, which found that staff who received hygiene training had higher mean scores on hygiene knowledge tests. Production staff also had higher knowledge of hygiene compared to service staff, dishwashers, and cleaning personnel (Yardımcı *et al*., 2015). Furthermore, because of limited participation, only 20 out of the 23 food handlers from 3 catering services were involved in this study, with no male subjects included. It is worth noting that this could potentially impact the results, as previous research has demonstrated gender differences in food hygiene and safety knowledge and attitudes among food handlers (Kubde *et al*., 2016).

The results of this study differ from those of previous studies that examined the knowledge, attitude, and practices of food handlers. A study in Malaysia found a significant correlation between educational level and attitude, knowledge and attitude, knowledge and practice, and attitude and practice among food handlers (Abdul-Mutalib *et al*., 2012). Another study in semi-industrial catering in a government office in Iran reveals that significant relations exist between knowledge and attitude and between attitude and practice (Fariba *et al*., 2018). Food safety attitude mediates between knowledge and hazard analysis critical control point practices in restaurant employees (Ko, 2013). The present study, however, did not take into account the impact of attitude, which may explain the lack of a relationship between knowledge and practice.

The study found that age did not significantly affect overall knowledge of food safety and hygiene. Other studies in Yogyakarta City and Kuala Pilah, Malaysia, also found no association between age and food safety practices among food handlers (Abdul-Mutalib *et al.*, 2012; Suryani *et al.*, 2019), consistent with the findings of the present study. However, age did correlate with specific hygiene practices, such as the appearance of food handlers ($p=0.022$) and hand-washing techniques ($p=0.023$). As age increased, appearance-related hygiene practices decreased, while good hand-washing practices increased. This aligns with previous research in Korea, which found that older individuals had better hand-washing habits than younger ones (Kim, 2019).

No significant correlation was found between employment duration and individual hygiene practices ($p>0.05$). Previous research in various areas of Yogyakarta has reported similar findings (Suryani *et al.*, 2019; Rivani and Putriningtyas, 2023). However, employment duration was inversely related to food safety knowledge ($p=0.027$; $r=-0.494$), indicating that as food handlers' employment duration increases, their food safety knowledge decreases. Food handlers who have worked for an average of six years (Table 1) may have developed habitual behaviors related to food handling practices. Consistent practice of food handling is likely to form a habit (Mullan and Wong, 2009). Studies suggest that half of employees' work behaviors are automatic (Renn *et al*., 2024), which may lead to some food handlers not prioritizing their knowledge of safe food handling practices. However, this assumption cannot be supported by empirical data as this study did not factor in habits or past behavior that could impact behavior.

Further statistical analysis using the independent samples t-test revealed that the food safety knowledge of individuals with one year or less of work experience (mean score of 72.50±10.61) was significantly different ($p=0.016$) from those who have worked for more than a year (mean of 43.33±14.95). These findings highlight the importance of refreshing knowledge through regular training, at least annually, to prevent a decline in food safety knowledge among food handlers. Periodic safety training is crucial for food handlers to apply learned knowledge while handling food (Putri and Susanna, 2021).

Microbiological quality of animal side dishes

Table 4 presents the outcomes of the microbiological test and their interpretation (Hanifi, 2019; Khoirunnisa, 2019). All chicken samples were safe for consumption, with *E. coli* and *S. aureus* within safe limits. However, one egg sample had 20 cfu/gram of *E. coli*, exceeding the acceptable limit.

The study found that the chicken samples were free from *E. coli* and *S. aureus*, which was consistent with prior research conducted in Yogyakarta (Blikon *et al*., 2017; Wulandari and Rahayu, 2018). However, one egg sample had *E. coli* contamination due to an egg beater falling near the rubbish dump in the Catering C kitchen. Catering faces challenges in preventing the spread of foodborne illnesses, with factors such as poor employee health and hygiene, cross-contamination, and contaminated equipment identified by the World Health Organization (Doğan and Tekiner, 2021). The study suggested a lack of knowledge of hygiene and sanitation among food handlers, particularly in preventing cross-contamination during food preparation and production processes. Home-based catering businesses are often run without adequate knowledge of proper sanitation practices (Rohmalia and Djajalaksana, 2013).

Ongoing training, implementation of standard procedures, and regular verification can reduce the risk of cross-contamination due to improper sanitation (Sneed *et al*., 2004). Auditing and sampling are also effective means of improving food quality standards and increasing food business operators' awareness of hygiene protocols (Bellio *et al*., 2012). The owner and food handlers at Catering C acknowledged the importance of microbiological food testing to ensure food safety. They expressed interest in conducting such examinations to ensure that the food prepared at specific times meets hygiene standards and remains safe for consumption.

The research showed strength in terms of microbiological testing, which used standardized methods that are commonly applied in examining food samples to confirm the cause of food poisoning in the local area. Additionally, researchers measured the food handlers' hygiene practices through direct participatory observation. However, the main limitation of the present study was the relatively small sample size due to the difficulty in obtaining commercial catering permits. This resulted in limited research subjects and food samples, and the interpretation of research findings should not be generalized to the general population of food handlers in contract catering. Nonetheless, the research emphasizes the significance of regular food safety training for food handlers, consistent with earlier research in Depok, Indonesia, albeit with a smaller sample size of only 20 participants (Maharani *et al*., 2018).

Conclusions

Food handlers in several contract catering companies in Yogyakarta, Indonesia have a relatively low level of food safety knowledge and hygiene practices, with no correlation found between the two. Furthermore, food handlers' food safety knowledge declines with longer employment. The microbiological test shows that all chicken and egg side dish samples are safe from *S. aureus* contamination; however, a single egg-based food sample is found to be contaminated with *E. coli* bacteria. These findings are highly concerning, as they indicate that customers may be at risk of contracting foodborne illnesses due to the unsafe food being served. To improve the quality of catered food, the Health Service Office is recommended to hold refresher courses annually. Catering businesses should obtain sanitation certificates, and future studies with a similar topic should involve larger sample sizes and government collaboration at the sub-district level to facilitate research permits.

The outcomes of the present study contribute to the existing body of literature on food safety issues and emphasize their practical significance. Specifically, the study highlights that inadequate sanitation and hygiene, along with cross-contamination, are among the five food-handling factors linked to foodborne illness outbreaks, as outlined by the World Health Organization. It also sheds light on the prevalence of *E. coli* bacteria as the primary causative agent of food poisoning outbreaks in Indonesia, which may be present in food produced by contract catering. The absence of food handling courses for employees and irregular bacteriological examinations by caterers can be attributed to a lack of awareness and understanding among catering owners, as well as cost factors.

The study underscores the critical role of training and awareness campaigns in enhancing the food safety knowledge of food service employees. Catering companies and their employees should understand the importance of food handling courses and bacteriological examinations. Proper training, certification, and testing are necessary investments, not budgetary burdens, to avoid foodborne illnesses that can lead to customer complaints, fatalities, and financial losses. Prioritizing food safety and quality will protect customers and ensure business longevity.

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Table 1. Characteristics of subjects. Reproduced from: Khoirunnisa, 2019.

Characteristics	Frequency	Percentage (%)	Mean±SD	Range
Place of work				
Catering A	2	10		
Catering B	5	25		
Catering C	13	65		
Sex				
Male	0	0		
Female	20	100		
Age (years)			47.5±11.03	22-68
Education level				
No formal education	1	5		
Elementary school	5	25		
Junior high school	5	25		
High school	9	45		
Working unit				
Food preparation	6	30		
Food cooking	10	50		
Food packaging	4	20		
Duration of employment (years)			6±5.5	0.5-25
Food safety training				
Yes	1	5		
No	19	95		

SD, standard deviation.

Table 2. Descriptive statistics of food safety knowledge and hygiene practice of food handlers. Reproduced from: Khoirunnisa (2019) for the food safety knowledge statistics.

Variable	Frequency	Percentage (%)	Mean±SD	Range
Food safety knowledge			46.25±16.93	5-80
Poor	15	75		
Medium	4	20		
Good	1	5		
Overall personal hygiene practice			12.50±2.01	9-16
Appearance when handling food (6 items)			3.05±0.99	1-5
Behavior during work (8 items)			4.65±0.99	3-6
Hand washing habits (5 items)			3.70±1.13	2-5
Correct hand-washing steps (6 items)			1.10±0.45	0-2

Table 3. Correlations between food safety knowledge, hygiene practices and demographic characteristics of food handlers.

Variables	p-value	r
Food Safety Knowledge-Overall personal hygiene practice	0.464[1]	+0.174
Food Safety Knowledge-Appearance when handling food	0.727[2]	-0.083
Food Safety Knowledge-Behavior during work	0.496[2]	+0.161
Food Safety Knowledge-Hand washing habits	0.243[2]	+0.274
Food Safety Knowledge-Good hand washing practices	0.782[2]	+0.066
Age-Food Safety Knowledge	0.467[1]	-0.173
Duration of employment-Food Safety Knowledge	0.027[1]*	-0.494
Age- Overall personal hygiene practice	0.743[1]	+0.078
Age-Appearance when handling food	0.022[2]*	-0.507
Age-Behavior during work	0.337[2]	+0.226
Age-Hand washing habits	0.547[2]	+0.143
Age-Good hand washing practices	0.023[2]*	+0.507
Duration of employment-Overall personal hygiene practice	0.612[1]	+0.121
Duration of employment-Appearance when handling food	0.114[2]	+0.364
Duration of employment-Behavior during work	0.425[2]	+0.189
Duration of employment-Hand washing habits	0.917[2]	-0.025
Duration of employment-Good hand washing practices	0.910[2]	-0.027

[1]Pearson correlation test; [2]rank-spearman correlation test; *significant ($p<0.05$).

Table 4. Microbiological quality parameters (numbers of *E. coli* and *S. aureus*) of the animal side dish menu. Reproduced from: Hanifi, 2019; Khoirunnisa, 2019.

Food Sample	Microbiological Quality Parameters	Satisfactory n (%)	Unsatisfactory n (%)	Total n (%)
Chicken dishes	*E. coli*	9 (100%)	0 (0)	9 (100%)
	S. aureus	9 (100%)	0 (0)	9 (100%)
Egg dishes	*E. coli*	11 (91.67%)	1 (8.3%)	12 (100%)
	S. aureus	12 (100%)	0 (0)	12 (100%)