

Factors Associated with the Presence of Bacteria (Escherichia Coli) in Food at Elementary Schools in Kota Baru District in 2025

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Abstract

Introduction: Food safety in elementary schools is essential to protect the health of school-aged children. One important indicator of food contamination is the presence of *Escherichia coli* bacteria, which reflects inadequate hygiene and sanitation practices. Personal hygiene of food handlers and environmental sanitation conditions play a crucial role in determining the microbiological safety of snack foods sold in schools. **Objective:** This study aimed to analyze factors associated with the presence of *Escherichia coli* in snack foods sold at elementary schools in Kota Baru District in 2025. **Methods:** This study employed a quantitative research design with a cross-sectional approach involving 45 food handlers. Data analysis was conducted using univariate and bivariate analyses with the Chi-square test. **Results and discussion:** Microbiological examination showed that 9 food samples (20.0%) were contaminated with *Escherichia coli*. Most food handlers demonstrated poor personal hygiene (66.7%) and inadequate environmental sanitation (71.1%). Statistical analysis revealed a significant association between personal hygiene and the presence of *Escherichia coli* ($p = 0.020$), as well as between environmental sanitation and bacterial contamination ($p = 0.042$). Better hygiene practices and adequate sanitation were associated with lower contamination risk. **Conclusion:** Personal hygiene of food handlers and environmental sanitation are significantly associated with *Escherichia coli* contamination.

How to Cite

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Introduction

Food plays a crucial role in sustaining life, as the quality of food consumed directly impacts an individual's health and nutritional status. Every year, billions of people worldwide are exposed to the risk of consuming unsafe or unsuitable food, ultimately triggering millions of illnesses and causing thousands of deaths. (Clousa, 2022). Snacks sold in school areas are highly popular among children (Sanjaya et al., 2024); (Susilowati et al., 2022). However, these foods carry a significant risk of exposure to biological and chemical contaminants that may negatively affect health in both the short and long term (Indra Trigunarto, 2020).

Food serving must be done by paying attention to the cleanliness of the behavior of the server and environmental conditions that meet the requirements of clean sanitation from insects and vectors that can be a nuisance (Ismainar et al., 2022). Individual hygiene among food handlers involves maintaining personal cleanliness and safe food handling behavior (Prasetyo & Khoiriani, 2023). Poor hygiene practices, such as smoking or talking while preparing food, using unclean utensils, leaving food uncovered, and operating in dusty environments with unsafe water sources, increase the risk of microbial contamination. These conditions pose health risks to elementary school students, whose immune systems are relatively vulnerable (Padilah et al., 2024). Foodborne illnesses are primarily caused by contamination with harmful microorganisms. Symptoms range from mild gastrointestinal disturbances to severe, life-threatening conditions (Hamidah et al., 2025). Another factor that influences the emergence of this disease is the level of individual awareness regarding the importance of maintaining food hygiene, both for personal health and for the surrounding environment (Isni et al., 2023).

Data collected by the World Health Organization (WHO) states that approximately 600 million cases of foodborne illness occur annually, and that consumption of unsafe food causes approximately 2 million deaths annually, especially among children. This food contains toxins, viruses, bacteria, and chemical additives. This disease causes 1 in 10 people to die from consuming contaminated food. In 2020, street food contributed 42 times more cases of food poisoning, or 14.4 percent of the total cases. According to the Food and Drug Monitoring Agency (BPOM), Indonesia experiences approximately one million cases of food poisoning each year (Sari et al., 2025). One of the world's biggest public health problems is infection caused by the bacterium *Escherichia coli*. According to data from the World Health Organization (WHO), *E. coli* is the leading cause of foodborne diarrhea, with the prevalence of infection reaching more than 1.4 million cases annually worldwide. (Mawarti, 2025).

Previous studies indicate that street foods sold without adequate protection are susceptible to contamination by bacteria such as *Staphylococcus aureus*, *Escherichia coli*, *Bacillus cereus*, and *Pseudomonas aeruginosa*, which can cause gastrointestinal infections and food poisoning (Sholehah & Rukaya, 2025). The Ath Thoriqoh study in Cakung, East Jakarta, found that 45% of school snack samples were contaminated with *E. coli*, with significant associations between contamination and unhygienic serving utensils (OR=5.00; p=0.044), improper storage (OR=6.11; p=0.007), and poor serving methods (OR=7.14; p=0.002) (Thoriqoh et al., 2020).

Based on Sulastri's 2023 research, reported that 93.1% of salted fish samples tested positive for *E. coli*, with sanitation and personal hygiene significantly influencing contamination (Ni Wayan Sulastri et al., 2023). In the research of Ramdaniati & Sasmita (2023) at the Merak Harbor Restaurant, it was emphasized the importance of the

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knowledge and education variables of food handlers, where even though 50% of samples were contaminated with *E. coli*, some traders had low knowledge (56.2%) and inadequate personal hygiene (34.8%), with a significant relationship between personal hygiene and the presence of bacteria ($p=0.006$). (Ramdaniati & Sasmita, 2024). Health data from Jambi City show dynamic trends in diarrhea cases from 2022 to 2024. Reported cases decreased slightly from 3,360 in 2022 to 3,152 in 2023 but sharply increased to 7,012 in 2024. Data from Kota Baru District indicate rising cases in both Paal V and Paal X areas, suggesting potential environmental sanitation risk factors requiring intervention

Initial field observations revealed that many food handlers around elementary schools did not meet recommended hygiene standards. Vendors often neglected equipment sanitation, failed to cover food, and did not wash hands before serving. Sales areas were also observed to lack adequate sanitation facilities. These conditions increase the risk of food contamination and related illnesses among students. Based on these findings, this study aims to analyze factors associated with the presence of *Escherichia coli* in food sold around elementary schools.

Method

This study employed a quantitative observational analytic design with a cross-sectional approach to examine the association between personal hygiene and environmental sanitation conditions and the presence of *Escherichia coli* in elementary school snack foods in Kota Baru District. The study was conducted from September to December 2025 in elementary schools within the district. The study population consisted of 60 food vendors operating in elementary schools, from which 45 vendors were selected using purposive sampling based on predefined inclusion and exclusion criteria. Data on personal hygiene and environmental sanitation were collected through structured questionnaires and direct observation using standardized observation sheets, while the presence of *E. coli* was determined through laboratory analysis of food samples. Laboratory testing involved aseptic sample collection, enrichment using Brain Heart Infusion media, cultivation on MacConkey Agar, and confirmation through IMViC biochemical tests. Data analysis included univariate analysis to describe the study variables and bivariate analysis using the chi-square test with a 95% confidence level ($\alpha = 0.05$) to assess associations between variables. Ethical principles were applied throughout the study, including informed consent, anonymity, and confidentiality of respondents' data.

Result and Discussion

1. Result

In this study, the respondents were food handlers who sold food in elementary school areas within Kota Baru District, totaling 45 respondents. The distribution of respondent characteristics is presented in the following table:

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Table 1
Characteristics of the Respondent

No.	Respondent Characteristics	Frequency	Percentage (%)
1	Age		
	≤ 25 years	4	8.9
	26-45 years	28	62.2
	≥ 46 years	13	28.9
2	Gender		
	Male	3	6.7
	Female	42	93.3
3	Education		
	Elementary School	7	15.6
	Junior High School	7	15.6
	Senior High School	30	66.7
	Higher Education	1	2.2
	Total	45	100.0

Source: Processed primary data, 2026.

Based on Table 1, the characteristics of the 45 respondents are described by age, gender, and education level. Most respondents were aged 26–45 years (62.2%), followed by those aged ≥46 years (28.9%), while the smallest proportion was ≤25 years (8.9%). The majority of respondents were female (93.3%). In terms of education, most respondents had completed senior high school or vocational education (66.7%), whereas only a small proportion had attained higher education (2.2%).

The distribution of respondents according to the study variables, including *Escherichia coli* presence, personal hygiene, and environmental sanitation, is shown in Table 2.

Table 2
Distribution of Respondents by Variable

No	Category	Frequency (n)	Percentage (%)
1	Escherichia coli Presence		
	Present	9	20.0
	Absent	36	80.0
2	Personal Hygiene	45	100.0
	Poor	30	66.7
	Good	15	33.3
3	Environmental Sanitation	45	100.0
	Poor	32	71.1
	Good	13	28.9
	Total	45	100.0

Source: Processed primary data, 2026.

Based on Table 2, most food samples were free from *Escherichia coli* (80.0%), while 20.0% showed contamination. In addition, the majority of respondents had poor personal hygiene (66.7%) and inadequate environmental sanitation conditions (71.1%).

Bivariate analysis was conducted to examine the association between personal hygiene and environmental sanitation with the presence of *Escherichia coli* in foods sold

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at elementary schools in Kota Baru District, Jambi. The results of the analysis are presented in Tables 3 and 4.

Table 3

Association Between Personal Hygiene and the Presence of *Escherichia coli* in Food

Personal Hygiene	Presence of <i>Escherichia coli</i>						P-Value	PR (95%CI)
	Present		Absent		Total			
	n	%	n	%	n	%		
Poor	9	30.0	21	70.0	30	100.0	0.020	0.700 (0.544- 0.885)
Good	0	0.0	15	100.0	15	100.0		
Total	9	20.0	36	80.0	45	100.0		

Source: Processed primary data, 2026.

Based on Table 3, food samples handled by respondents with poor personal hygiene showed a higher proportion of *Escherichia coli* contamination (30.0%) compared to those with good personal hygiene, in which no contamination was detected. Statistical analysis showed a significant association between personal hygiene and the presence of *E. coli* in food ($p = 0.020$), indicating that good personal hygiene was associated with a lower risk of contamination.

Table 4

Association Between Environmental Sanitation and the Presence of *Escherichia coli* in Food

Environmental Sanitation	Presence of <i>Escherichia coli</i>						P-Value	PR (95%CI)
	Present		Absent		Total			
	n	%	n	%	n	%		
Poor	9	28.1	23	71.9	32	100.0	0.042	0.719 (0.579- 0.893)
Good	0	0.0	13	100.0	13	100.0		
Total	9	20.0	36	80.0	45	100.0		

Source: Processed primary data, 2026.

As shown in Table 4, *Escherichia coli* contamination was more frequently found in food samples from vendors with poor environmental sanitation (28.1%), while no contamination was detected among vendors with good environmental sanitation. The chi-square test indicated a statistically significant association between environmental sanitation and the presence of *E. coli* ($p = 0.042$), suggesting that adequate environmental sanitation reduces the risk of food contamination.

2. Discussion
Escherichia Coli

A study conducted on food handlers selling food at an elementary school in Kota Baru District, Jambi City, in 2025 showed that 9 (20.0%) of all respondents in food samples sent to the laboratory for *Escherichia coli* testing contained *E. coli*, while 36 (80.0%) did not. Based on Ayuning Setiara et al.'s (2024) study on School Children's Snacks (PJAS), *Escherichia coli* bacteria were found to potentially contaminate meatball skewers sold in schools. This study, conducted by researchers from Medan State University, examined various previous studies in Indonesia relevant to the period 2018–2024. The results indicated that the presence of *E. coli* in meatball skewers is generally caused by unhygienic processing and serving practices, such as the use of contaminated

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water, poor hygiene of processing equipment, and substandard sanitation in the sales environment. *E. coli* was found to function as an indicator of fecal contamination, so its presence indicates that the food poses a risk of causing health problems, especially diarrhea in school children.(Setiara et al., 2024)

Based on research conducted by Pramono et al. (2020), a risk of *Escherichia coli* bacterial contamination was found in pempek food produced by household industries and food processing factories. This research was conducted in Samarinda City, East Kalimantan Province, using laboratory examinations. The research sample consisted of 20 boiled pempek consisting of 10 household production samples and 10 factory production samples. The examination results showed that most of the pempek samples experienced high microbiological contamination, where 18 of the 20 samples (90%) did not meet SNI quality standards. The presence of *Escherichia coli* in the pempek was used as an indicator of the quality of hygiene and sanitation of the production process, which indicates the still low implementation of hygiene and sanitation in the processing, storage, distribution, and serving stages of pempek, this condition has the potential to cause health problems, especially diarrhea.(Pramono et al., 2020)

Personal Hygiene

The results of the research that has been conducted that the personal hygiene of food handlers in elementary schools in Kota Baru sub-district from 45 respondents, the majority of respondents have poor personal hygiene, as many as 30 people (66.7%), while respondents who have good personal hygiene are 15 people (33.3%). The univariate results of the frequency of the research questionnaire obtained that each question showed results of more than 50% doing it, this makes those who have direct contact with food handlers have met the requirements such as questions in good health, using head coverings/hairnets, short nails, always washing hands, not wearing jewelry, when processing not smoking, sneezing, spitting carelessly, chewing food, scratching limbs, undergoing health checks and having received counseling on ready-to-eat food safety. Questions below 50% such as the use of aprons, masks, taking food using gloves or tools. To support good practices to form correct personal hygiene behavior, there is a need for facilities that support the hygiene of handlers, such as hand washing facilities and soap, complete personal protective equipment/PPE (aprons, hair coverings, masks, and gloves), this is supported by the regulation of the Indonesian Minister of Health Decree No. 942/MENKES/SK/VII/2003. (Minister of Health of the Republic of Indonesia, 2003).(Menteri Kesehatan Republik Indonesia, 2003)

Based on the results of the bivariate analysis using the Chi-Square test, a p-value of 0.020 ($p < 0.05$) was obtained, indicating a significant relationship between personal hygiene of food handlers and the presence of *Escherichia coli* in food at elementary schools in Kota Baru District, Jambi City in 2025. Food samples from food handlers with poor personal hygiene were still found to be contaminated with *Escherichia coli*. Conversely, all food samples from handlers with good personal hygiene were free of *Escherichia coli*. The prevalence ratio (PR) value of 0.700 with a 95% confidence interval (0.544–0.885) indicates that good personal hygiene is protective against the presence of *E. coli*. This means that food handlers with good personal hygiene have a lower risk than those with poor personal hygiene. These results indicate that individual food handler hygiene plays a crucial role in preventing food contamination. Hands, nails, and food

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handler behavior can be the primary means of bacterial transmission. Therefore, personal hygiene is a key factor in the food safety of school snacks.

Research conducted by Azzahra et al. (2024) showed a relationship between personal hygiene of food handlers and the presence of *Escherichia coli* bacteria. Based on laboratory examinations of 11 food samples sold in the Terusan Ambarawa area of Malang City, 10 samples (90.9%) were found to not meet the *Escherichia coli* quality standards stipulated in the 2023 Minister of Health Regulation. Statistical analysis using the chi-square test showed a p-value of 0.012, indicating a significant relationship between personal hygiene practices and *Escherichia coli* contamination. This indicates that poor personal hygiene of food handlers has the potential to increase the risk of bacterial contamination in consumed food.(Azzahra et al., 2024) Candraning Diyanah et al. (2021) showed that not all aspects of food handlers' personal hygiene were significantly related to the presence of *Escherichia coli*. The study found that although personal hygiene is an important factor, the presence of *E. coli* is also influenced by other factors such as food processing, raw material quality, and environmental conditions. Good personal hygiene does not necessarily guarantee the absence of bacterial contamination in food. The study showed that food handlers' knowledge and education played a greater role in determining food quality than personal hygiene. This indicates that individual hygiene needs to be supported by a proper understanding and behavior in food processing.(Diyanah et al., 2021)

Environmental Sanitation

The research results showed that 32 of the 45 respondents (71.1%) reported inadequate environmental sanitation, while 13 (28.9%) reported good personal hygiene. Bivariate analysis using the Chi-Square test between environmental sanitation and the presence of *Escherichia coli* bacteria showed a p-value of 0.042 ($p < 0.05$). This indicates a significant relationship between environmental sanitation and the presence of *E. coli* bacteria in street food at elementary schools in Kota Baru District, Jambi City, in 2025. Food samples from respondents with poor environmental sanitation were still contaminated with *Escherichia coli* bacteria. Conversely, no *Escherichia coli* was found in any food samples from respondents with good environmental sanitation.

The prevalence ratio (PR) of 0.719 with a 95% confidence interval (0.579–0.893) indicates that good environmental sanitation is protective against the presence of *E. coli* bacteria. This means that respondents with good environmental sanitation had a lower risk than those with poor environmental sanitation. Environmental sanitation includes the provision of clean water, waste management, waste disposal, and vector control. If these aspects are not met, the risk of bacterial contamination will increase. This demonstrates the importance of a clean environment in maintaining food safety.

This research is supported by Hidayati (2021), who found that not all aspects of environmental sanitation were significantly associated with the presence of *Escherichia coli* bacteria. In that study, the variable of trash bins did not show a statistically significant relationship with *E. coli* contamination. This suggests that although environmental sanitation plays a crucial role, its influence on bacterial presence depends on conditions and other contributing factors.(Hidayati, 2022) Based on research conducted by Safira et al. (2023) at SDN 70 Banda Aceh, it can be seen that environmental sanitation conditions are related to the presence of *Escherichia coli* bacteria in school snacks. The results of the study showed that all beverage samples sold in the school environment were

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contaminated with E. coli bacteria, while no contamination of the food samples was found. This finding indicates that environmental sanitation, especially related to the cleanliness of water, equipment, and beverage sales locations, plays a significant role in the occurrence of bacterial contamination. Thus, environmental sanitation that does not meet health standards can increase the risk of E. coli presence, so efforts to improve hygiene and sanitation are needed to ensure the safety of snacks for students. (Safira, 2023)

Conclusion

This study concludes that personal hygiene and environmental sanitation are significantly associated with the presence of Escherichia coli in foods sold at elementary schools in Kota Baru District, Jambi. Food handlers with poor personal hygiene showed a higher proportion of E. coli contamination (30.0%) compared to those with good personal hygiene, in which no contamination was detected ($p = 0.020$; PR = 0.700; 95% CI: 0.544–0.885). Similarly, inadequate environmental sanitation was associated with a higher occurrence of E. coli contamination (28.1%), whereas no contamination was found in foods handled under good sanitation conditions ($p = 0.042$; PR = 0.719; 95% CI: 0.579–0.893). These findings imply the need for strengthened hygiene education for food handlers, routine sanitation inspections, and stricter enforcement of food safety standards in elementary school environments to prevent foodborne diseases and protect children's health.

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