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Enhancing Food Safety: An Analysis of Food Handlers' Knowledge and Behavior in Uncertified School Catering Services

Siti Maisyaroh Bakti Pertiwi [a,1,*], Hanifa M. Denny [a,2], Nurjazuli Nurjazuli [b,3], Syamsulhuda Budi Musthofa [c,4]

a Program Doctoral Public Health Faculty of Public Health, Universitas Diponegoro, Semarang City, Indonesia
b Department of Environmental Health Faculty of Public Health, Universitas Diponegoro, Semarang City, Indonesia
c Department of Health and Promotion Faculty of Public Health, Universitas Diponegoro, Semarang City, Indonesia
1 smbaktipertiwi16@gmail.com*; 2hanifadenny@live.undip.ac.id; 3 nurjzlfkmundip@yahoo.com; 4 syamsulhuda@gmail.com
*Coresponding author: hanifadenny@live.undip.ac.id

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ABSTRACT

Background: Foodborne illnesses are a significant global health risk, especially in schools with uncertified catering. Food handlers are crucial for food safety, however inadequate knowledge and hygiene can lead to contamination by pathogens like *Staphylococcus aureus*. This study investigates the relationship between food handlers' knowledge, behavior, and *S. aureus* contamination in uncertified school catering.

Method: A *cross-sectional* study involved 88 food handlers from six private schools in Semarang City, selected through *purposive sampling*. Data were collected via questionnaires and swab tests for *S. aureus* detection. Bivariate analysis using the Chi-Square test assessed relationships between knowledge, behavior, and *contamination* rates.

Results: Food handlers with good knowledge had an S. *aureus* contamination rate of 8.6%, compared to 37.7% for those with less knowledge (p = 0.005). Those practicing good hygiene had an 11.8% contamination rate, significantly lower than the 11.8% rate among poorly behaved *handlers* (p = 0.0029).

Conclusion: Increased knowledge and better hygiene practices are associated with lower *S. aureus* contamination in food handlers at uncertified school caterers. Enhanced food safety training is essential to improve hygiene and protect students from foodborne illnesses.

1. Introduction

Foodborne diseases continue to pose a significant threat to the global health system and affect public health (1). Studies show that foodborne illnesses are widespread worldwide, yet only a small percentage of cases are reported due to a lack of surveillance systems (2),(1). According to the World Health Organization (WHO), about 600 million people, or nearly 1 in 10 people in the world each year, suffer from illness from consuming contaminated food, with developing countries being the most affected (3).

The food provided in schools has an important function, not only providing nutritious food but also meeting the aspect of being safe for consumption (4). Children or students are a population that is vulnerable to foodborne diseases because their immune systems have not developed optimally, so they are more susceptible to foodborne diseases (5),(6). Inadequate food safety practices in school catering services can lead to outbreaks of foodborne illnesses. Various studies have shown the need for better education and training for food handlers to ensure the safety of the food served to children

(6),(7). In Indonesia, many schools have provided in-house catering services but often need formal certification or adequate food safety training for food handlers. Food handlers can be a major source of contamination, especially if they carry pathogens such as *Staphylococcus aureus*, which can cause food poisoning (8). This condition increases the risk of food contamination by dangerous pathogens such as *Staphylococcus aureus*, which can lead to foodborne illness (5),(6).

Studies conducted in several cities in Indonesia found that more than 90% of foodborne diseases (FBD) are caused by microbiological contamination, including typhoid fever, bacterial/amoebic dysentery, botulism, and intoxication by other bacteria such as Listeriosis and Trikinelosis (11),(12). However, research focusing on uncertified internal school catering is still minimal, although food handlers in these neighborhoods play an important role in maintaining food safety and student health.

This research is important to fill the gaps in food safety regulations in uncertified school catering services. Children, as the most vulnerable group, are at great risk of being exposed to foodborne diseases if food safety practices are not carried out properly(13). The lack of formal training for food handlers in these schools will increase the potential for health hazards (14).

This study has offered a new approach by directly studying the relationship between food handler knowledge and behavior and the presence of *S. aureus contamination.* In addition, demographic factors such as age, gender, education, and food safety trai However, research specifically focusing on uncertified internal school catering is still very limited, although food handlers in these neighborhoods play an important role in maintaining food safety and student health. ning experience may affect food handlers' practices. Thus, this research is expected to provide real recommendations to improve food safety standards in schools.

2. Method

This cross-*sectional* design study recruited 150 food handlers who work in the internal catering service managed by the school. The research sample was 88 food handlers from 6 private schools in Semarang that had been selected through *the purposive sampling* method. The inclusion criteria include food handlers who work in catering services to provide student lunches, the school itself manages them, and those who have not received food safety certification. Food handlers who work in private school catering services are willing to be respondents. The exclusion criteria are food handlers who have received food safety certification.

A swab test was carried out to detect the presence of *S. aureus* bacteria on the hands of food handlers. Eighty-eight food handlers from the school's internal catering were assessed for the presence of *Staphylococcus aureus* on their hands. Specimens are collected using sterile swabs. Both hands were swabbed, and the samples were placed on Baird-Parker Egg Yolk Tellurite medium (LabM, Bury, United Kingdom), followed by aerobic incubation at 37°C for 48 hours. Typical colonies were then transferred to Mannitol Salt Agar (MSA; Pronadisa, Madrid, Spain) and incubated aerobically at 37°C for 24 hours. Presumptive *S. aureus* colonies on MSA (yellow colonies with yellow halos, Gram-positive, catalase-positive, coagulase-positive, and DNase-positive) were transferred to Agar Soy Tryptone (TSA; Pronadisa) before being stored at −80°C in Brain Heart Infusion (BHI; LabM) containing 30% glycerol.

Data Analysis

The data collected was analyzed using IBM SPSS 20 statistical software. Univariate analysis was used to describe the demographic characteristics of food handlers, their level of knowledge, behavior, and the presence of *S. aureus bacteria* on their hands. Bivariate analysis was carried out using *the Chi-square test* to identify the relationship between independent variables (knowledge, behavior of food handlers) and dependent variables (contamination of S. aureus). The presence of S. aureus bacteria was reported in the form of positive/negative results, as well as the percentage of contaminated food handlers.

Ethical Approval

This research has received approval from the research ethics committee with the number No: 578/EA/KEPK-FKM/2023. All participants were provided with complete information about the research objectives and their rights as research subjects.

3. Result

This study examines the relationship between food handlers' knowledge and behavior and the contamination of *S. aureus* bacteria in school catering services that provide lunch for students who have yet to be certified. Of the 88 food handlers tested, several findings showed significant differences between knowledge, behavior, and contamination risk.

Table 1. Frequency distribution of demographic characteristics, knowledge, the behavior of food handlers, and contamination of *S. aureus bacteria* in food (n = 88)

Characteristic	Frequency	Percentage
1. Age		
< 40 years	24	27.3%
> 40 tahun	64	72.7%
Total	88	100%
2. Gender		
Male	22	25 %
Female	66	75%
Total	88	100%
3. Long Term Employees		
< 4 Year	36	40.9%
>4 Year	52	59.1%
Total	88	100%
4. Training Experience		
Never Training	66	75%
Training	22	25%
Total	88	100
5. Knowledge of Food Handlers		
Bad	53	60.2%
Good	35	39.8%
Total	88	100
6. Handler Behavior		
Good	34	38.6%
Bad	54	61.4%
Total	88	100%
7. S. Aureus bacterial contamination		
Positif	21	23.9%
Negative	67	76.1%
Total	88	100%

Based on Table 1, the majority of the handlers were over 40 years old (72.7%) and female (75%). A total of 59.1% of handlers have been employed for more than 4 years, but only 25% have attended food safety training, indicating a lack of access to formal education on food hygiene.

According to Table 2, food handlers with good knowledge had a S. *aureus bacteria* contamination rate of 8.6% (3 out of 32 respondents). In comparison, handlers with less knowledge showed a contamination rate of 37.7% (20 out of 53 respondents). Although the difference was not very significant numerically, statistical analysis showed that there was a significant relationship between knowledge level and contamination risk (p = 0.005). These findings suggest that better knowledge is associated with a reduced risk of bacterial contamination. However, knowledge alone may not be enough to eliminate the risk of contamination, so it is necessary to measure another variable, namely the behavior of food handlers.

The next results were found in the behavior of food handlers. Handlers with good behavior had an S. *aureus bacteria* contamination rate of 11.8% (4 out of 34 respondents), while those with poor behavior showed a much higher level of contamination at 33.3% (19 out of 54 respondents). This difference was statistically significant (p = 0.043), which suggests that good hygienic behavior is very effective in reducing the risk of contamination. Proper behavior, such as regular handwashing and separating raw foods from ready-to-eat foods, clearly has a greater impact on food safety than knowledge alone. Figure 1 shows evidence of findings in this study, namely *S. aureus* bacteria on the hands of food handlers.

Table 2. Bivariate Analysis

Variable	Kontaminasi S.Aureus				Total		PR (95% CI)	*P Value*
	Negatives		Positif		N	%		
	N	%	N	%	N	%		
Food Handlers Knowledge								
Good	32	91.4%%	3	8.6%	35	100%	1.468 (95%CI:1.163-1.853)	0.005
Bad	33	62.3%	20	37.7%	53	100%		
Total	65	73.9%	23	26.1%	88	100%		
Food Handler Behavior								
Good	30	88.2%	4	11.8%	34	100%	1.361 (95%CI:1.080-1.761)	0.029
Bad	35	66.7%	19	33.3%	54	100%		
Total	65	73.9%	23	26.1%	88	100%		

Figure 3. S. aureus (+) colony on MSA media

4. Discussion

This study examined the relationship between food handlers' knowledge and behavior and *Staphylococcus aureus bacteria* contamination on their hands. These results provide a realistic picture of how food handlers' daily knowledge and behavior impact food safety and student health in school catering services.

The results of the study found that food handlers with good knowledge showed a contamination rate of S.aureus is lower, at only 8.6% (3 out of 35 respondents). On the other hand, food handlers in the lack of knowledge category had a contamination rate of 37.7% (20 out of 53 respondents). Although the difference was not very large, a value *of p*=0.005 indicated that better knowledge was associated with a lower risk of contamination. This study is supported by previous research that the presence of *S. aureus* is significant among food handlers; namely, 37.5% of food handlers in one study are carriers of S. aureus, with 39.4% of these isolates producing enterotoxin, which is very important in causing foodborne illness. Another study found that 32% of food handlers were carriers of *S. aureus* (15). This contamination generally occurs through contact with the habit of holding the nose and from the hand of the toucher (8).

Adequate knowledge of food safety plays an important role in reducing contamination, as supported by previous research, which found that food handlers who had good category knowledge tended to pay more attention to hygiene when processing food (16). However, differences in contamination levels between the two groups suggest that knowledge alone may not be enough, so more thorough interventions are needed to improve food safety practices in the field (17). Although the level of knowledge about food safety among food handlers is good, there often needs to be a significant gap between actual knowledge and practice. For example, in a study conducted in Turkey, food handlers scored high in knowledge of food safety. However, a large number of hand samples were contaminated with pathogens, including *S. aureus*(18).

Food handler behavior also plays an important role in increasing the risk of S. aureus contamination. Food handlers with good hygiene behavior had a much lower level of *S. aureus* contamination at 4.6% (3 out of 35 respondents) compared to food handlers with poor hygiene behavior, where the contamination rate reached 33.3% (19 out of 54 respondents). *P value* = 0.029 shows a significant relationship between good behavior and low risk of contamination. Hand hygiene practices are one of the most important behaviors in reducing the number of bacteria on the hands of food handlers. Proper handwashing habits and maintaining hand hygiene can reduce the risk of S. aureus contamination from hands to food (19–21).

Previous research has also shown that *S. aureus bacteria* contamination generally occurs through direct contact with the nose or hands, where the bacteria are often found on human skin(22). Several studies noted a significant prevalence of S. aureus among food handlers, with one study suggesting that 37.5% of food handlers carried *S. aureus bacteria*, and 39.4% of these isolates produced enterotoxin, which can lead to food contamination (8). Another study found that 32% of food handlers were also carriers of *S. aureus bacteria* (23). This study emphasizes the importance of implementing strict hygiene practices among food handlers to prevent contamination.

The harm posed by S. aureus is mainly due to the ability of this bacterium to produce an enterotoxin, which causes symptoms such as nausea, vomiting, diarrhea, and stomach cramps (24). These enterotoxins are resistant to heat, so even if the food has been reheated, the toxins can still survive and cause food poisoning. These enterotoxins are particularly worrying in school settings where vulnerable students are more at risk of severe gastrointestinal symptoms due to contamination (25)(26).

The findings of this study indicate that while knowledge about food safety is important, consistent hygiene behavior in the field has a greater impact on food safety. Therefore, food safety training programs should emphasize strengthening hygiene behavior, not just theory.

Continuing education and hands-on training are essential to improve food safety practices. Other studies show that while training can improve knowledge, it does not always result in significant behavioral changes in hygiene practices (27). A more comprehensive and interactive training program, which includes simulated field practices and regular evaluations, can help reduce the gap between knowledge and practice in the field.

Regular training and continuous monitoring of food handlers are hoped to reduce the risk of foodborne diseases and protect the health of students, the most vulnerable group (28)(29).

5. Conclusion

This study found a significant relationship between food handlers' knowledge and behavior and *Staphylococcus aureus bacteria* contamination in uncertified school catering. Handlers with good hygienic behavior have a lower risk of contamination, but consistent behavior in daily practice is more important than knowledge alone. A comprehensive and sustainable food safety training program is indispensable to reduce the risk of contamination and protect the health of vulnerable students.

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